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TABLE OF CONTENTS

EXECUTIVE SUMMARY vi

I. INTRODUCTION 1

PART ONE INFANT MORTALITY IN KING COUNTY: AN OVERVIEW

II. TRENDS IN INFANT MORTALITY 9

III. RACE/ETHNICITY AND INFANT MORTALITY 28

IV. REGIONAL VARIATION IN INFANT MORTALITY WITHIN KING COUNTY 39

PART TWO INFANT MORTALITY IN KING COUNTY: CASE BY CASE REVIEW

V. CASE REVIEW METHODS 47

VI. FACTORS CONTRIBUTING TO INFANT DEATHS IN KING COUNTY: SUMMARY OF THE CASE-BY-CASE REVIEW 53

VII. SOCIOECONOMIC AND BEHAVIORAL ISSUES IDENTIFIED THROUGH INFANT DEATH REVIEW 66

VIII. IMPROVING SUPPORT SERVICES FOR PREGNANT WOMEN AND INFANTS 83

IX. IMPROVING CARE DURING LABOR AND DELIVERY 98

X. RECOMMENDATIONS 110

APPENDIX A 118

APPENDIX B SUPPLEMENTAL TABLES 134

EXECUTIVE SUMMARY

The infant mortality rate is a fundamental indicator of a community's health and well-being. Few events are as tragic as the death of an infant. This report is the product of the Infant Mortality Review. It summarizes trends in infant mortality in King County, describes factors contributing to infant deaths and suggests strategies for preventing these deaths in the future. The report draws upon two major sources of information: birth and death certificates and the findings of a case-by-case detailed review of all infant deaths occurring between 1992-1994. The key findings of the report include:

- The infant mortality rate in King County in 1994 (the most recent year for which data are available) was 6.3 per 1000 live births. Provisional data shows that the infant mortality rate for King County in 1995 was 5.6 per 1000 live births. The 1994 Seattle rate was 4.8 per 1000, the Washington rate was 6.2 per 1000 and the United States rate was 7.9 per 1000.

- The infant mortality rates in King County and Seattle have declined substantially since 1980, especially since the late 1980s. In the County, the rate decreased by 40 percent since 1980 and in Seattle, by an even greater 63 percent. Since 1988, the county rate has decreased by 30 percent and the city rate by 61 percent.

- The leading causes of infant death were premature births, medical complications during and after birth, congenital anomalies and SIDS (Sudden Infant Death Syndrome). The declining SIDS rate was the largest contributor to the reduction in overall infant mortality.

- Several factors have contributed to the decrease in infant deaths:
    - A decline in risk factors for infant mortality as measured by vital statistics data, including inadequate prenatal care, tobacco and alcohol use, teen births and unmarried parents

    - Appreciation of the association of prone (on the stomach) infant sleeping position and SIDS, leading to changes in infant sleep position

    - Advances in the delivery of health and social services to pregnant women and infants, including expansion of Medicaid eligibility, the First Steps program, outreach efforts to pregnant women and families with infants, a community system of screening and referral to facilitate pregnant women getting prenatal care and increased public health nurse home visits

    - Important advances in the care of sick newborns such as the use of the medication surfactant, improvements in neonatal intensive care and better treatments for infants born with congenital anomalies.

  Infant mortality and risk factors for infant death remained associated with poverty, although poverty may have become less influential in recent years. The rate of infant death has declined substantially in high poverty areas of the county since the mid 1980s. During the 1984-86 period, infants living in high poverty areas had an infant mortality rate twice that of infants living in low poverty tracts. By the 1992-94 period, the rate in the high poverty areas was only 1.4 times higher.

- African and Native Americans remained at higher risk of dying as infants, but the gap between their infant mortality rates and that of whites diminished substantially. The ratio between African American and white rates reached a peak of 3.1 in the 1988-1990 period and then declined to 1.9 by the 1992-1994 period. The infant mortality gap between African Americans and whites decreased from 13.9 to 5.0 per 1,000 births. While African Americans continue to experience higher rates of risk factors for infant death than whites, the differences have decreased since 1990.

- The infant mortality rate during the 1992-94 period was significantly higher in the South Seattle and South County regions than in the North Seattle and North/East County regions. The South County rate stopped declining in recent years while the other regions continued to show improvements. As a result of these divergent trends, the South Seattle, whose rate was 62% higher than South County's in the 1986-88 period, reached parity with South County by 1992-94. In particular, South County lagged behind in a reduction in deaths due to SIDS and prematurity. South Seattle showed impressive improvements in its SIDS death rate.

- Among small areas within the county, infant mortality rates in Central and Southeast Seattle were 1.8 and 1.6 times higher than the county rate. They were the only areas to significantly exceed the county average during the 1990-1994 period.

- The case-by-case review examined 247 cases between 1992-1994 and identified factors which contributed to death in 49 percent of them. Factors considered highly important in causing the death and highly modifiable were present in 29 cases (12 % of all those reviewed). The Review has considered factors associated with inadequate support services, medical care during labor and delivery, and infant sleep conditions in detail. Future work will focus on the areas of preterm labor, access to prenatal care, medical care of the infants, and maternal substance abuse.

- The review of cases with inadequate support services during pregnancy revealed instances of:
    - Lack of referral of high risk clients to public health nurses or CPS (Child Protective Services) for evaluation and follow-up
    - Inadequate case tracking and follow-up by public health nurses
    - Poor coordination and lack of appropriate cross-referrals between multiple service providers, especially between CPS and public health nurses
    - Lack of referral to prenatal care and inadequate follow-up to assure receipt of prenatal care
    - Failure of CPS to remove infants from families that were unable to care for them and premature return of infants to families prior to rehabilitation
    - Administrative problems with CPS case management, including lack of coordination between CPS and Child Welfare System, poor internal CPS communication and inadequate supervision of case workers
    - Lack of screening, appropriate treatment options and monitoring of CPS contracts for substance-abusing pregnant and parenting women

- Case review generated concerns about the medical care received by some mothers or infants during labor and delivery, including:

- Delay or lack of maternal transfer to a hospital capable of providing an appropriate level of care despite clear indications of the need for transfer
- Delay in arrival of pediatric care provider or delay in notifying pediatric care provider of the need for attendance at delivery
- Problems with electronic fetal monitoring during labor such as inadequate monitoring or failure to recognize or act on signs of fetal distress detected by monitoring
- Technical errors in medical procedures, including lack of early recognition of herpes simplex and group B streptococcus infections and inadequate resuscitation of compromised newborns

- Examples of modifiable unsafe sleeping conditions included broken cribs and dangerous non-crib sleep locations (e.g. crowded adult bed, soft sofa with pillows, adult bed with dry-cleaning bags)

- Other highly important and highly modifiable conditions included:
  - failure to seek necessary medical care
  - social factors, such as placing excessive workplace physical demands on pregnant women, substance abuse, crowded housing and other poverty-related factors
  - medical problems, such as infections during pregnancy, incompetent cervix, obstetrical complications (e.g. prolonged second stage of labor)
  - inadequate number and delayed onset of prenatal visits
  - lack of patient education on symptoms of preterm labor, child safety, and CPR

- The Review also identified social, economic and behavioral issues which, while not directly contributing the deaths among the cases examined, were noteworthy for their potential to cause adverse consequences for mothers and infants. These issues included low income, lack of social support, stress, domestic relationship problems, housing problems, unemployment, lack of transportation, child abuse, substance abuse, unplanned pregnancies, underdeveloped parenting skills and unsafe home conditions.

CONCLUSIONS

The infant mortality rate in King County has entered a period of rapid decline. The encouraging trend may be explained by reductions in risk factors for infant death through expanded health services for pregnant women, advances in medical care and changes in infant sleep position. The infant mortality gap between African Americans and whites has diminished, although both African and Native Americans continue to experience higher rates of infant mortality and risk factors for infant death. The improvements in infant mortality have not been uniform across the regions of King County; South Seattle has made impressive gains in recent years while South County has lagged behind.

Further progress in reducing infant deaths will come from collaborative work from many sectors of our community. Strategies should focus on assuring access to prenatal care and maternity support services, reducing substance abuse, improving coordination of services by multiple providers, assuring comprehensive follow-up of high-risk clients, improving the quality of medical care during labor and delivery, and strengthening the capacity and accountability of CPS to protect infants.

CHAPTER I. INTRODUCTION

Infant mortality is a major public health concern, both nationally and in King County, Washington. The slow rate of decline in infant mortality in King County between 1984 and 1988, and the persistent disparity between rates among whites and African Americans, led the Seattle-King County Department of Public Health to establish an infant mortality review in 1992. The main goals of the review were to establish a system to monitor infant deaths and identify factors that contribute to infant deaths and can be changed.

This is the first report of the findings of the review. It is divided into two major parts. Part One provides an overview of trends in infant mortality from 1980-1994 using statistical data from birth and death certificates. Part Two contains provides more detailed information from a case-by-case review of 247 infant deaths occurring between 1992-1994.

THE SIGNIFICANCE OF INFANT MORTALITY

Infant death remains one of the largest components of mortality from birth into adulthood. Few life experiences are as tragic as the death of a loved child. The sense of loss that families experience is one of the main reasons why infant mortality continues to command such intense public attention and general public sympathy.

A community's infant mortality rate is a fundamental indicator of its health and well-being. As such, it is not only an important health measure but also an intensely political indicator. The infant mortality rate in the United States ranks among the highest of any industrialized nation. A child born in Japan, Finland, Hong Kong, Ireland, Australia, Canada, Singapore or one of twelve other industrialized nations has a better chance of surviving his or her first year than a child born in the United States.[1] Furthermore, the United States ranked 24th among the nations of the world in 1988, with an infant mortality rate of 10 per thousand live births. The African-American rate for the same year was 17.6 compared to a rate of 8.5 for whites. The National Commission to Prevent Infant mortality has estimated that at least half of these 40,000 deaths per year were preventable.

WHY AN INFANT MORTALITY REVIEW?

In 1988, the United States Public Health Service proposed that communities develop local reviews of infant deaths as a specific strategy to reduce infant mortality rates. This approach featured a community-specific examination of a broad array of social, economic, public health, behavioral, administrative, educational, environmental and health and social service systems factors related to maternal and child health. Policy makers recognized that economic, social, and environmental forces as well as limited access to health care were important factors that had an impact on infant health, a hypothesis supported by the scientific literature. Socioeconomic characteristics, such as low income [2 3 4 5 6] and fewer years of parental education [7 8] had been shown to be associated with higher infant mortality rates. Similarly, smoking and substance abuse had been strongly associated with elevated rates.[9 10 11 12 13 14] Inadequate use of and lack of access to health care,[15 16 17 18 19 20 21] stress, [22 23] and lack of social support [24] had been shown to increase low birthweight and prematurity, both of which are major causes of infant mortality. A lack of understanding of risk factors and interventions for Sudden Infant Death Syndrome (SIDS) and prematurity, the most common causes of infant death, frustrated efforts to decrease infant mortality.

At the same time, concern regarding infant deaths was growing in King County, Washington. Improvements in the infant mortality rate slowed or ceased during the mid 1980s.[25] The large disparity between the number of deaths of African American and white infants also increased during this time period.

While the traditional approach of analyzing data from vital records provided a great deal of information about infant mortality, it also left unanswered many questions that could only be addressed through the systematic evaluation of individual cases at the local level. Autopsy reports have added some additional information, but classification of infant deaths with such restricted information has offered limited insight into the prevention of infant deaths. Therefore, the review established an on-going system for conducting detailed case review of infant deaths. By collecting information from interviews with the caretakers of infants who died and by reviewing medical and social service records, a fuller picture emerged. In addition to examining the more traditional biological risks for infant death, this additional information facilitated identification of factors associated with the delivery of health and human services, inadequate social support for pregnant women and families, stress, substance abuse and poverty.

The Seattle-King County Department of Public Health's infant mortality review was comprised of two parts: the case review and the case-control study. The case review included systematic evaluation of individual infant deaths by an interdisciplinary team which confirmed the infant's cause of death and identified factors that had contributed to his or her death. The team then developed recommendations for addressing the modifiable contributing factors with the intention of reducing the occurrence of these factors in order to prevent future deaths.

Case review alone can suggest that a particular factor may have been related to infant death. However, the likelihood that a factor did indeed contribute to the deaths is greater if it can be shown that the factor occurred more often among infants who died than among those who survived. The project therefore collected information on a group of infants who survived infancy (control group) and compared them to those who died (case group), using the epidemiological tool of case-control analysis. The results of this analysis will be presented in a future report.

HOW TO READ THIS REPORT

This report uses a number of epidemiological methods and technical terms to analyze data on infant mortality. The following definitions and explanations will assist the reader in studying this report.

Epidemiology: The study of the distribution and determinants of health conditions in a specified population and the application of this study to the control of health problems.[26]

Infant Mortality Rate: The infant mortality rate is the number of live born infants who die before reaching their first birthday in a given year, for every 1,000 infants born alive in that year.

Low Birthweight: A newborn weighing less than 2,500 grams (5.5 pounds) is considered to be low birthweight.

Preterm/Premature Birth: The average pregnancy lasts 40 weeks. An infant born at less than 37 weeks gestation is considered premature or preterm. The gestational age of a newborn is calculated as the interval between the newborn's date of birth and the first day of the mother's last menstrual period before she conceived.

Rate Per 1,000: Using the infant mortality rate as an example, this is the total number of infant deaths occurring within a population (such as King County), during a specified time period (usually a year), divided by the total population (all live births in King County) during the same time period, and then multiplied by 1,000. The resulting rate is the number of events occurring in a group of 1,000 members of the population being described.

Rolling Averages: For populations of small size, small changes in the number of events can cause large fluctuations in rates, making year-to-year changes difficult to interpret. To help stabilize the rate for the examination of a time trend of an event, the rates are aggregated into "rolled" averages (such as in 3 or 5 year intervals) across the total observed period. For example, if there is a highly fluctuating rate caused by low numbers of events for years 1987 through 1992, the rates are instead reported as three-year rolling averages: 1987 to 1989, 1988 to 1990, 1989 to 1991, 1990 to 1992. Each set of three year averages includes a higher number of cases than a single year, and thus smoothes out random year-to-year fluctuations. A disadvantage of rolling averages is that they can make it hard to see the beginning of recent trends. We always look at year-by-year trends before computing rolling averages to ensure they accurately reflect the data.

Significant Trend: Epidemiologists use a statistical test called the chi-square test to see whether a change in a rate is statistically significant. A significant trend indicates that the change in a rate is not random and that an increase or decrease is likely to be occurring in a population. Trend tests are always applied to year-by-year trends, not rolling averages. The significance level used for a significant trend is $p < 0.05$.

Relative Risk/Odds Ratio: The relative risk is the ratio between rates for two different groups. For example, if the infant mortality rate for African Americans is 20 per 1,000 live births and that for whites is 10 per 1,000, then the rate ratio is 20/10 = 2.0. This means that African American infants are 2.0 times as likely to die as compared to white infants. The odds ratio, derived from case-control studies, provides information similar to the relative risk.

Risk Difference: This is the difference of risk between rates for two different groups. For example, if the infant mortality rate for African Americans is 20 per 1,000 and 10 per 1,000 for whites, then the risk difference is 20 - 10 = 10 per 1,000. This means that ten more deaths occur among every 1,000 African American infants than among every 1,000 white infants.

Excess Number of Deaths: The excess number of deaths in group A relative to group B is the excess number of actual (observed) deaths in group A over the number of deaths expected to occur in group A if group A had the same rate of deaths as group B. For example, to calculate excess deaths for African American infants as compared to whites for the year 1993, first the **Expected Number of Deaths** for African Americans is calculated as follows:

$$\text{expected deaths}_{\text{African American}} = (\text{infant mortality rate}_{\text{white}}) \times (\text{number of births}_{\text{African American}})$$

The **Excess** African American Death is then calculated as follows:

$$\text{excess deaths}_{\text{African American}} = (\text{observed deaths}_{\text{African American}}) - (\text{expected deaths}_{\text{African American}})$$

For example, if the infant mortality rate for whites in 1993 was 5/1000 and the total African American number of births for 1993 was 1559, then the expected number of deaths would be :

$$\text{expected deaths } (5/1000) \times 1559 = 8.$$

If the actual number of African American deaths was 18, then the excess African American deaths would be:

$$\text{excess deaths} = 18 - 8 = 10.$$

This means that African Americans had 10 excess infant deaths as compared to whites.

Bar Charts With Confidence Intervals: The following is important to note when reading a bar chart: the top of each bar represents the actual value of the rate. The black line marked with two endpoints at the top of each bar represents the 95 percent confidence interval of the rate. Again, we expect the true rate to fall within the confidence interval 95 percent of the time. If you are comparing two rates with each other and the confidence intervals overlap, the rates are not considered to differ statistically from each other.

Regions: We have also divided King County into four major regions because of important differences in birth rates across these regions: North and South Seattle and East/North and South County. The approximate boundary between the two Seattle regions is Mercer Street and between the County regions is SE May Valley Road. The region definitions are contained in Appendix A.

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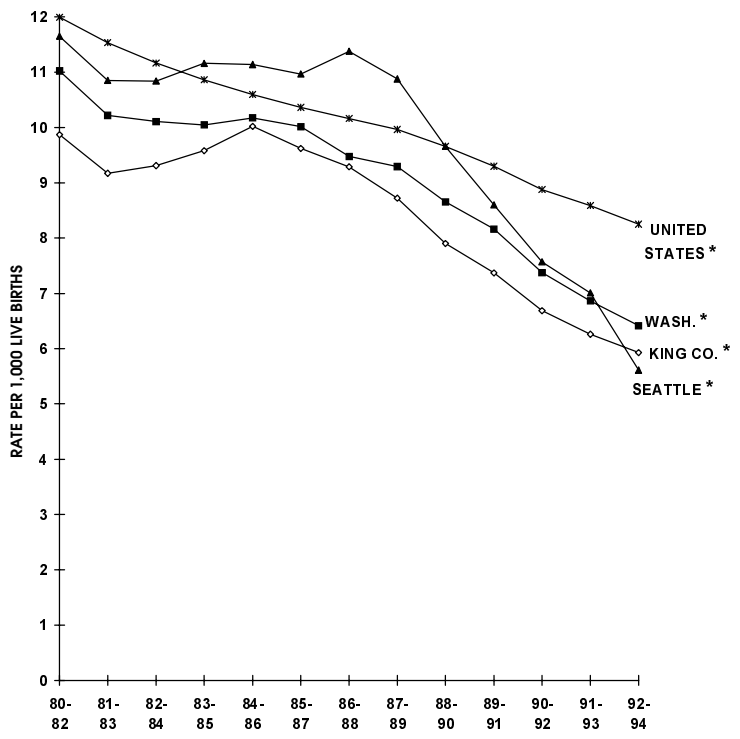
CHAPTER II. TRENDS IN INFANT MORTALITY

This chapter examines trends in infant mortality using data from vital records. It also suggests explanations for these trends. Subsequent chapters explore in more detail the infant mortality rates of specific racial groups and regions within King County.

TRENDS IN INFANT MORTALITY FOR THE UNITED STATES, WASHINGTON, KING COUNTY AND SEATTLE

The infant mortality rate in King County in 1994 (the most recent year for which data are available) was 6.3 deaths per 1000 livebirths. The Seattle rate was 4.8 per 1000, the Washington rate was 6.2 per 1000 and the United States rate was 7.9 per 1000. The number of infants who died in King County in 1994 was 138 and the number in Seattle was 31.

FIGURE 2.1:
INFANT MORTALITY RATES
U.S., WASHINGTON, KING COUNTY, SEATTLE
THREE YEAR ROLLING AVERAGES, 1980-1994



*TRENDS FROM 1988-1994 SHOW A STATISTICALLY SIGNIFICANT DECREASE.
SOURCE: BIRTH AND DEATH CERTIFICATES.

The infant mortality rates in King County and Seattle have declined substantially over the past fifteen years. In the County, the rate decreased by 40 percent since 1980 and in Seattle, by an even greater 63 percent. While 187 infants died in King County in 1985, the count decreased to 138 in 1994. In Seattle, 84 infants died in 1988 compared to 31 in 1994.

This decline has been most apparent in recent years. In the early 1980s, the rate decreased at a moderate pace, and then increased in the mid-1980s. In the late-1980s and early 1990s, a favorable trend emerged as the rate declined more rapidly than at any other time during the past fifteen years (Figure 2.1, Table 2.1 and Table B.1 in Appendix B).[a]

This pattern was most notable in Seattle where the rate decreased an average of 6.3 percent per year from 1980 to 1983, then *increased* by 3.2 percent per year from 1983 to 1988, and then dropped steeply by 10.2 percent per year from 1988 to 1994. A similar pattern was apparent in King County.

[a] The appendices contain tables with more detailed data.

TABLE 2.1
PERCENT CHANGE IN INFANT MORTALITY RATE
U.S., WASHINGTON, KING COUNTY, AND SEATTLE

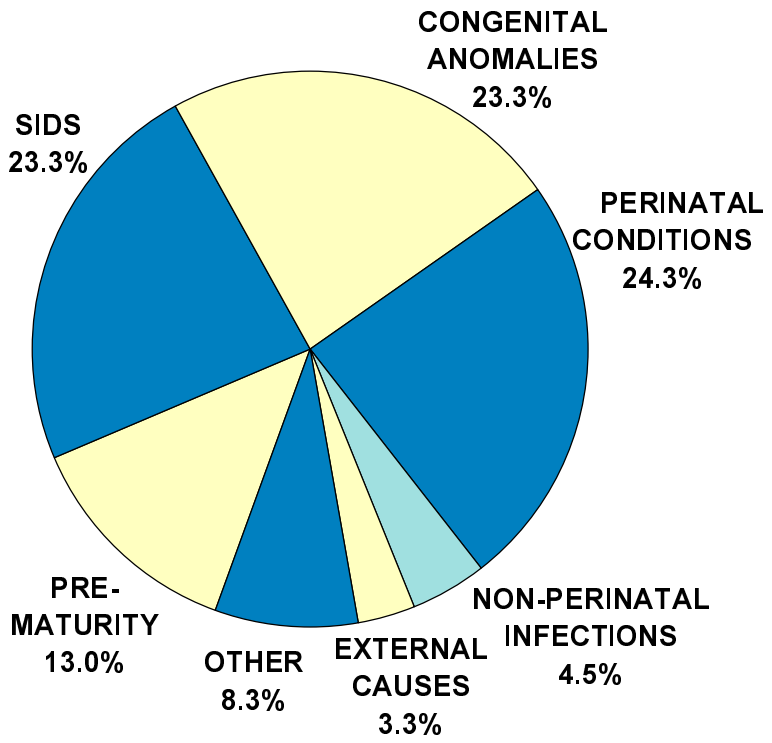
LOCATION	1ST TIME PERIOD: 1980-1983	2ND TIME PERIOD: 1983-1988	3RD TIME PERIOD: 1988-1994	TOTAL TIME PERIOD: 1980-1994
UNITED STATES	decrease 11%	decrease 11%	decrease 21%	decrease 37%
WASHINGTON	decrease 19%	decrease 5%	decrease 31%	decrease 47%
KING COUNTY	decrease 20%	increase 8%	decrease 30%	decrease 40%
SEATTLE	decrease 19%	increase 16%	decrease 61%	decrease 63%

SOURCE: BIRTH AND DEATH CERTIFICATES.

TRENDS IN SPECIFIC CAUSES OF INFANT MORTALITY

The infant mortality rate is a summary indicator describing the death rate among infants from all causes of death combined. These causes are quite diverse, and each is associated with its own set of risk factors and prevention strategies. Therefore, it is useful to examine the specific causes in more detail.

FIGURE 2.2
CAUSES OF INFANT MORTALITY
KING COUNTY
THREE YEAR AVERAGE, 1992-1994

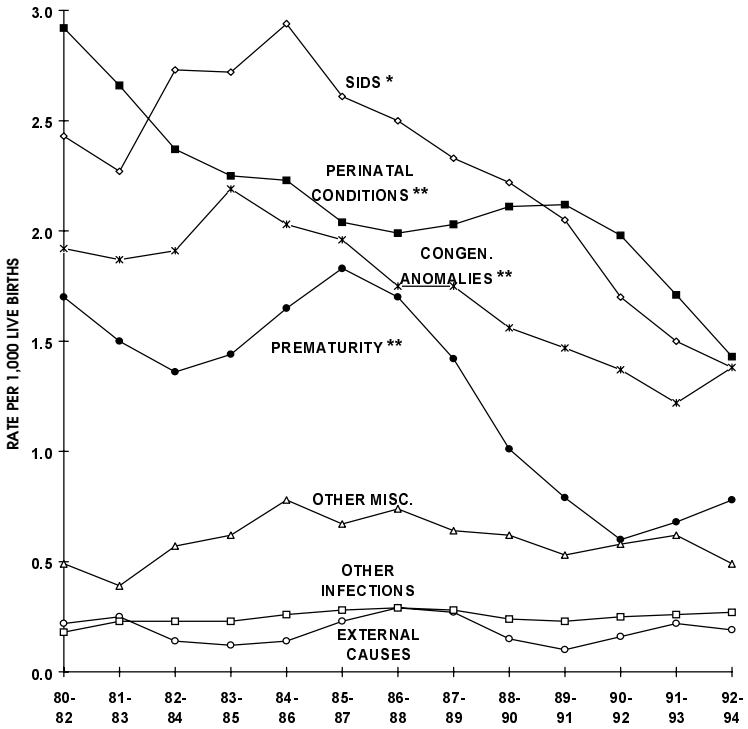


SOURCE: BIRTH AND DEATH CERTIFICATES.

The three leading causes of infant deaths in the 1992 to 1994 period were perinatal conditions (conditions causing death during the first 27 days of life, including problems with the lungs, birth-related injuries, suffocation during birth, and infections), congenital anomalies (birth defects), and SIDS (Sudden Infant Death Syndrome). Each accounted for slightly less than a quarter of all deaths. Deaths due to prematurity[b] also figured prominently and contributed 13 percent of the total (Figure 2.2). Infections (such as pneumonia or meningitis) occurring after the perinatal period, external causes (injuries, both intentional and unintentional), and miscellaneous other causes each added smaller numbers of cases. Definitions of each of these causes of death are contained in Appendix A.

[b] The categorization of causes of infant death is limited by the overlap between the perinatal and prematurity groups. A large portion of infants assigned to the perinatal category were born prematurely. Deciding whether the death of these infants was due primarily to their prematurity or to a complication in the perinatal period is imprecise, probably resulting in the classification of some infants whose deaths were due primarily to prematurity into the perinatal category.

FIGURE 2.3
CAUSES OF INFANT MORTALITY
KING COUNTY
THREE YEAR ROLLING AVERAGES, 1980-1994



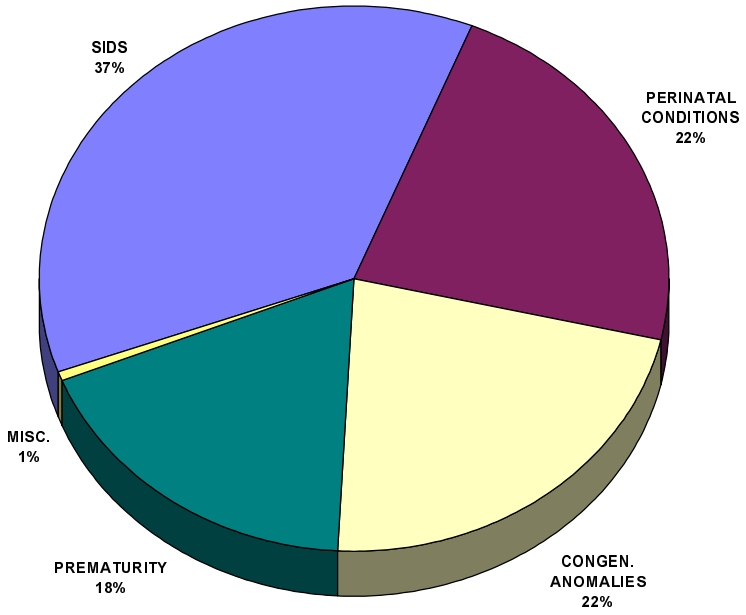
* TRENDS FROM 1984-1994 SHOW A STATISTICALLY SIGNIFICANT DECREASE.

** TRENDS FROM 1980-1994 SHOW A STATISTICALLY SIGNIFICANT DECREASE.

SOURCE: BIRTH AND DEATH CERTIFICATES.

Significant decreases in the rates of all four of the major causes of infant death occurred during the 1980-94 time period (Figure 2.3). Each declined by more than 50 percent from their high points in the 1980s to their low points in the early 1990s. No significant changes occurred in the rates of death from other infections and external causes. While perinatal conditions and SIDS death rates have continued to decline through 1994, the prematurity death rate seems to have leveled in recent years. Explanations for these findings are discussed in more detail later in this section.

FIGURE 2.4
PROPORTION OF DECREASE IN INFANT MORTALITY FROM 1983-1985 TO 1992-1994 ATTRIBUTABLE TO SPECIFIC CAUSES KING COUNTY



SOURCE: BIRTH AND DEATH CERTIFICATES.

The King County infant mortality rate peaked in 1984 and reached its low point in 1993. The declining SIDS rate contributed 37 percent of this decrease, while the declining rates of death from perinatal conditions and congenital anomalies each contributed 22 percent and prematurity contributed 18 percent (Figure 2.4).

HOW CAN THE DECLINE IN INFANT MORTALITY BE EXPLAINED?

The factors influencing infant mortality are complex and only partially understood. This section explores some of the local influences on the infant death rate. Declining risk factors for infant mortality were an important part of the explanation. We discuss possible explanations for the changing occurrence of these risk factors, including recent improvements in the delivery of health services to pregnant women. Another important contributor to the lower infant mortality was recent progress in medical science.

CHANGING RISK FACTORS FOR INFANT MORTALITY

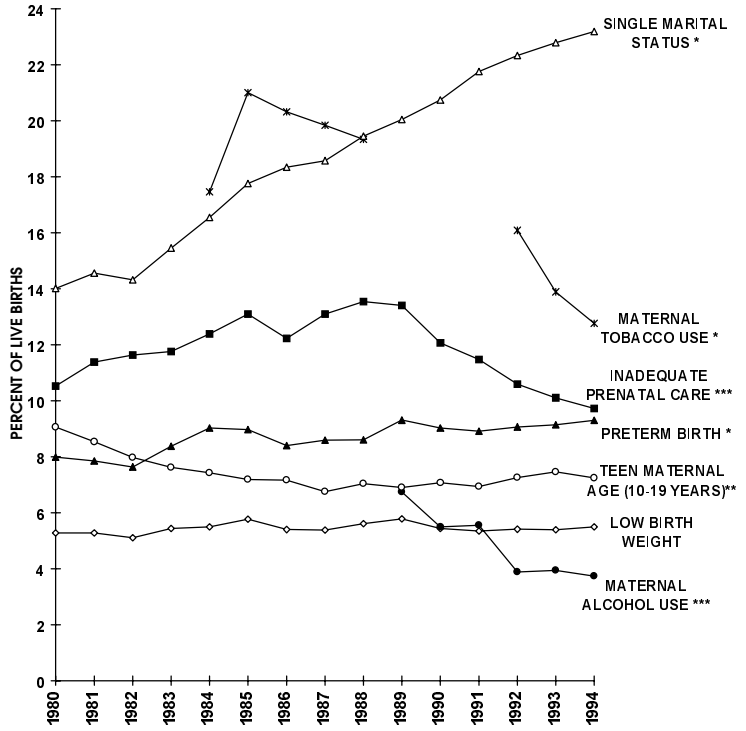
A *risk factor* for infant mortality is a characteristic or condition that increases the chances that an infant may die. Many risk factors have been identified through epidemiological research.[1-23] The occurrence of an infant's death can be viewed as the culmination of a chain or web of multiple risk factors. Some risk factors (*distal risk factors*) may be "further away" from the death and exert their influence by causing the occurrence of other risk factors (*proximal risk factors*) "closer" to the death. Oftentimes, proximal risk factors are physiologic or pathologic conditions. For example, smoking during pregnancy increases the risk of infant death. In part, it does this through slowing fetal growth in utero as well as causing premature birth, resulting in a baby with a low birthweight. Low birthweight, a physiologic condition, is one of the strongest risk factors for infant death. In this example, smoking is a distal risk factor (further away) and low birthweight is a proximal (closer) risk factor. Low income and race (more precisely, racism) are fundamental distal risk factors which influence the occurrence of many of the other risk factors for infant death.

In this section, we consider the physiologic, proximate risk factors of low birthweight and prematurity as well as a number of distal risk factors such as health-related behaviors and problems with access to health services. Part of the explanation for the observed decrease in infant mortality lies in the recent favorable trends in some of these risk factors. Race as a risk factor is discussed in Chapter III.

The risk factors considered in this section ("measured risk factors") are limited to those included on the birth certificate, the only currently available source of routinely collected risk factor data[c]. Many other known risk factors go "unmeasured", in addition to other unidentified ones. Chapters VI-IX discuss the occurrence of some of these unmeasured factors among cases of infant deaths, as revealed by the Infant Mortality Review process.

Among the measured risk factors available from the birth certificate, the rates of smoking, alcohol use, teen births and inadequate prenatal care decreased in recent years, while the proportion of births to unmarried parents increased.

FIGURE 2.5
LIVEBIRTHS WITH SELECTED RISK FACTORS
KING COUNTY
1980-1994



* THIS TREND FROM 1980-1994 IS A STATISTICAL SIGNIFICANT INCREASE.
** THIS TREND FROM 1980-1994 IS A STATISTICAL SIGNIFICANT DECREASE.
*** THIS TREND FROM 1989-1994 IS A STATISTICAL SIGNIFICANT DECREASE.
SOURCE: BIRTH AND DEATH CERTIFICATES.

The low birthweight rate has not changed while the rate of premature births has increased slightly. Trends in these risk factors are summarized in Figure 2.5 and Table 2.2.

For each risk factor, the first column of Table 2.2 shows the percentage of all births with the risk factor present during the 1983 to 1985 period when infant mortality was at its highest point during the period covered by this report (1980 to 1994). The next two columns display the rate during the most recent period (1992 to 1994) and the percent change in the rate between the two periods.

The table also displays the increased risk (odds ratio) of dying among infants with the risk factor compared to those without the factor. Both "crude" and "adjusted" odds ratios are presented. The crude ratio shows the risk for each factor examined in isolation from all the others.

However, many of these factors are interrelated. For example, infant mortality is associated with smoking, alcohol consumption and inadequate prenatal care. Women who smoke are also more likely to

[c] In the near future, data from PRAMS (the Pregnancy Risk Assessment Monitoring System) will be available and will provide information on a broader range of risk factors for poor birth outcomes among pregnant women in Washington State and King County.

drink, so some of the increased risk associated with smoking may be due to the higher drinking rate among smokers, and vice-versa. Some of the effects of prenatal care on reducing infant mortality may be due to its ability to influence pregnant women to decrease their smoking and drinking. But prenatal care may also reduce infant mortality through other pathways. The increased risks associated with teen births and births to unmarried women are due in part to the association of these factors with other factors, such as smoking and inadequate prenatal care. One way to clarify the situation is to do a statistical analysis which simultaneously examines the effects of all these factors and provides an "adjusted" risk for each factor which reflects the independent contribution of each factor. The odds ratios for low birthweight and prematurity are not adjusted, because they are proximal, final common pathways for many risk factors. The adjusted odds ratios for smoking, alcohol, teen birth, single marital status and prenatal care have each been adjusted for all the other factors in this group. In the following chapter on race and infant mortality, we discuss the combined effects of these risk factors with race and income.

The next column displays the proportion of infant deaths associated with each factor (population attributable risk). For example, nine percent of all infant deaths were associated with smoking, after adjusting for the other distal risk factors. In other words, eliminating smoking among pregnant women has the potential to decrease infant mortality by nine percent, independently of interventions addressing the other risk factors in the table.

TABLE 2.2
TRENDS IN SPECIFIC RISK FACTORS FOR INFANT MORTALITY
KING COUNTY FROM 1983-1985 TO 1992-1994

	PERCENT OF BIRTHS			ODDS RATIO: INCREASED RISK OF INFANT DEATH	ODDS RATIO: INCREASED RISK OF INFANT DEATH	% INFANT DEATH
RISK FACTOR	1983 TO 1985	1992 TO 1994	PERCENT CHANGE	ASSOCIATED WITH FACTOR (1992-1994) CRUDE RATE (95% CI)	ASSOCIATED WITH FACTOR (1992-1994) ADJUSTED (95% CI)***	ATTRIBUTABLE TO FACTOR (PAR%)**** (1992-1994)
LOW BIRTHWEIGHT	5.57	5.43	-0.14%	20.4 (15.7-26.4)	----	---
PRETERM BIRTH (CALCULATED)	8.79	9.17	0.38%	9.1 (7.0-11.8)	----	---
MATERNAL SMOKING	19.23*	14.26	-4.97%	2.3 (1.7-3.1)	1.7 (1.2-2.5)	9.1
MATERNAL ALCOHOL USE	N/A**	3.86	N/A	1.3 (0.7-2.4)	1.1 (0.6-2.2)	0.4
INADEQUATE PRENATAL CARE	12.43	10.15	-2.28%	1.7 (1.3-2.2)	1.5 (1.1-2.0)	4.8
YOUNG MATERNAL AGE (10-19 YEARS)	7.41	7.32	-0.09%	1.9 (1.3-2.8)	1.1 (0.7-1.8)	0.7
SINGLE MARITAL STATUS	16.61	22.76	6.15%	2.0 (1.5-2.6)	1.5 (1.1-2.2)	10.2

* RATES ARE UNAVAILABLE BEFORE 1984, SO THE RATES ARE PRESENTED FOR ONLY TWO YEARS (1984-1985).
** RATES ARE UNAVAILABLE BEFORE 1989, SO NO RATE IS PRESENTED FOR 1983-1985.
*** THE ODDS RATIO FOR EACH FACTOR IS ADJUSTED FOR THE OTHER FACTORS USING LOGISTIC REGRESSION. NO ADJUSTMENT WAS MADE FOR LOW BIRTHWEIGHT OR PREMATURITY
**** CALCULATION OF PAR% USING ADJUSTED ODDS RATIOS

LOW BIRTHWEIGHT

An infant is considered to have a low birthweight if she or he weighs less than 2500 grams (5 1/2 pounds) at birth. Low birthweight is the single strongest predictor of infant death. In King County, an infant with a low birthweight was 20.4[d] times more likely to die than an infant of normal weight. This risk factor accounted for 31 percent of all infant deaths during the 1992 to 1994 period. Infants born with very low birthweight (less than 1500 grams or 3.3 pounds) had an extremely high risk of dying. Nearly a quarter of them died during the first year of life in the 1992 to 1994 period. They were 86 times more likely to die than infants with normal birthweights. Low birthweight infants may develop problems breathing, are more prone to infections and can develop neurological difficulties, all of which may lead to death. An infant can be born with low birthweight because of slow growth during pregnancy, premature birth, or both. Many of the other risk factors for infant mortality have their impact because they in turn cause low birthweight. The low birthweight rate of 5.5 percent of all livebirths has not changed since 1980.

PRETERM BIRTH

An infant is considered preterm if he or she is born before completing 37 weeks gestation. Preterm birth is a strong predictor of infant death. Such infants are 9.1[e] times more likely to die. Prematurity was associated with 14.8 percent of infant deaths. Prematurity and low birthweight are closely linked. Nearly one third (32.5 percent) of preterm births result in low birthweight infants and most (71.4 percent) infants who are born with low birthweight are underweight because they are born prematurely. The birth rate for premature babies increased significantly by 16 percent since 1980. In 1994 it made up 9.3 percent of all births.

MATERNAL SMOKING

A mother was considered a smoker if her baby's birth certificate indicated any smoking during pregnancy. Smoking increased the risk of infant death 2.3 times (risk adjusted for other measured risk factors = 1.7) and was associated with 9.1 percent of deaths. In 1994, 13 percent of mothers reported smoking. The rate decreased by 39 percent from a high of 21 percent in 1985, the first year with complete reporting.

MATERNAL ALCOHOL USE

A mother was classified as using alcohol during her pregnancy if the birth certificate indicated any use during pregnancy. Alcohol use was associated with a 1.3-fold increase (adjusted risk = 1.1) in infant death. In 1994, 3.7 percent of mothers used alcohol during pregnancy, compared to 6.7 percent in 1989, the first year such data were collected.

INADEQUATE PRENATAL CARE

Measurement of the adequacy of prenatal care is inexact. Information about the content of care (i.e. counseling offered, tests performed, treatment provided) is not readily available, so most measures assess the quantity of care. We have used the Kotelchuck Index, which takes into account both how early in her pregnancy a mother began her care and the number of visits she made.[24] Inadequate prenatal care was associated with a 1.7-fold increase (adjusted risk = 1.5) of infant death and 4.8 percent of infant deaths

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[d] This is the crude or unadjusted odds ratio. After adjustment for gestational age, the odds ratio for low birthweight decreased to 9.3, indicating that part of the effect of low birthweight on infant mortality was related to prematurity.

[e] This is the crude or unadjusted odds ratio. After adjustment for birthweight, the odds ratio for prematurity decreased to 2.9, indicating that part of the effect of prematurity on infant mortality comes through the relationship between low birthweight and prematurity. Most low birthweight infants are premature.

were attributable to it. The rate of inadequate care increased from 1980 to a maximum of 13.5 percent of all births in 1988, and then steadily declined, reaching an improved 9.7 percent in 1994.

YOUNG MATERNAL AGE

Young maternal age may best be thought of as a marker for other, unmeasured social risk factors. Infants born to mothers age 10 to 19 years old were 1.9 times more likely to die than those born to older mothers (adjusted risk = 1.1, indicating that nearly all the increased risk associated with young age is accounted for by the higher rate of the other risk factors among young women). Teen births were associated with less than one percent of infant deaths in the 1992 to 1994 period. The birth rate among women age 10 to 19 increased steadily to a peak of 36.6 births per 1,000 women age 10-19 in 1992, and then declined to 32.7 per 1,000 by 1994. The percentage of all births among women age 10 to 19 years old decreased from 8.9 percent in 1980 to 7.0 percent in 1994, reflecting both the lower birth rate among teens and a higher rate among older women.

OLDER MATERNAL AGE

Women who are 35 and older are at higher risk of certain complications of pregnancy, including congenital anomalies, low birthweight, delayed fetal growth and neonatal deaths,[25] although such problems tend to be uncommon. However, our analysis did not find that infants born to women age 35 and older in King County were at increased for infant death. In King County, a larger proportion of all births in recent years have occurred among women age 35 and older: in 1980 they accounted for only 5.4 percent of all births while in 1994 they contributed 17.1 percent. The birth rate among this age group increased from 8.8 per 1000 to 18.2 per 1000.

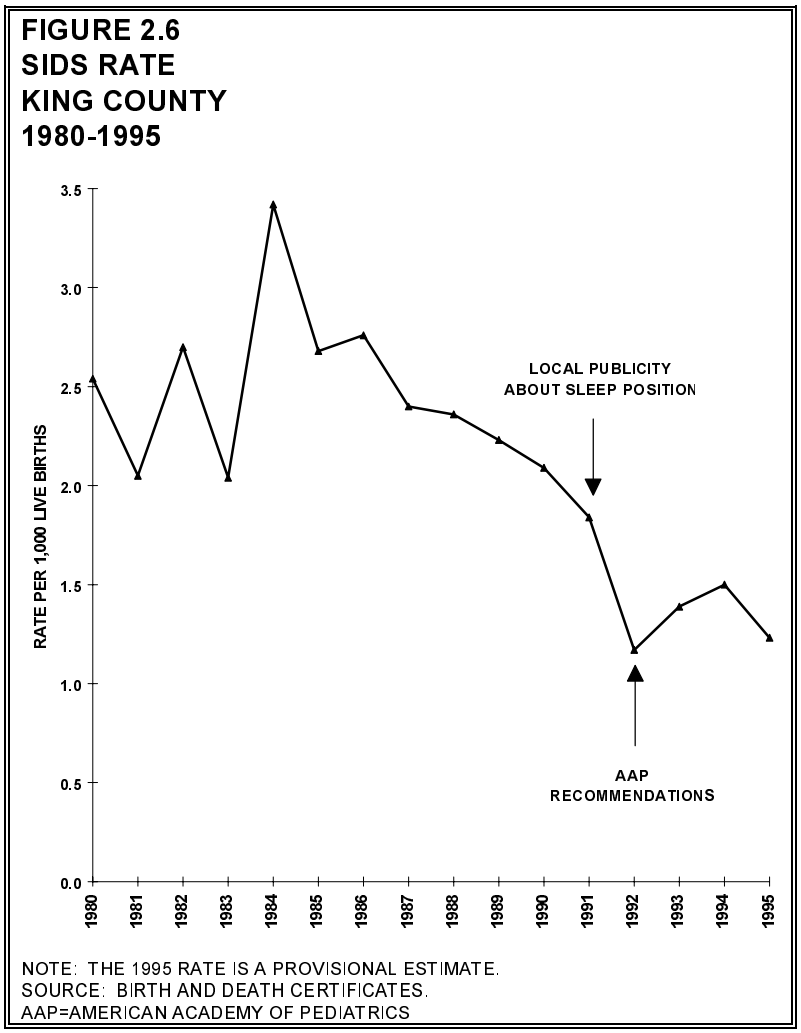
SINGLE MARITAL STATUS

The marital status of the newborn's parents influences birth outcomes through many pathways. Usually, when the parents are not married, the mother assumes responsibility for raising the child, often under adverse conditions of limited income and social support. Unmarried status is thus a marker for other, unmeasured, social risk factors.[26] Simply increasing the proportion of parents who are married will not address these risk factors. An infant born to unmarried parents was 2.0 times more likely to die (adjusted risk = 1.5) than one born to married parents and 10.2 percent of infant deaths were associated with this risk factor. The proportion of births to unwed parents increased by 54 percent since 1980, growing from 14 percent to 22 percent of all births.

It is clear that not all of the decline in infant mortality can be explained by changes in measured risk factors or improved health services. Statistical analysis indicates that the measured risk factors of maternal age, smoking, alcohol use, inadequate prenatal care and unmarried parents explain at most a quarter of infant deaths. Other important determinants of infant health that are not routinely measured in vital statistics records, such as socioeconomic conditions, various maternal behaviors, and the social environment therefore have a major influence on the infant mortality rate. We next consider two important "unmeasured" factors: sleep position and income. Additional factors derived from the Infant Mortality Review are discussed in Chapters VI-IX.

SLEEP POSITION

One important risk factor not currently measured, and which most likely played a major role in the declining rate of infant mortality, is an infant's sleep position. Numerous studies have shown that infants who sleep prone (on their stomachs) are at increased risk of dying from SIDS, [27 28 29 30 31 32 33] including one study done in King County.[34]



These studies have also demonstrated that communities which develop campaigns that encourage parents to position their infants in a non-prone sleep position are successful in decreasing the rate of prone sleeping and the SIDS rate. The SIDS rate in King County dropped during 1991 and 1992, when recommendations about sleep position and SIDS were brought to the attention of health providers and parents by local experts and the American Academy of Pediatrics (AAP) (Figure 2.6).

No local data exist on the frequency with which infants are placed to sleep on their stomachs, so we cannot report on trends in sleep position. We do know from the Infant Mortality Review that between 1990 and 1993, 72 percent of the infants dying from SIDS in King County were placed to sleep in the prone position before they died.

SOCIOECONOMIC STATUS

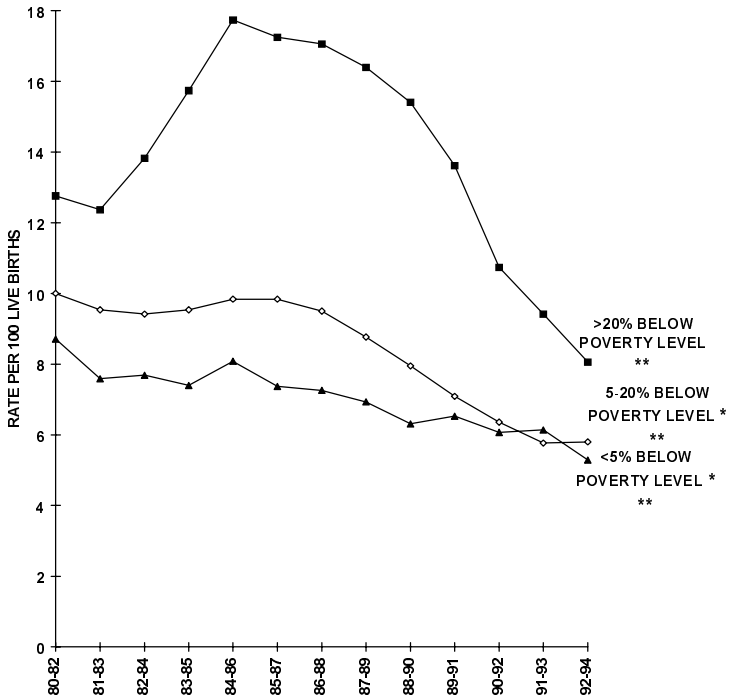
Socioeconomic status is a fundamental determinant of infant mortality. Universally, infants of low socioeconomic status have higher infant mortality rates. [35 36 37 38 39] King County is no exception. The only measure of socioeconomic status that is readily available from birth certificates (added in 1992) is the number years of education completed by the infant's mother. Infants born to mothers who have not completed high school were 1.8 times more likely to die than those born to mothers with more education during the 1992-94 period (95% CI=1.2-2.7).[f]

[f] The increased risk is the same if the analysis is restricted to women 25 years and older. After adjusting for maternal age, smoking and alcohol use, inadequate prenatal care and marital status, the odds ratio decreased to 1.3.

Another measure of socioeconomic status is low income. While no easily accessible data[g] exist indicating how many King County infants are born into poverty, we can compare infant mortality rates among poor and better-off areas within the county. The U.S. Census provides data for each census tract on the proportion of female residents age 12 to 64 who live in households with incomes below the poverty line.[h] A census tract is a geographic area which contains approximately 4,000 residents; there are 285 census tracts in King County. We grouped the census tracts into those in which more than 20 percent of the female population age 12 to 64 lived in poor households (high poverty tracts), those in which 5 to 20 percent were below poverty (medium poverty tracts), and those in which fewer than 5 percent were below the poverty level (low poverty tracts).

The infant mortality rate in the high poverty tracts has been consistently higher than the rate in the medium and low poverty tracts (Figure 2.7). During the 1984 to 1986 period, infants living in high poverty areas had an infant mortality rate more than twice that of infants living in low poverty tracts.

FIGURE 2.7
INFANT MORTALITY RATES
BY CENSUS TRACT POVERTY LEVEL IN KING COUNTY
THREE YEAR ROLLING AVERAGES, 1980-1994



* THIS TREND FROM 1980-1994 IS A STATISTICAL SIGNIFICANT DECREASE
** THIS TREND FROM 1985-1994 IS A STATISTICAL SIGNIFICANT DECREASE
SOURCE: BIRTH AND DEATH CERTIFICATES.

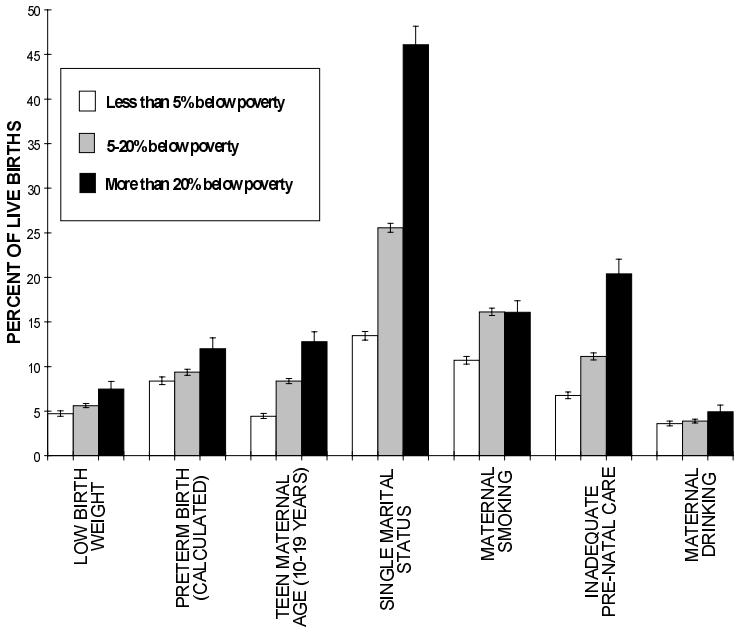
By the 1992 to 1994 period, the rate in the high poverty areas, although still exceeding the rate in the low poverty areas, was only 1.5 times higher. This improvement was due to the striking 55 percent decline in the rate in the high poverty areas. Less substantial, but still important declines of 41 percent and 34 percent in the medium and low poverty areas, respectively, also occurred during this interval.

Thus, declining levels of infant mortality among high poverty areas explains some of the decrease in the overall King County rate. The decline in infant deaths in the high poverty areas was, in turn, partially due to improvements in the risk factor levels in these areas.

[g] Birth certificates do not assess maternal income. Information on source of payment for prenatal care has been collected since 1992. Source of payment can serve as a proxy for income because mothers whose source is classified as Medicaid or charity care are likely to have low incomes. The birth certificate also contains information on the educational attainment of the mother, which is an important measure of socioeconomic status. However, information on education is missing on 15.5 percent of birth certificates.

[h] $12,674 per year for a four-person household in 1989, the year for which the Census collected information.

FIGURE 2.8
RISK FACTORS FOR INFANT MORTALITY
BY CENSUS TRACT POVERTY LEVEL, KING COUNTY
THREE YEAR AVERAGE, 1992-1994



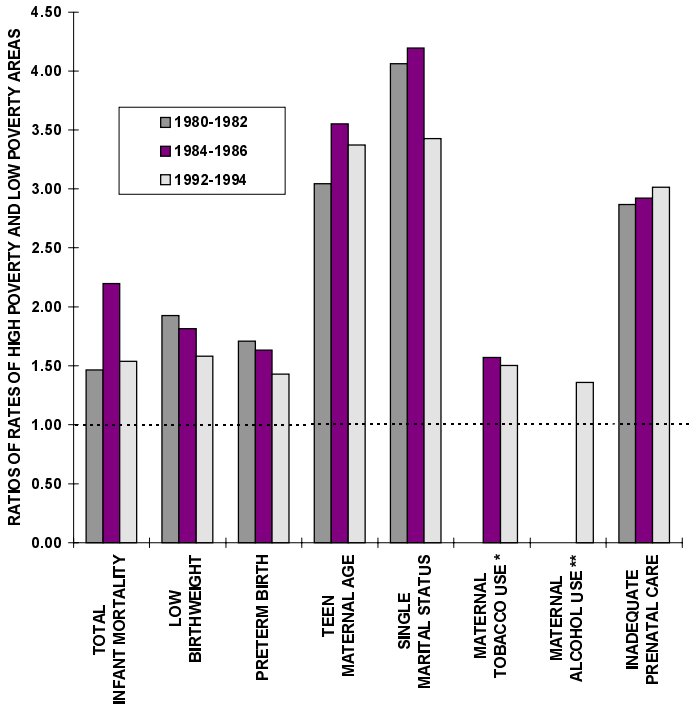
SOURCE: BIRTH AND DEATH CERTIFICATES.

Low income populations experienced higher levels of all the measured risk factors for infant death.

Relative to low poverty areas, the high poverty areas had rates of low birthweight 1.6 times as high, preterm birth 1.4 times as high, smoking 1.5 times as high, alcohol use 1.4 times as high, births to young mothers 2.9 times as high, births to unmarried parents 3.4 times as high and inadequate prenatal care 3.0 times as high (Figure 2.8).

Although the mothers in the high poverty areas had higher levels of risk factors for problems with births and their infants' health, these risk factors became less frequent over the most recent five years (Figure 2.9).

FIGURE 2.9
RATIOS OF BIRTH INDICATORS
HIGH POVERTY TO LOW POVERTY AREAS
KING COUNTY, 1980-1994



*DATA ON TOBACCO STARTED TO BE COLLECTED SINCE 1984
**DATA ON ALCOHOL STARTED TO BE COLLECTED SINCE 1989
SOURCE: BIRTH AND DEATH CERTIFICATES.

The ratios of the risk factor levels in the high poverty areas to the levels in the low poverty areas have also generally declined (Figure 2.9), contributing to the narrowing of the gap in infant mortality.

In addition to these favorable changes within the high poverty areas a smaller proportion of all births took place in high poverty areas over the past ten years. In the 1984-86 period, 7.4 percent of all births took place in high poverty areas, compared to 6.5 percent in 1992-94.

These improvements are all the more noteworthy because there has been little change in the proportion of the population living in poverty and a widening of the gap in income between rich and poor in recent years. For example, in 1989 the median income in the low poverty areas was 2.6 times higher than that in the high poverty areas. By 1994, this ratio rose to 2.7.[i]

In summary, despite widening income inequity and little change in the proportion of people living in poverty, the impact of socioeconomic inequity on infant mortality diminished. The decreased effect of income on infant mortality seems in part to be due to fewer infants being born in high poverty areas as well as improved birth outcomes among those who are born in these areas.

[i] Data sources: US Census and Claritas, Inc.

To further improve birth outcomes among the disadvantaged, interventions must continue to address risk factors for infant death in this population. The measured risk factors discussed above explain only a portion of the increased infant mortality in the high poverty areas. Many other unmeasured risk factors also occur more commonly among low income populations, including:

- Lack of social support
- Stress
- Unintended pregnancy
- Illicit drug use
- Financial and non-financial barriers to health care
- Inadequate resources to cope with difficult life circumstances
- Lack of control over one's economic, physical and social environments. [40 41]

Changes in these unmeasured risk factors may have contributed to both the decline in infant mortality in low income areas as well as in the population as a whole. The Infant Mortality Review collected information on some of these unmeasured factors, which are described in Chapters 6-9, but accurate population-based estimates of their prevalence and trends over time are unavailable.

WHY ARE RISK FACTORS CHANGING?

While it is clear that risk factors for infant mortality have declined, the reasons for this favorable trend are complex and not fully understood. However, recently implemented important advances in the delivery of health and social services to pregnant women appear to have contributed to the declining rates of risk factors for infant death.

MEDICAID EXPANSION

In July of 1987, Washington State implemented changes in the state's Medicaid health insurance program to increase the number of pregnant women eligible for Medicaid coverage, regardless of their eligibility for financial assistance (see Appendix A under "Medicaid" for more information). Medicaid is a government program that pays for the medical care of people with low incomes. These changes increased the income threshold for eligibility for Medicaid for pregnant women from sixty percent of poverty ($7,588 annual income for a household of four in 1989) to ninety percent of poverty ($11,382 annual income for a household of four in 1989).[42] Expanding the number of women eligible for Medicaid increased the proportion of women with health coverage and thus removed an important barrier to obtaining prenatal and obstetrical care for many low income pregnant women. Women who receive prenatal care are more likely to:

- Refrain from smoking, alcohol consumption and other behaviors associated with poor birth outcomes
- Have complications of pregnancy diagnosed and treated
- Have symptoms of preterm labor more aggressively managed
- Have more social support.

Thus, expanded access to prenatal care through the Medicaid program may have reduced the frequency of risk factors for infant death.

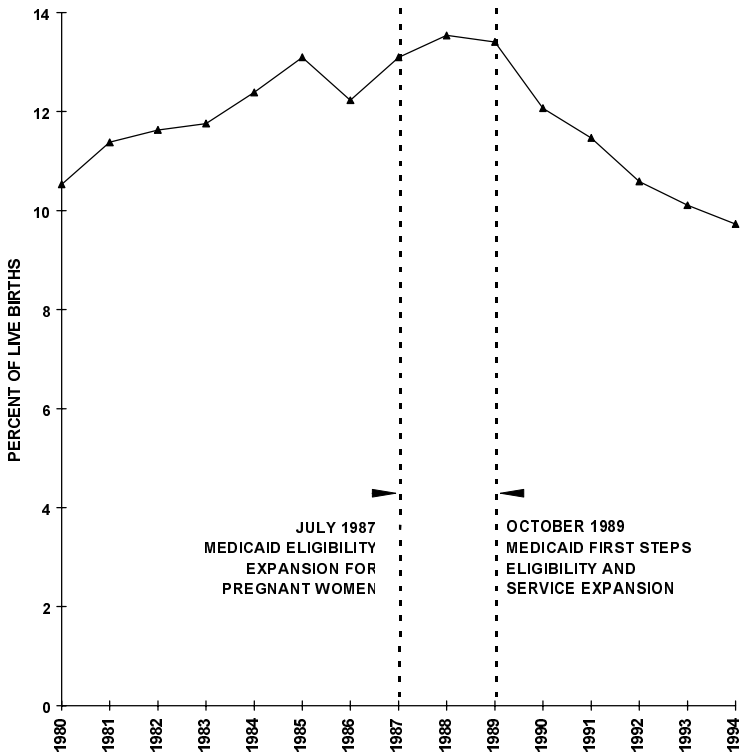
THE FIRST STEPS PROGRAM

Washington State enacted the Maternity Care Access Act in 1989. Known as the "First Steps" program, its goal was to provide maternity care to promote healthy birth outcomes for low-income families. The program included:

- A further expansion of Medicaid eligibility from 90 percent of federal poverty to 185 percent of the federal poverty level
- The addition of maternity support services (e.g., community health nursing visits, nutrition services, childbirth education and psycho-social counseling)
- Case management for women at high-risk of poor pregnancy outcomes
- Increased reimbursement for maternity care providers
- Accelerated application and eligibility determination processes
- A statewide public education campaign
- Assistance with transportation and child care for medical appointments.

The program also made pregnant women the highest priority for substance abuse treatment.

FIGURE 2.10
PERCENT BIRTHS WHERE MOTHER RECEIVED INADEQUATE PRENATAL CARE (KOTELCHUCK)
KING COUNTY
1980-1994



SOURCE: BIRTH AND DEATH CERTIFICATES.

The implementation of these programs resulted in Medicaid becoming the single largest payer for maternity services in Washington. The proportion of births covered by Medicaid statewide increased from 24 percent to 35 percent.[44] Evaluation of First Steps [43 44] found improvement in both access to care and birth outcomes. Fewer Washington women received late or no prenatal care following implementation of First Steps (Figure 2.10). The low birthweight rate declined for low-income births following the initiation of this program.

Local data confirmed these findings for King County. The expansion of coverage and maternity services in the late 1980s was associated with a reduction in the proportion of pregnant women in King County who received inadequate prenatal care.

KING COUNTY INITIATIVES TO PROMOTE MATERNAL AND INFANT HEALTH

In addition to the First Steps Program, several additional local initiatives to improve maternal and infant care have been implemented in King County in recent years. These programs may also have contributed to the observed improvements:

1982 - Maternity screening services were established by the Health Department and community clinics to promote early entry of pregnant women into prenatal care and utilization of state Prenatal Care funds. Virginia Mason Hospital received a Kellogg Foundation grant to establish the Community Obstetric Referral Program, which linked pregnant women with physicians accepting new obstetrical patients. Maternity Network meetings to share information and coordinate scarce prenatal care resources began.

1987 - Health Department maternity screeners used expanded Medicaid access to increase the number of women getting prenatal care in their own communities.

1989 - Maternity Network agencies worked collaboratively to educate patients and providers about First Steps and to develop Maternity Support Service teams in each clinic and WIC (Women Infant and Children Food Supplementation Program) site. By the end of 1990, 70 percent of pregnant women covered by Medicaid had received at least one Maternity Support Service.

1991 - The Health Department used state grant funds to contract with community agencies to begin outreach programs to prevent infant mortality. The programs were targeted to minority populations in Central and Southeast Seattle and focused on pregnant women and families with infants.

1992 - The Health Department's Infant Mortality Review began. The City of Seattle expanded the infant mortality outreach projects which had been initially supported through state funds.

1993 - Both the City of Seattle and King County recognized the importance of home visiting to families of newborns and funded additional Health Department nurses to reach new families.

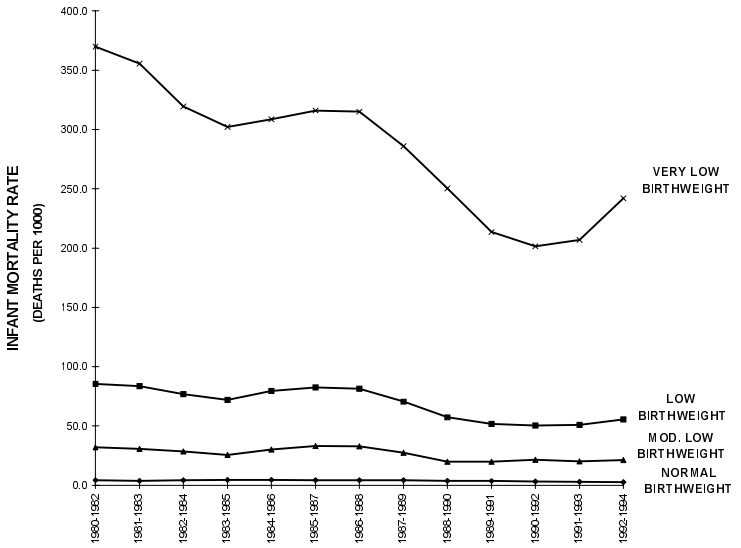
1995 - The University of Washington Medical Center expanded funding to the infant mortality outreach projects to enhance collaborative efforts for their clients. The King County and Washington State Health Departments launched the "Back to Sleep" Campaign to promote and reinforce the importance of placing infants on their backs rather than on their bellies to sleep.

ADVANCES IN MEDICAL CARE

Recent advances in the care of sick newborns have also made important contributions to the declining infant mortality rate. [45] These advances have made their impact through improving the survival rates of preterm and other sick newborns..

The decrease in mortality from prematurity and low birthweight described above was due to the improved survival of preterm and low birthweight infants. The rate of preterm births actually *increased* during the past 15 years, while the rate of low birthweight and very low birthweight infants did not vary substantially.

FIGURE 2.11
BIRTHWEIGHT SPECIFIC MORTALITY RATES
KING COUNTY
1980-1994



*TRENDS FROM 1980 TO 1994 ARE STATISTICALLY SIGNIFICANT
SOURCE: BIRTH AND DEATH CERTIFICATES.

This interpretation is supported by the following analysis of birthweight-specific infant mortality rates. The death rate among infants with very low birthweight (<1500 grams) declined dramatically, by 32 percent, between the 1980 to 1982 and 1992 to 1994 periods (Figure 2.11). The mortality among moderately low birthweight infants also declined. Therefore, even though the same proportion of infants were born with very low and moderately low birthweights, because of their improved odds of survival, the mortality rate from prematurity and low birthweight decreased.

The finding of decreasing mortality rates among moderately low birthweight and very low birthweight infants was equally true for infants born to mothers living in high poverty areas and low poverty areas and for African Americans as well as whites.

Several major advances in medical treatment have contributed to improved infant survival, especially among premature infants. The immaturity of the lungs of preterm infants causes difficulties with breathing. The increasing use of the medication *surfactant* to improve the function of immature lungs has greatly improved the survival of premature infants.[46 47] Surfactant was first used locally at the University of Washington Medical Center in 1989, and its use spread throughout King County in 1990. Technologies used in neonatal care units also improved in recent years, including more sophisticated ventilators (devices that ensure optimum lung ventilation) and oxygen saturation meters (which continuously and easily track the level of oxygen in the blood to facilitate monitoring of lung function) .

However, as noted above, the decline in prematurity-related deaths has ceased in recent years. This trend may indicate that the potential of the recent advances in medical care has been fully realized and that further improvements will come only from measures which decrease the rate of preterm delivery. These measures may include new medical treatments (such as more aggressive treatment of certain female reproductive tract infections) [48] and social interventions aimed at reducing stress and increasing social support among pregnant women. [49]

Improved medical care may also partly explain the declining death rate from congenital anomalies. While the decreasing rate could be due either to a lower incidence of infants born with anomalies or a better survival rate of such infants, local experts have indicated that improved survival is the more likely explanation. Other factors may include routine availability of amniocentesis for women over 35 years of age to screen for Downs Syndrome, universal alpha-feto-protein screening for neural tube defects and more widespread use of high definition ultrasound to detect cardiac and other birth defects early in gestation.

CONCLUSIONS

In conclusion, the infant mortality rate in King County has entered a period of more rapid decline. Among all causes of infant death, the decrease in the SIDS rate made the largest contribution to this reduction. The encouraging trend may be explained by reductions in risk factors for infant death through expanded health services for pregnant women, advances in medical care and changes in infant sleep position.

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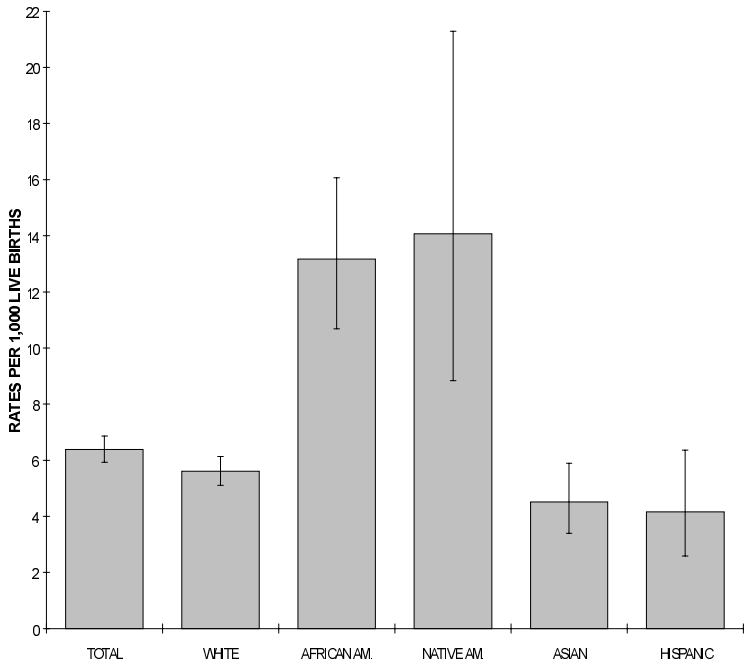
CHAPTER III. RACE/ETHNICITY AND INFANT MORTALITY

Concern about disparities in infant mortality rates across the racial/ethnic groups of King County was an important factor leading to the establishment of the Infant Mortality Review. This chapter discusses trends in infant mortality by race/ethnicity and focuses on the gap in infant mortality between African Americans and whites.

TRENDS IN INFANT MORTALITY BY RACE/ETHNICITY

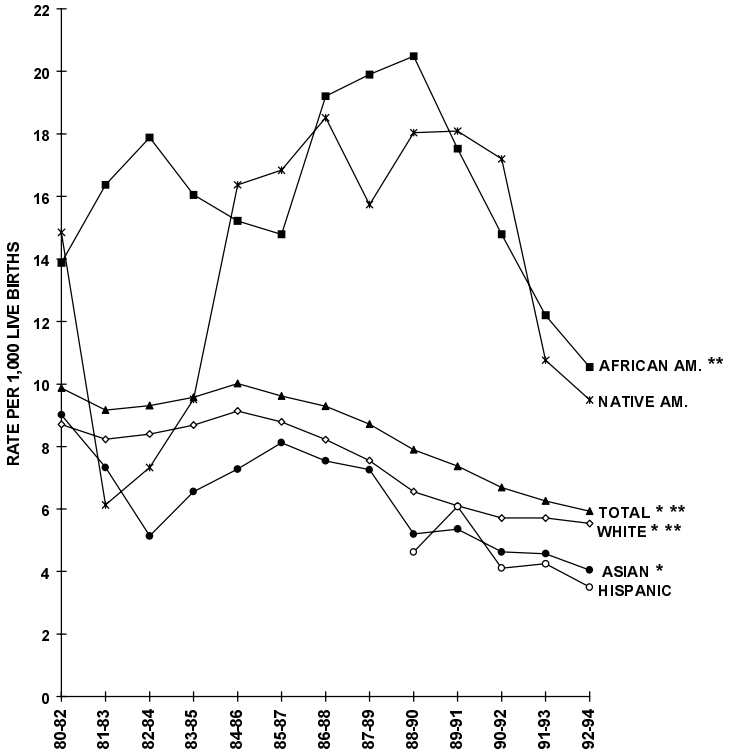
FIGURE 3.1
INFANT MORTALITY BY RACE/ETHNICITY, KING COUNTY, FIVE YEAR AVERAGE, 1990-1994



SOURCE: BIRTH AND DEATH CERTIFICATES.

Infant mortality varied significantly across the major racial/ethnic groups living in King County (Figure 3.1). The rates were higher than average among African Americans and Native Americans. Compared with whites, their rates were 2.4 and 2.5 times higher, respectively, during the 1990 to 1994 period. If their rates had been equal to the rate among whites, 11 fewer African American infants and 3 fewer Native American infants would have died each year during this five-year period. An average of 93 white, 19 African American, 11 Asian, 4 Native American and 4 Hispanic infants died each year during this time period.

FIGURE 3.2
INFANT MORTALITY BY RACE/ETHNICITY, KING COUNTY, 1980-1994

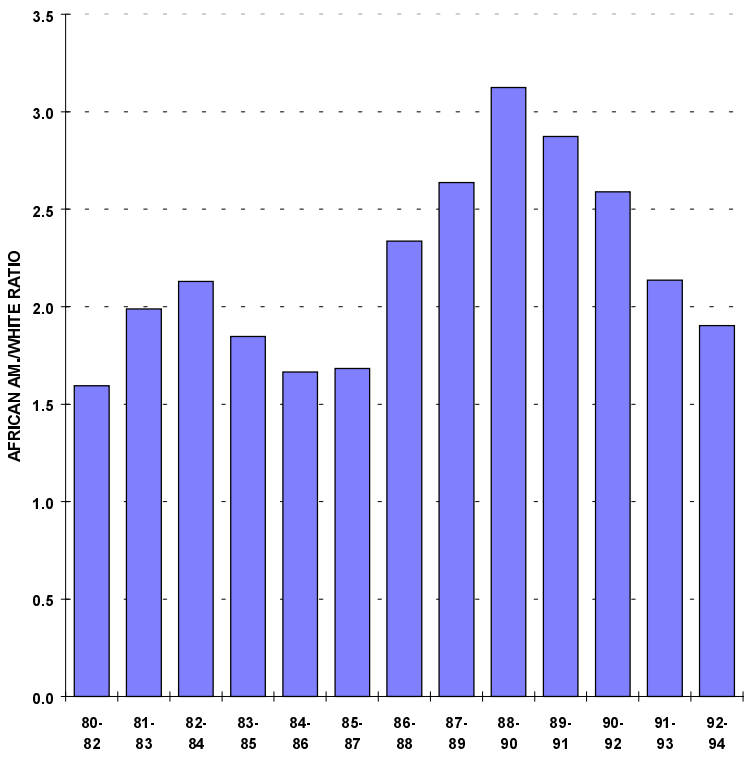


* THIS TREND FROM 1980-1994 IS A STATISTICAL SIGNIFICANT DECREASE.
** THIS TREND FROM 1988-1994 IS A STATISTICAL SIGNIFICANT DECREASE.
SOURCE: BIRTH AND DEATH CERTIFICATES.

The patterns of infant mortality over time also differed among the groups (Figure 3.2). The white infant mortality rate fluctuated without significant change from 1980 to 1984, then decreased significantly, dropping most rapidly between 1989 to 1990. The rate seems to have plateaued in recent years.

Among African Americans, the rate generally increased through 1990, and then began a dramatic decline in 1991. The small number of deaths among Native Americans makes trend interpretation difficult, but the rate appeared to increase in the early 1980s, remained high in the late 1980s and then declined beginning in 1991. Asians showed a fluctuating pattern until 1988, when the rate began a general downward trend. Data on Hispanics became available in 1988; since that time, their infant mortality rate has generally trended downwards.

FIGURE 3.3
AFRICAN AMERICAN/WHITE RATIO FOR INFANT MORTALITY, KING COUNTY, THREE YEAR ROLLING AVERAGES, 1980-1994



SOURCE: BIRTH AND DEATH CERTIFICATES.

The disparity in infant mortality between Native and African Americans on the one hand and whites on the other has consistently been a cause for concern. The ratio between African American and white rates reached a peak of 3.1 in the 1988 to 1990 period (Figure 3.3). At that time, an average of 19 more deaths occurred each year among African Americans infants relative to the expected number, had they had the same rate as whites. By the 1992 to 1994 period, the African American/ white ratio declined to 1.9 and the average number of excess deaths per year dropped to 8. The infant mortality gap[a] between African Americans and whites decreased from 13.9 to 5.0 per 1,000 live births.

The gap between Native Americans and whites peaked at 12.0 deaths per 1000 live births in the 1989 to 1991 period and has since decreased to 4.0 during the 1992-94 period.

The decrease in the gap for both Native and African Americans is encouraging. However, more work remains if King County is to reach the goal of eliminating the gap completely. To do so, a better understanding of the factors causing the gap is needed. We explore potential explanations of the gap and its decline in the next section. We focus on the African American/white disparity because the relatively small number of deaths among Native Americans makes further analysis difficult.

[a] The infant mortality gap, or rate difference, is defined as the African American infant mortality rate minus the white infant mortality rate: $IMR_{African\ American} - IMR_{white}$.

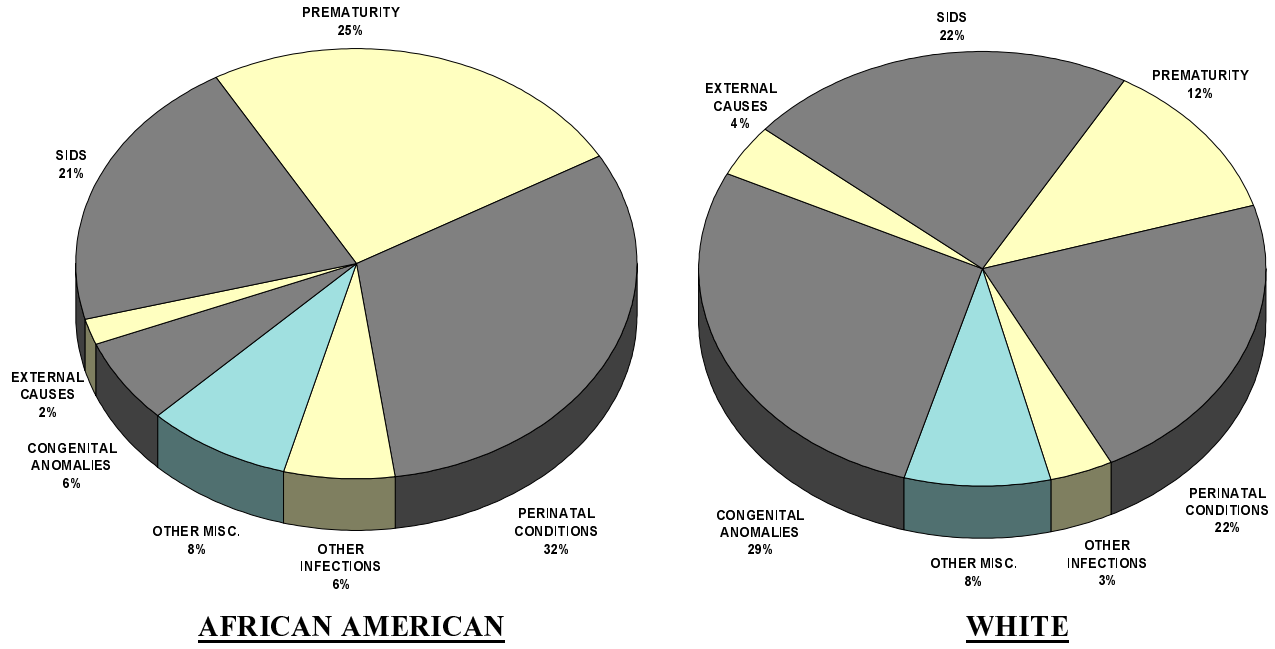
TRENDS IN AFRICAN AMERICAN INFANT MORTALITY

This section examines the trends in specific causes of infant deaths and trends in risk factors for infant deaths among African Americans. This allows us to better understand the reasons for the high infant mortality rate among African Americans and the recent improvement in the rate.

CAUSES OF DEATH

The leading causes of infant mortality differed among African Americans and whites (Figure 3.4). Prematurity and perinatal conditions figured more prominently among the deaths of African American infants while congenital anomalies made up a larger share of deaths among whites. This difference may have been due in part to the larger role that adverse social and economic conditions play in the causation of deaths from prematurity and perinatal conditions. African Americans are more likely to be exposed to such conditions than whites. SIDS (Sudden Infant Death Syndrome) accounted for slightly more than 20 percent of deaths in both groups.

FIGURE 3.4
MAJOR CAUSES OF INFANT MORTALITY, AFRICAN AMERICANS COMPARED TO WHITES, KING COUNTY, 1992-1994

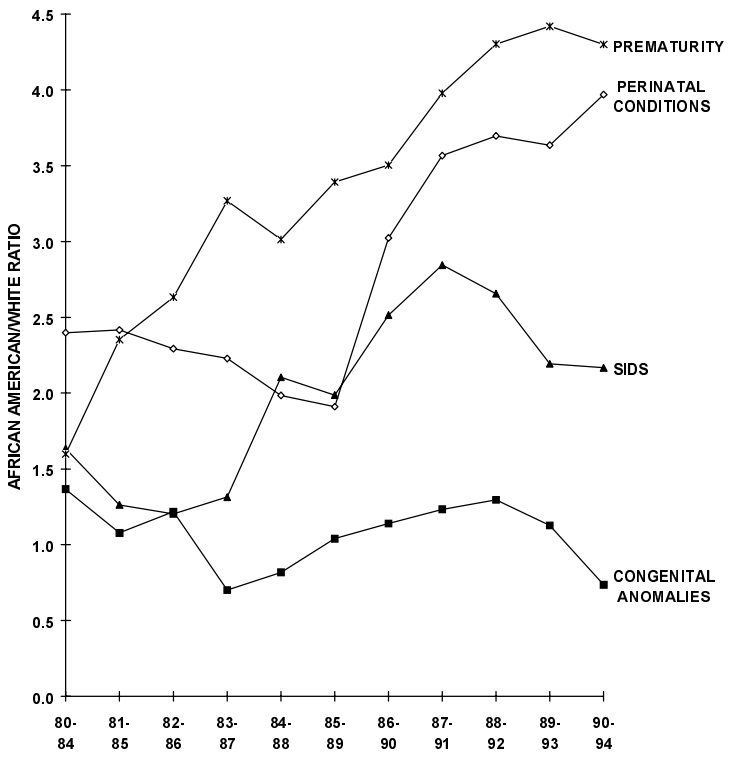


SOURCE: BIRTH AND DEATH CERTIFICATES.

Trends in the four major causes of death (prematurity, perinatal conditions, SIDS and congenital anomalies) differed between blacks and whites. Infant deaths from all of these causes decreased among whites, beginning in the mid-1980s, with the largest declines occurring in SIDS and prematurity. Among African Americans, mortality decreased from SIDS, prematurity and congenital anomalies since the mid 1980s but deaths from perinatal conditions rose and only recently began to decline.

These differing trends in causes of death among African American and white infants, lead to prematurity and perinatal conditions having the highest African American-to-white death ratios among the major causes of death. (Figure 3.5)

FIGURE 3.5
MAJOR CAUSES OF INFANT MORTALITY, RATIO OF AFRICAN AM. TO WHITE RATES, FIVE YEAR ROLLING AVERAGES, 1980-1994



SOURCE: BIRTH AND DEATH CERTIFICATES.

The large decrease in the SIDS rate among African Americans contributed most to narrowing the infant mortality gap between the 1988-90 and 1992-94 periods, accounting for nearly 40 percent of the decrease.

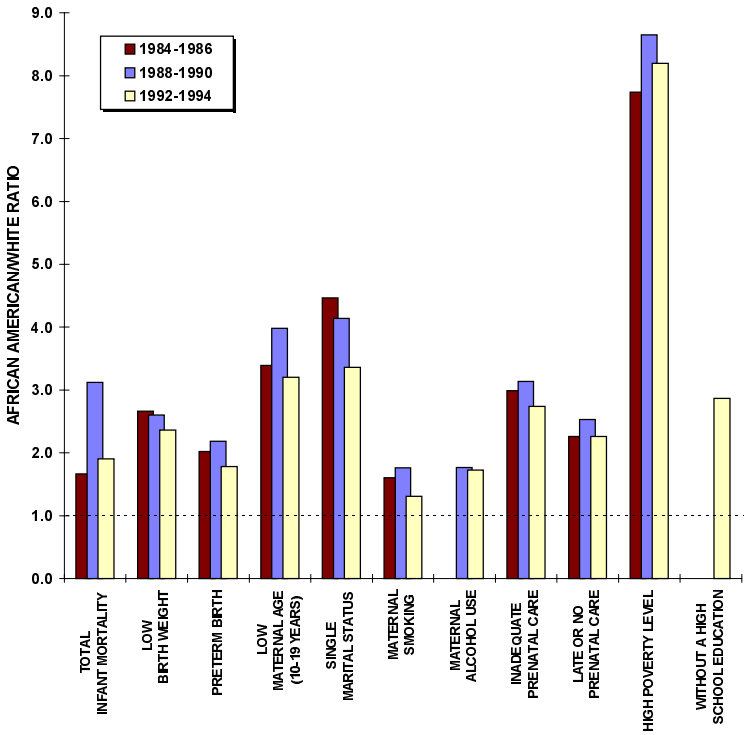
Declining rates of deaths from prematurity and congenital anomalies also contributed to closing the gap. During the 1992-94 period, perinatal conditions and prematurity were the largest components of the gap, each contributing 40 percent of the total.

Future efforts to narrow the gap between African Americans and whites should focus on prevention of prematurity and assuring that infants are placed on their backs to sleep.

RISK FACTORS

African Americans had higher levels of measured risk factors for infant death relative to whites. For example, the low birthweight rate for African American infants was 2.4 times higher than that of whites. The smoking rate among pregnant women was 1.3 times higher and the rate of inadequate prenatal care was 2.7 times higher during the 1992-94 period.

FIGURE 3.6
RATIOS OF BIRTH INDICATORS, AFRICAN AMERICAN TO WHITE, KING COUNTY, 1980-94



HIGH POVERTY LEVEL: PERCENT OF ALL BIRTHS OCCURRING IN HIGH POVERTY CENSUS TRACTS
WITHOUT HIGH SCHOOL EDUCATION: PERCENT OF ALL BIRTHS AMONG WOMEN AGE 20 OR OLDER WHO HAVE NOT COMPLETED HIGH SCHOOL
*DATA ON EDUCATION STARTED TO BE COLLECTED SINCE 1992.
SOURCE: BIRTH AND DEATH CERTIFICATES.

The effects of the measured risk factors explain nearly all (80 percent) of the increased risk of death among African American infants.[b] As shown in Figure 3.6, the occurrence of risk factors among African Americans relative to whites increased in the late 1980s and then declined.

The improving African American / white ratios for low birthweight, preterm birth, teen birth and unmarried parents were primarily due to declining rates of risk factors among African Americans, as shown in Table 3.1.

[b] The crude odds ratio of infant death among African Americans relative to whites was 2.1. After adjustment for maternal age, adequacy of prenatal care, alcohol and smoking, maternal education and marital status, the odds ratio decreased to 1.2 (95 percent CI: 0.59-2.55).

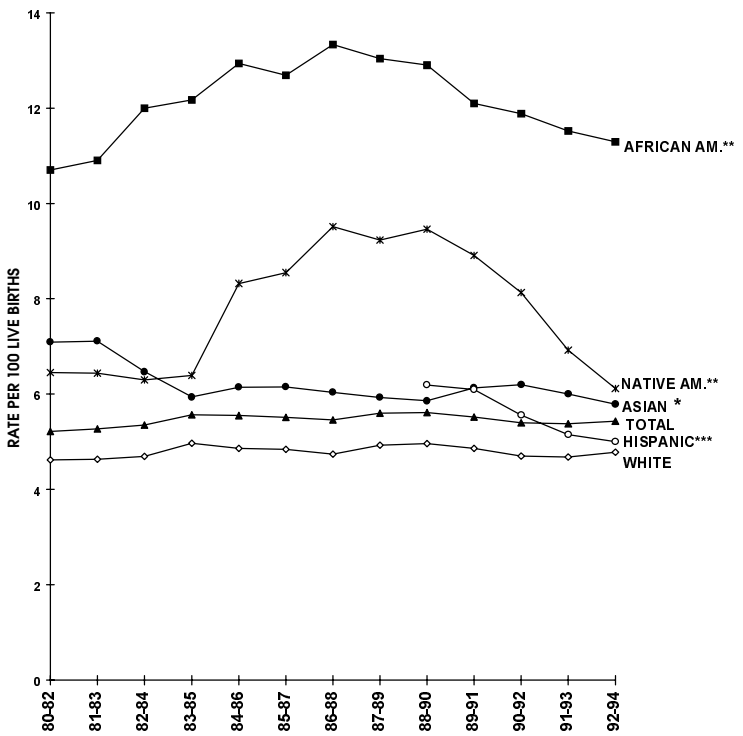
TABLE 3.1
INFANT MORTALITY RISK FACTOR TRENDS
KING COUNTY
FROM 1988-1990 TO 1992-1994

	1988-1990		1992-94		% change: 88/90 - 92/94	
Risk Factor	white	African American	white	African American	white	African American
Low Birthweight	4.98	12.99	4.78	11.29	-4.02	-13.09
Preterm Birth	8.09	17.73	8.24	14.68	1.85	-17.20
Inadequate Prenatal Care	10.13	33.05	7.49	20.59	-26.06	-37.70
Teen Pregnancy	5.51	21.90	5.86	18.79	6.35	-14.20
Unmarried Parents	15.72	65.14	18.21	61.21	15.84	-6.03
Smoking	20.02*	33.43*	15.48	20.21	-22.68	-39.55
Drinking	6.20**	10.97**	3.98	6.88	-35.81	-37.28

*Data from 1986-88 because of inconsistent data between 1989-91
**Data from 1989-90 because first year data were collected was 1989

These improvements in risk factors among African Americans partially explained the narrowing African American/white gap in infant mortality. Despite these improvements, risk factor levels remained high among African Americans.

FIGURE 3.7
LOW BIRTH WEIGHT
BY RACE IN KING COUNTY
THREE YEAR ROLLING AVERAGES, 1980-1994

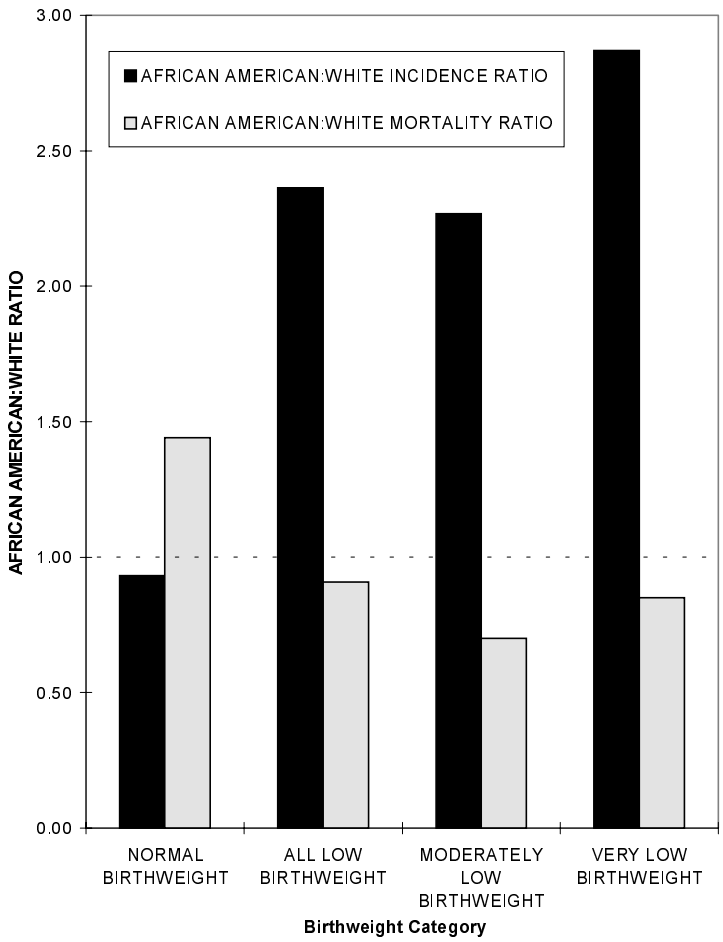


* TREND FROM 1980-1994 IS A STATISTICALLY SIGNIFICANT DECREASE
** TREND FROM 1988-1994 IS A STATISTICALLY SIGNIFICANT DECREASE
*** TREND FROM 1989-1994 IS A STATISTICALLY SIGNIFICANT DECREASE
SOURCE: BIRTH CERTIFICATES.

Their presence shows the need for further progress. Low birthweight is a particularly significant cause of infant death. A decrease in the low birth weight rate and/or improved survival among low birthweight infants would result in a lower infant mortality rate.

As the following data suggest, it is the higher low birthweight rate among African Americans rather than poorer survival of low birthweight African American infants that contributed to the infant mortality gap. Similarly, it was the improvement in the low birthweight rate among blacks relative to whites that led to a lessening of the gap in recent years. The total, white, and Asian low birthweight rates in King County have not changed since 1980, while the African American, Native American and Hispanic rates have improved since the late 1980s (Figure 3.7).

FIGURE 3.8
LOW BIRTHWEIGHT INCIDENCE AND MORTALITY
AFRICAN AMERICAN TO WHITE RATIOS
KING COUNTY, 1992-1994



SOURCE: BIRTH AND DEATH CERTIFICATES.

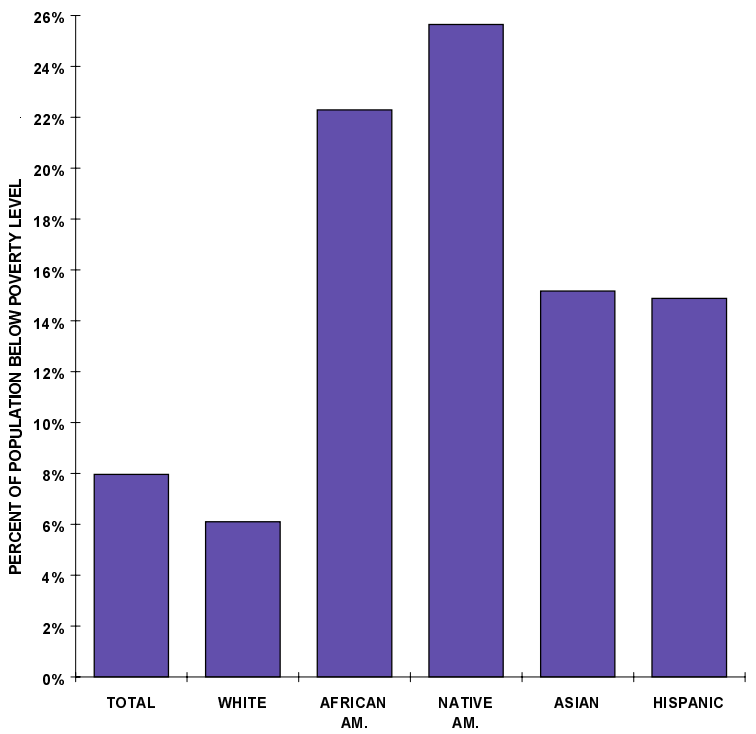
While the *occurrence* of low birthweight infants is higher among African Americans, Figure 3.8 shows that the *mortality rate* of these low birthweight infants is actually lower among African Americans. This means that reducing the *occurrence* of low birthweight among African Americans is a key strategy for decreasing infant mortality.

The most important strategy for reducing the low birthweight rate among African Americans is to decrease the occurrence of premature births. The preterm birth rate among black babies has decreased significantly since 1988, as shown above in Table 3.1. Improving access to prenatal care, further reducing smoking and substance abuse, diagnosing and treating genital tract infections and addressing stress and lack of social support are all potential interventions to further reduce preterm births.

We can conclude from this analysis that risk factors available from birth certificate explain most of the excess deaths among infants born to African American mothers and that decreases in these risk factors (especially those causing preterm births) are partly responsible for the decreasing infant mortality gap.

In addition, exposure to unmeasured factors such as higher levels of family and personal stress or lower levels of social support can put African American infants at risk.

FIGURE 3.9:
POVERTY RATES BY RACE
KING COUNTY, 1989



SOURCE: 1990 CENSUS.

The next question to address is *why* risk factors are more common among African Americans. Lower socioeconomic status among African Americans may be part of the answer (Figure 3.9). As described in Chapter II, low socioeconomic status is associated with the measured risk factors for infant death. The federal poverty level is a good measure of socioeconomic status because it takes into account both income and the number of people in a household supported by that income. African Americans (and Native Americans) living in King County are much more likely to live in poverty than whites. In 1989, over 22 percent of African Americans in King County lived in households with incomes below poverty level, compared to six percent of whites. An even higher proportion of Native Americans lived in poverty.

In addition, 23.6% percent of African American births occurred among women living in high poverty census tracts while only 2.9% percent of white mothers lived in these tracts.

Therefore, a portion of the higher rates of infant mortality and risk factors among African American families may have been due to their higher poverty level. Although vital records do not have income information, level of education was added to the birth certificate data in 1992. Education is another useful marker of socioeconomic status. Maternal education attainment of less than twelve years was associated with a 1.3 fold increase in risk of infant death and explained up to 40 percent of the increased risk among African Americans, even after controlling for the presence of other risk factors. The higher ratio of risk factors may in part be due to the impact of discrimination and racism,[1] which may lead to harmful coping mechanisms, increase stress and discourage the use of appropriate health services. Further research is needed to identify these additional factors and to develop and evaluate interventions to address them.

CONCLUSIONS

Infant mortality rates are higher among African and Native Americans than among other ethnic groups in King County. A large portion of this infant mortality gap is explained by the lower socioeconomic status of these groups as well as by the increased rates of measured risk factors for poor birth outcomes such as inadequate prenatal care, smoking, alcohol use and single marital status. Additional unmeasured risk factors most likely also play an important role, including the effects of racism and discrimination, stress and lack of social support.

The gap in infant mortality between Native and African Americans had diminished in recent years. Measured risk factors have declined in these groups. Especially noteworthy is the decline in the occurrence of low birthweight infants among Native and African Americans; no change occurred in the rate among whites. A large part of the decrease in the low birthweight rate is due to the decline in preterm deliveries. It appears that public health and community efforts to reduce the gap are producing good results. Further efforts are needed to continue this progress and should focus on reducing risk factors for preterm birth through improving access to prenatal care, further reducing smoking and substance abuse, diagnosing and treating genital tract infections and addressing stress, discrimination, racism and lack of social support. Another important tool to decrease the gap is to emphasize safe (supine) sleep positions for infants to prevent SIDS.

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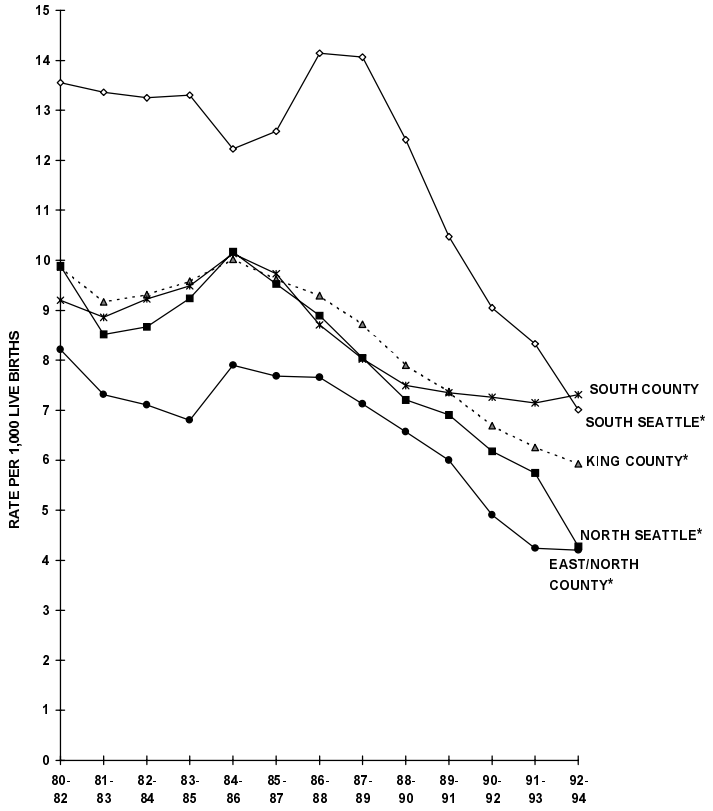
CHAPTER IV. REGIONAL VARIATION IN INFANT MORTALITY WITHIN KING COUNTY

King County is quite large and diverse. Consequently, the health status of its population varies among its different regions. This chapter describes trends in infant mortality, causes of infant death and risk factors by region.

TRENDS IN INFANT MORTALITY BY REGION

The infant mortality rate during the 1992 to 1994 period was significantly higher in the South Seattle and South County regions than in the North Seattle and East/ North County regions. Trends in infant mortality also varied across the regions. While all regions experienced slight increases in the early 1980s and decreases in the late 1980s, the South County rate stopped declining in recent years while the other regions continued to show improvements (Figure 4.1).

FIGURE 4.1
INFANT MORTALITY RATES
KING COUNTY, SEATTLE,
SOUTH CO., EAST/NORTH CO.
THREE YEAR ROLLING AVERAGES, 1980-1994



* THIS TREND FROM 1989-1994 IS A STATISTICALLY SIGNIFICANT DECREASE.
TRENDS FROM 1980-1994 ARE A STATISTICALLY SIGNIFICANT DECREASE FOR KING COUNTY AND ALL REGIONS
SOURCE: BIRTH AND DEATH CERTIFICATES.

As a result of these divergent trends, the South Seattle rate, which was 62 percent higher than the South County rate in the 1986-88 period, reached parity with the South County rate by 1992-94.

The steeper and more sustained decline in the North Seattle rate relative to the East/North County rate resulted in these two rates becoming equal by the 1992-94 period.

North Seattle registered the largest percentage decline (56 percent) in infant mortality between the high period of 1983-85 and the most recent 1992-94 period. South County had the smallest percentage decline (25 percent) for the same period.

The largest absolute decline took place in South Seattle (6.1 per 1000) while the smallest occurred in South County (2.4 per 1000).

TRENDS IN CAUSES OF INFANT DEATH

Infant mortality from each of the four major causes of death (congenital anomalies, perinatal complications, prematurity, SIDS) declined in each of the regions from the 1984-86 period of high infant mortality to 1992-94, the most recent period examined (Table 4.1). While all regions demonstrated decreases in the SIDS rate, South County showed smaller absolute and proportional decrements. South County also lagged behind in reduction of deaths due to prematurity. Both South Seattle and South County had smaller than average declines in deaths due to perinatal conditions. North Seattle showed marked improvement in the death rates due to prematurity and perinatal conditions. South Seattle posted impressive decreases in deaths from SIDS and prematurity.

TABLE 4.1
CHANGES IN MAJOR CAUSES OF INFANT MORTALITY BY REGION OF KING COUNTY, 1984-86 VS. 1992-94

SIDS	1984-1986* RATE	1992-1994* RATE	DECREASE* IN RATE	DECREASE IN RATE
KING COUNTY	2.94	1.38	1.56	53%
SOUTH KING COUNTY	3.10	2.02	1.08	35%
EAST/NORTH KING COUNTY	2.28	0.61	1.67	73%
NORTH SEATTLE	2.73	0.97	1.76	64%
SOUTH SEATTLE	3.90	1.55	2.35	60%
PERINATAL CONDITIONS				
KING COUNTY	2.23	1.44	0.79	35%
SOUTH KING COUNTY	2.08	1.58	0.50	24%
EAST/NORTH KING COUNTY	1.91	1.13	0.78	41%
NORTH SEATTLE	2.45	0.97	1.48	60%
SOUTH SEATTLE	2.64	2.06	0.58	22%
CONGENITAL ABNORMALITIES				
KING COUNTY	2.03	1.38	0.65	32%
SOUTH KING COUNTY	2.13	1.58	0.55	26%
EAST/NORTH KING COUNTY	1.91	1.28	0.63	33%
NORTH SEATTLE	2.35	1.36	0.99	42%
SOUTH SEATTLE	1.48	1.03	0.45	30%
PREMATURITY				
KING COUNTY	1.65	0.77	0.88	53%
SOUTH KING COUNTY	1.39	0.95	0.44	32%
EAST/NORTH KING COUNTY	1.05	0.56	0.49	47%
NORTH SEATTLE	1.79	0.19	1.60	89%
SOUTH SEATTLE	2.74	1.13	1.61	59%

* DEATHS PER 1000 LIVE BIRTHS

TRENDS IN RISK FACTORS

The measured risk factors for infant death did not change uniformly across the regions of King County (Table 4.2). South Seattle showed the largest percentage decreases for all factors and the smallest increase in single marital status. Despite these favorable changes, the occurrence of all risk factors remained highest among South Seattle births. South County had either the smallest decreases or largest increases in all risk factors and tended to have the second highest rates of occurrence of risk factors. East/North County usually had the lowest levels of risk factors.

These patterns are consistent with the large drop in infant mortality observed in South Seattle and the stagnation of the rate in South County.

TABLE 4.2
CHANGES IN RISK FACTORS FOR
INFANT MORTALITY BY REGION OF KING COUNTY, 1984-86 vs. 1992-94

	INFANT MORTALITY*			LOW BIRTH WEIGHT**			PRETERM BIRTH**		
REGION	1984-86	1992-94	PERCENT CHANGE	1984-86	1992-94	PERCENT CHANGE	1984-86	1992-94	PERCENT CHANGE
NORTH SEATTLE	10.17	4.28	-57.92	5.41	4.93	-8.87	8.15	8.35	2.45
SOUTH SEATTLE	12.23	7.01	-42.68	8.07	7.18	-11.03	11.82	11.24	-4.91
EAST/NORTH COUNTY	7.90	4.20	-46.84	4.47	4.50	0.67	7.37	8.30	12.62
SOUTH COUNTY	10.14	7.31	-27.91	5.37	5.66	5.40	8.92	9.44	5.83
	INADEQUATE PRENATAL CARE**			SINGLE MARITAL STATUS**			TEEN MATERNAL AGE**		
REGION	1984-86	1992-94	PERCENT CHANGE	1984-86	1992-94	PERCENT CHANGE	1984-86	1992-94	PERCENT CHANGE
NORTH SEATTLE	4.47	3.05	-31.77	14.04	17.61	25.43	4.13	3.99	-3.39
SOUTH SEATTLE	10.82	7.30	-32.53	36.68	39.55	7.82	13.33	11.35	-14.85
EAST/NORTH COUNTY	3.20	2.67	-16.56	9.24	12.58	36.15	4.39	4.02	-8.43
SOUTH COUNTY	5.98	5.01	-16.22	17.25	25.88	50.03	8.25	9.48	14.91
	SMOKING**			ALCOHOL**					
REGION	1984-86	1992-94	PERCENT CHANGE	1984-86	1992-94	PERCENT CHANGE			
NORTH SEATTLE	14.46	10.71	-25.93	---	5.39	---			
SOUTH SEATTLE	24.39	14.64	-39.98	---	4.97	---			
EAST/NORTH COUNTY	14.57	10.66	-26.84	---	3.82	---			
SOUTH COUNTY	23.82	17.93	-24.73	---	2.89	---			

* DEATHS PER 1000 LIVE BIRTHS
** PERCENT OF ALL LIVE BIRTHS

INFANT MORTALITY AND RISK FACTORS BY HEALTH PLANNING AREA

To further understand the regional variation in infant mortality, we analyzed the rate for each of the 21 health planning areas in King County. Central and Southeast Seattle were the only areas whose rates significantly exceeded the county average during the 1990 to 1994 period. All areas within South County were above the county average with the exceptions of White Center/Skyway and Federal Way.

The following map (Figure 4.2) illustrates the variation in infant mortality rates by health planning area. The areas with the darkest shading have rates that exceed the County average by one standard deviation.

FIGURE 4.2
INFANT MORTALITY RATE IN KING COUNTY BY HEALTH PLANNING AREA
5 YEAR AVERAGE, 1990 - 1994

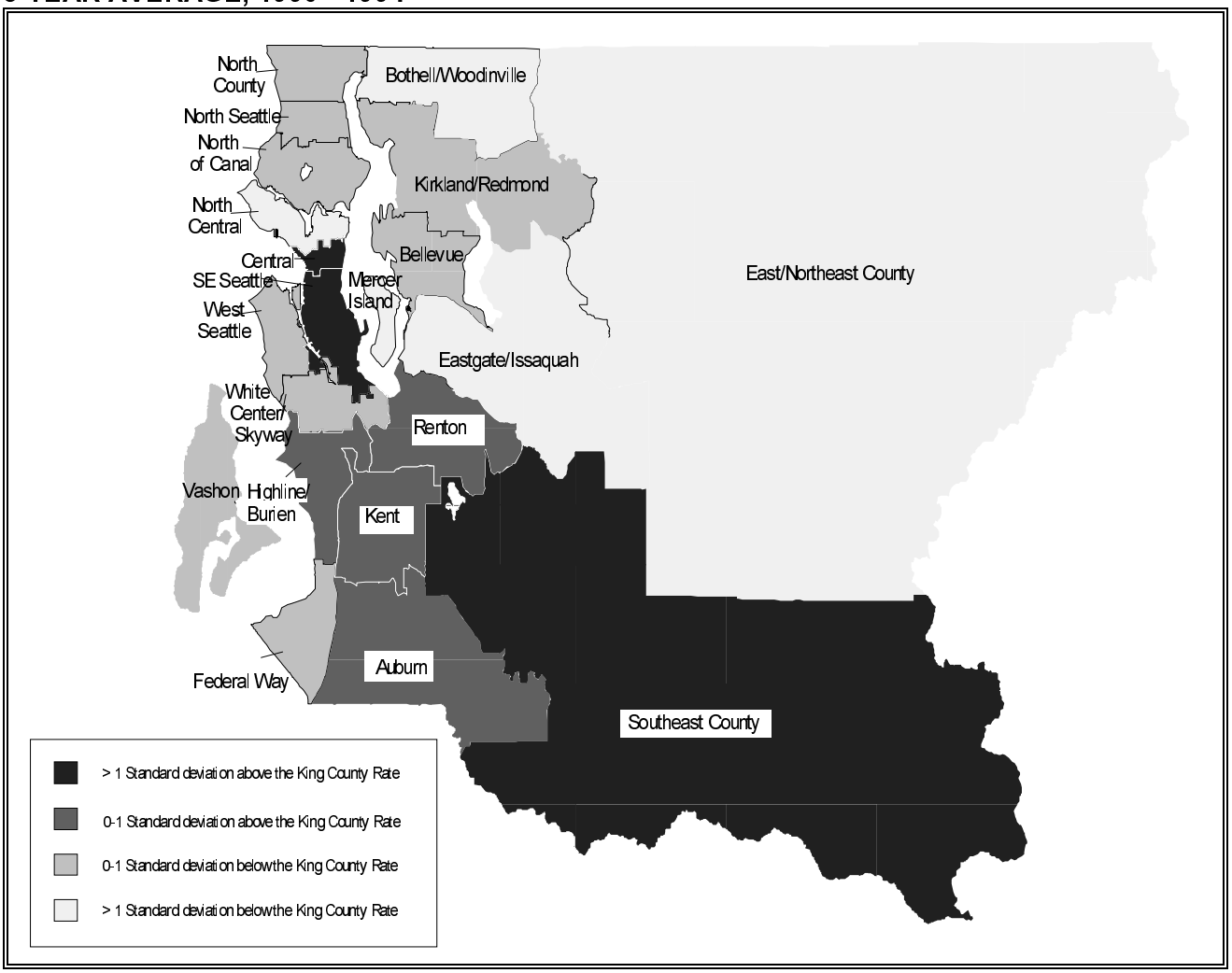


Table B.2 in Appendix B contains the infant mortality rates for each health planning area during the 1990-1994 period.

Time trends in infant mortality also varied among the small areas. The stagnation in the infant mortality rate observed in South County was apparent in all of its health planning areas except Federal Way. Even though Auburn, White Center/Skyway, Kent and Southeast County experienced sharp decreases in the late 1980s, these declines were not sustained in the early 1990s. Health planning areas elsewhere in King County demonstrated consistent declines throughout the 1990s.

CONCLUSIONS

Important shifts in infant mortality and risk factors have occurred within King County during the past decade. The improving trends in South Seattle are encouraging . They are in part due to intensive efforts to improve maternal and infant health over the past several years. In addition to the expansion of Medicaid and the First Steps programs, several community agencies have implemented outreach and education programs to help pregnant women in this area, as described in Chapter II. Because the infant mortality rate in South Seattle remains higher than average, continued efforts in South Seattle are needed to produce further gains in maternal and infant health.

The lack of improvement in infant mortality and its risk factors in South County is of concern. In part, this may be explained by the changing demographic composition of South County, although the necessary demographic data to confirm this hypothesis are not available from existing data sources. Census data are current only through 1990. Birth certificates lacked socioeconomic markers until 1992 and are therefore not useful for tracking trends. This leaves only race from birth certificates as a proxy marker for socioeconomic status. The proportion of white women among all women giving birth in South County has dropped from 92% in 1980 to 72% in 1994, while the proportions of births of African and Asian American mothers have increased. Since members of these two ethnic groups who live in South County tend to be less well off than whites, it seems reasonable to conclude that more births are occurring among women with lower socioeconomic status. It is also possible that the minority mothers who have arrived in South County more recently may experience both financial and cultural barriers to obtaining services which promote healthy pregnancies and infants. Regardless of the causes of the flattened trend in infant mortality, more efforts focused on this region of the county are in order.

CHAPTER V. CASE REVIEW METHODS

This chapter describes the process used in the case-by-case review of infant deaths. The goal of this review was to identify factors which contributed to infant deaths in King County, especially those factors which could be modified. Subsequent chapters report on the findings of the Review.

CASE IDENTIFICATION

The Review's identification of cases of infant death began in 1992 and is still ongoing. This report includes cases of infants who died between 1992 and 1994, as the review of some cases from 1995 is still ongoing.

Eligibility for the Review was limited to live born infants who died before their first birthday and whose parents were residents of King County at the time of their child's birth and death. Only King County residents were included because our aim was to describe factors specific to King County. After the first fourteen months of the Review, infants with congenital anomalies (birth defects) were excluded because few contributing factors associated with these deaths could be changed. The Review did not consider cases where homicide was the suspected cause of death because homicides comprise a very small number of King County infant deaths, averaging of 1.4 annually, and because staff working on the review could not be involved in the lengthy litigation and potential legal issues surrounding these cases.

Selection of eligible cases was made after reviewing the death certificates of all infants who died in King County and in neighboring Pierce and Snohomish counties. These were compared to death certificates collected by the Washington State Center for Health Statistics for King County infant deaths to assure complete ascertainment of all death records.

DATA SOURCES

Data were gathered from vital records (birth and death certificates), maternal and infant medical records, medical examiner reports, autopsies, transport records, and information from Child Protective Services and other social service agencies. Whenever possible, a voluntary interview with the mother or the caregiver of the infant was conducted to provide further information.

VITAL RECORDS

Birth certificates in Washington State provide generally accurate reporting of maternal and infant race, maternal age, marital status, indirect measures of socioeconomic class such as education and payer for medical insurance (Medicaid and other), gestational age, birthweight, initiation of prenatal care, smoking, and birth complications.[1] Several studies have demonstrated that the Washington State vital records contain valid data, with a very small error rate (see Appendix A under "The Validity of Vital Records Data" for more information). The major limitation of vital records is their lack of information on delivery of health and human services, social support, stress, substance abuse and poverty. Therefore, data on these factors were mainly captured through record abstraction and interviews.

RECORD ABSTRACTION

Maternal and infant medical records from hospitals and outpatient providers delivering prenatal, labor and delivery, and post-natal infant care were abstracted, using a standardized form. All records were abstracted by a specially trained physician or public health nurse. Information gathered from maternal

medical records included obstetrical history, medical conditions during the mother's pregnancy, diagnostic procedures, timing and amount of prenatal care, and medical conditions and complications during labor and delivery. From infant records we collected information on the infant's health status at the time of delivery and the subsequent course, timing and content of well-child visits and medical care for all illnesses. Medical examiner reports, autopsies, transport records, information from Child Protective Services, and social services records were also included.

INTERVIEW

The purpose of the interview was twofold: First, it gathered information from the mother or infant's primary caregiver about the mother's pregnancy, the infant's health, and the circumstances of the infant's death. Second, it provided grief assessment, support, and referral to community resources. Realizing the sensitive nature of the visit and the fragility of families following the death of a child, contacts were delayed until six weeks following each infant's death. A letter was then sent to the mother or primary caregiver, expressing sympathy over the death of the baby, explaining the Review and asking for an interview. The letter was then followed by telephone contacts by public health nurses to set an appointment time for an interview. If the nurses were unable to contact the family by telephone after several attempts spread over several weeks, or if the family had no telephone number, they then made an informal home visit to deliver the letter and encourage an interview. A $25 gift certificate was offered to those participating in the interview in recognition of their participation.

The interview, averaging about two and one half hours in length, gathered information on the social and health circumstances of the family and demographic information such as income, employment and education. Additional data were gathered on reproductive history, family composition, whether the deceased child had been planned, prenatal care, stress, available social support, and behavioral risk factors such as smoking, alcohol and drug use. Information was also collected on several aspects of delivery and post-partum care, including knowledge of different care needs, satisfaction, problems, and payment. Each family told their story of their child's death and their accounts were recorded.

The public health nurses paid careful attention to the psychological and emotional needs of family members during the interview. They assessed each individual's grieving process and offered support. This was an important part of the visit. The nurses took this opportunity to share information concerning community resources for grieving families as well as sources of help for other identified needs. Referrals were made when appropriate.

As noted, we revised the data collection process in the beginning of 1993, because we had found that infant deaths due to congenital anomalies or to extreme prematurity revealed few modifiable contributing factors. These cases were referred to field-based public health nurses for a home visit and a screening interview. The nurses visited the mother or caregiver of the deceased infant and offered grief support and referrals to various services as deemed necessary, in addition to a brief screening interview. The interview included questions about the mother's socio-demographic characteristics, prenatal care issues, past pregnancy history, behavioral risks, stress, the amount of social support that the mother had during pregnancy, circumstances surrounding the infant's death, medical advice received during pregnancy and child birth, and services offered to her or her infant after birth and after the infant's death. The nurse also assessed the home environment (e.g., whether house or apartment, number of bedrooms, urban/rural location, number of household members and who they are, number of children, household members who smoked, and cleanliness). Data collected by the field nurses were subsequently screened by project staff and a more detailed review, including medical record abstraction and full expert panel

review, was performed for any cases with the potential of revealing new or unique modifiable contributing factors.

While much important information was available from these sources, they did not necessarily provide a complete description of the events leading to the infant's death. For example, medical records may not have recorded all the observations and actions of providers. The providers involved with the case may have had unique and important insights into the case that remained unknown to the Review committees.

CASE REVIEW PROCESS

The process used for reviewing cases is summarized in figure 5.1. The Review staff prepared a written summary of each case from all data sources which was then reviewed by one of two expert panels. The more complex cases were reviewed by the **Technical Review Committee (TRC)** consisting of:

- Obstetricians
- Pediatricians
- Family practice physicians
- Midwife
- Genetic counselor
- Epidemiologists
- Associate Medical Examiner
- Social workers
- Hospital and public health nurses
- Representative of Child Protective Services (CPS).

The less complicated cases were reviewed by the **Brief Review Committee (BRC)**, a smaller panel composed of:

- Obstetrician
- Family practice physician
- Pediatrician
- Nurses
- Epidemiologists

In each case, the committees reached consensus on the cause of death and then identified factors which contributed to the death. A factor was considered a **contributing factor** if, in the opinion of the panel, it was reasonably likely to have been part of a causal pathway leading to the death of the infant. The determination of whether a factor was contributing was reached on a case-by-case basis. The same factor may have been judged to have contributed to death in one case because of the context in which it occurred but not to have contributed in another.[a]

[a] For example, a mother went into preterm labor and laboratory tests detected use of cocaine at the time of delivery. The committee deemed her drug use to be contributory to fetal distress and premature delivery. However, in another case, the infant of a mother who admitted to cocaine use prior to her pregnancy diagnosis was born prematurely. The newborn died of a respiratory infection acquired while hospitalized for prematurity. The TRC decided that the infant's lung problems, caused by prematurity, and the acquired infection both contributed to the infant's death. There was insufficient evidence in this case to implicate drug use as contributing to the death.

Contributing factors were rated for their *importance* in causing the infant's death. In addition, the committees assessed whether the factor was of high, moderate or low *modifiability* through health, social service or other interventions. Determination of importance and modifiability was also case-specific. Multiple factors were identified in many cases. Cases where the cause of death was unknown were not assigned contributing factors. Because the cause of SIDS is unknown, the committees could not assign contributing factors to SIDS cases.

In addition to describing the contributing factors, the committees identified conditions (which we called "**associated factors**") that had the potential to adversely affect the health of pregnant women and infants, although insufficient information was available to determine whether they contributed to the specific death under review. While the range of associated factors was broad, many were social and economic issues. The latter are discussed in Chapter VII.

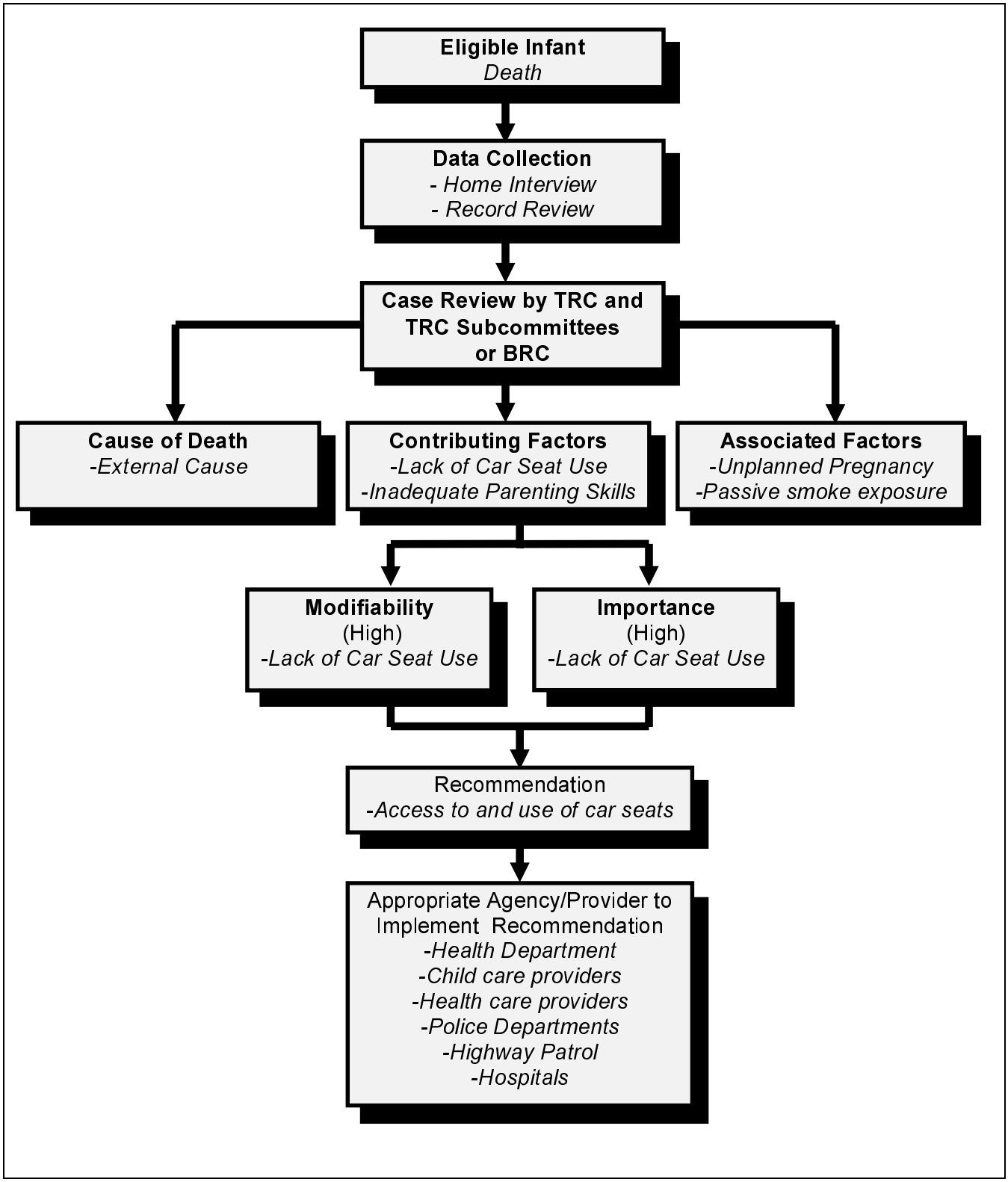
The assessment of some groups of factors required special expertise and the review committees referred them to specialized subcommittees. Three areas were initially identified for subcommittee review:

- **Obstetrical Subcommittee** - reviewed cases with factors related to pregnancy, labor and delivery, and those involving the newborn immediately after birth.
- **SIDS and Sleep Safety Subcommittee** - reviewed cases where sleep conditions and sleep safety were of interest. This included both SIDS cases and infants who died of accidental suffocation while sleeping.
- **Inadequate Support Services Subcommittee** - reviewed cases with factors related to community and ancillary services for pregnant women and infants.

After careful review of the case groupings, recommendations for interventions were made. Reports from the Support Services and Obstetrical sub-committees are included in Chapters VIII and IX of this report. The findings of the SIDS and Sleep subcommittee will be presented in a future report. Additional subcommittees will consider cases of prematurity, lack of prenatal care, substance abuse, and management of infant health problems.

Figure 5.1 illustrates the process of assigning causes and factors related to infant death:

FIGURE 5.1
PROCESS FOR ASSIGNING CAUSE OF DEATH, AND FACTORS CONTRIBUTING TO DEATH[a]



[a] Text in italics is offered as an example

HUMAN SUBJECTS PROTECTION

The protocols of this project were reviewed and approved by the University of Washington Institutional Review Board.

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[1] Frost F, Starzyk P, George S, et al.: Birth complication reporting: The effect of birth certificate design. Am J Public Health 1984; 74:505-506.

CHAPTER VI. FACTORS CONTRIBUTING TO INFANT DEATHS IN KING COUNTY: SUMMARY OF THE CASE-BY-CASE REVIEW

This chapter describes the factors contributing to infant mortality in King County as identified through the review of the cases of 247 infants who died during the 1992-94 period. During this time, 399 infants who were residents of King County died. Among these infants, 262 were eligible for inclusion in this review (refer to Chapter V for eligibility criteria). Medical records were obtained for all eligible cases, interviews were conducted for 173, and expert committee review completed for 247 (Table 6.1).

TABLE 6.1
CASE REVIEW STATUS FOR KING COUNTY INFANT DEATHS, 1992-1994

	Number of Cases	Percent of Total	Percent of Eligible
Total Infant Deaths in King County	399	100.0	---
Total Eligible for Review by Expert Panel	262	65.7	100.0
Total Reviewed by Expert Panel	247	61.9	94.3
Interviewed	173	43.4	66.0
Refused	48	12.0	18.3
Unable to Interview	41	10.3	15.6
Cases Pending Review	15	3.8	5.7

The Review identified at least one contributing factor in 49 percent of the 247 infant deaths reviewed (Table 6.2). Factors that were both highly important and highly modifiable occurred in 29 cases (12 percent of the total). The identification of these factors offers guidance in planning the next steps to further reduce infant mortality in King County.

The types of factors varied among the major causes of infant death. We therefore summarized the contributing factors for each cause of death separately. More than half of the cases within each cause of death, except congenital anomalies and SIDS, had contributing factors. Nearly all deaths caused by prematurity and external causes had contributing factors. Because contributing factors could not be assigned to cases in which the cause of death was unknown, none were assigned to SIDS cases.[a] Only cases associated with external causes and perinatal conditions had high proportions of contributing factors which were both highly important and highly modifiable. While many of the factors in the prematurity cases were highly important, few were considered modifiable.

TABLE 6.2
NUMBER OF CASES WITH CONTRIBUTING FACTORS AND WITH HIGHLY IMPORTANT/HIGHLY MODIFIABLE (HIGH IMP/MOD) CONTRIBUTING FACTORS IN EACH CAUSE OF DEATH GROUP

Cause of Death	Number of Cases	Number of Cases with Contributing Factors	Percent of Cases with Contributing Factors	Number of Cases with High Imp/ Mod Factors	Percent of Cases with High Imp/ Mod Factors
Prematurity	87	82	94.3	7	8.0
Perinatal Conditions	29	20	69.0	12	41.4
Congenital anomalies	33	5	15.2	3	9.1
External Causes	9	9	100.0	7	77.8
Other Infections	5	3	60.0	0	0.0
Other Miscellaneous	10	1	10.0	0	0.0
SIDS[1]	74	0	0.0	0	0.0
Total	247	120	48.6	29	11.7

1) BY THE DEFINITION OF CONTRIBUTING FACTOR USED BY THE REVIEW, SIDS CASES WERE NOT ASSIGNED CONTRIBUTING FACTORS (SEE TEXT)

The following sections describe in more detail the contributing factors for each major cause of death.

[a] The cause(s) of SIDS remain an area of active research.

PREMATURITY

Eighty seven infants died of prematurity or prematurity-related complications.[b] At least one contributing factor was present in 82 of these cases (94 percent). Six broad groups of contributing factors occurred among these cases (Table 6.3). The largest groups were maternal pregnancy-related health complications and problems with the delivery of health services.

TABLE 6.3
FACTORS CONTRIBUTING TO CASES WITH PREMATURITY AS CAUSE OF DEATH (TOTAL CASES = 87)

Factor Group	Cases with Factor Group	Percent of Cases with Factor Group*
Maternal health problems predating the pregnancy	3	3.4
Maternal health problems arising during pregnancy and delivery	81	93.1
Medical/Obstetrical complications of pregnancy	81	93.1
Trauma during pregnancy	1	1.1
Socioeconomic and behavioral factors during pregnancy	7	8.0
Health services problems	23	26.4
Health services problems during pregnancy	21	24.1
Health services problems during labor and delivery	6	6.9
Labor and delivery factors	3	3.4
Neonatal/Postneonatal factors	6	6.9

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

Seven of the 87 infants (8 percent) had factors that were both highly important and highly modifiable. Table 6.4 describes these factors.

TABLE 6.4
HIGHLY IMPORTANT AND HIGHLY MODIFIABLE CONTRIBUTING FACTORS FOR PREMATURITY DEATHS (TOTAL CASES =87)

Factor Group	Factor	Cases with Factor	Percent of Cases with Factor
Socioeconomic and behavioral factors during pregnancy		1	1.1
	Job-related stress due to high physical demands		
Health services problems during pregnancy and labor and delivery		6	6.9
	Inadequate patient education regarding symptoms of preterm labor/preterm premature rupture of membranes by provider		
	Inadequate evaluation and treatment of preterm labor		
	Failure to detect multiple gestation		

The following sections explore the prematurity-related factors in further detail and offer explanations of how they contributed to infant deaths.

[b] There were 5 sets of twins who died of prematurity. For conditions that pertain to mothers, such as management of preterm labor, each set is counted as one case. For conditions that are relevant to the infants, such as an infant lung infection, each infant of the twin set is counted as one case.

MATERNAL HEALTH PROBLEMS WHICH PREDATED PREGNANCY

This small group of contributing factors consisted of a maternal psychiatric problems and cases with histories of cone biopsies of the cervix. This group of factors was present in three of the mothers (3 percent) whose infants died of prematurity.

The relationship between psychological illness in pregnant women and poor birth outcomes is a poorly researched area. Some evidence exists that psychological disorders can lead to adverse pregnancy outcomes.[1 2] The effects of psychological disorders can be mediated directly through physiological mechanisms or indirectly through adverse health behaviors such as smoking, alcohol use and drug consumption.[3 4 5] Proposed physiological mechanisms include impairment in the function of the placenta resulting in impaired fetal growth or the increased production by the body of certain chemicals (catecholamines) that may precipitate preterm delivery. Psychological disorders may also constitute a barrier for a pregnant woman to adequately participate in prenatal care,[6] which in turn can hinder proper management of the pregnancy. Additionally, mental health problems can impede patient education and maternal involvement with the pregnancy. The side effects of medications used to treat mental disorders have also been associated with poor birth outcomes.[7]

Other cases in this group were women with histories of cone biopsies. Cone biopsy is used as a treatment for certain diseases of the cervix, such as cervical cancer. This procedure involves excision of tissue from the cervix, which may alter its shape and function and lead to a condition called cervical incompetence. This condition causes the cervix to open abnormally in the second trimester of pregnancy, resulting in premature birth. Under selected circumstances, a procedure called cerclage can be performed during pregnancy to prevent an early delivery due to an incompetent cervix. Infection, premature rupture of membranes, and preterm labor and delivery were conditions that accompanied the cases with a history of cone biopsy.

Although mental illness and history of cone biopsy were identified by the Review as contributing to the infant's death, none of these factors were rated as being highly modifiable due to lack of conclusive research regarding preventive measures for these conditions.

MATERNAL HEALTH PROBLEMS DURING PREGNANCY AND DELIVERY

The largest group of factors contributing to infant death due to prematurity was medical and obstetrical disorders during pregnancy. Such complications were present in 81 mothers (93 percent) whose infants died of prematurity, and consisted mainly of preterm labor, preterm premature rupture of fetal membranes,[c] chorioamnionitis, and multiple gestation.[d]

Preterm premature rupture of fetal membranes is often the event which initiates preterm labor.[8 9 10] In some cases early rupture of membranes is caused by an inflammation of the fetal membranes, known as chorioamnionitis. Chorioamnionitis is probably caused by infections such as group B streptococcus, chlamydia and bacterial vaginosis.[11 12 13] Rupture of fetal membranes can also occur due to trauma from falls or motor vehicle injuries.

None of the mothers with health problems during pregnancy had highly modifiable conditions. Despite the strong evidence that chorioamnionitis and preterm premature rupture of membranes are associated with preterm labor and delivery, and despite the high prevalence of these conditions among mothers

[c] Spontaneous rupture of the fetal membranes [bag of water] before term and the onset of labor
[d] Greater than one fetus in the womb

whose infants' died of prematurity during the review, they are not currently highly preventable conditions. More clinical and basic science research is needed to develop effective preventive measures for these conditions.

SOCIOECONOMIC AND BEHAVIORAL FACTORS DURING PREGNANCY

A total of seven prematurity cases (8 percent) had socioeconomic or behavioral factors contributing to the death of the infant. These factors included job-related physical stress and drug use.

Physically challenging work contributed to the development of preterm labor. Excessive exertion (but not ordinary levels of physical activity) during pregnancy can increase the occurrence of preterm labor.[14 15 16] Such stress can cause the body to produce certain substances (catecholamines and oxytocin) which increase contractions of the uterus (womb).[17] It can also cause the body to produce other substances (corticosteroids) that makes women more vulnerable to infections, particularly chorioamnionitis, which in turn can lead to preterm labor.

Drug use, particularly cocaine, contributed to six infant deaths. Cocaine has been reported to increase poor fetal outcomes, such as preterm birth and low birthweight.[18 19 20] In addition to the heart and brain problems that affect the mothers who use drugs,[21 22] potential hazards to the fetus include problems with the blood vessels of the brain, early separation of the placenta from the uterus and increased uterine contractions leading to preterm labor.[23 24] The abuse of cocaine in these specific cases did not appear to be preventable.

The following vignette (as are all others in this report) is a composite of several similar cases written to illustrate some of these issues while preserving the privacy of the individuals involved.

ILLUSTRATIVE VIGNETTE: Susan (a fictitious name) became pregnant for the second time when her youngest child was two years old. She had been under a great deal of stress because of arguments with her partner and difficulty finding a place to live. In the past she had used cocaine occasionally, and as the pregnancy progressed she resumed drug use. When she was 25 weeks pregnant, she went into early labor after using cocaine and delivered a premature baby. The baby died of complications of prematurity within a few hours of birth.

Tobacco is another commonly used substance that strongly increases the risk of early labor.[25 26] Smokers are at increased risk of preterm premature rupture of fetal membranes and early separation of the placenta from the uterus. [27 28] These conditions may occur because smokers have lower levels of oxygen and elevated levels of carbon monoxide in their blood, which make less oxygen available for their body tissues (including the placenta).[29] As described in Chapter II (Trends in Infant Mortality), fourteen percent of all mothers in King County smoked during pregnancy in the 1992-94 period and the mothers of 38% of the cases included in the Review were smokers. Because of the difficulty of conclusively concluding in any individual case that smoking caused that particular death, the Review decided not to include smoking as a contributing factor, but recognize smoking as an important and modifiable risk factor at the population level.

Further discussion of the socioeconomic and behavioral issues associated with infant mortality is contained in Chapter VII. A subsequent report will address issues of substance abuse among pregnant women and parents of infants.

HEALTH SERVICES ISSUES

This group was the second largest group of factors contributing to deaths from prematurity and occurred in 23 of the premature infants (26 percent). Six of these cases (7 percent) had highly important and highly modifiable factors, which made this group the largest for which interventions might reduce infant deaths. Inadequate prenatal care, inadequate management of preterm labor, patient knowledge deficits regarding symptoms of preterm labor and warning signs for obstetrical problems because of inadequate patient education by the provider, inadequate social services, and inappropriate level of delivery facility to manage the high risk status of the pregnancy were the most common contributing factors.

ILLUSTRATIVE VIGNETTE: Mary (a fictitious name) was pregnant for the fourth time. She was at increased risk for early labor because she previously had a premature birth. During this pregnancy she had some obstetrical problems and sought care from her provider. She received an ultrasound, which was normal. However, she was not checked for early signs of labor, such as opening of the cervix. That evening she was admitted to the hospital in active labor. She delivered a premature baby who subsequently died from complications of prematurity.

Further details and recommendations for interventions to improve support services and health services are presented in detail in Chapters VIII (Improving Support Services For Pregnant Women and Infants) and IX (Improving Care During Labor and Delivery).

LABOR AND DELIVERY FACTORS

Three mothers (3 percent) had factors contributing to their infant's death which were related to complications of labor and delivery. None were considered highly preventable. These conditions included precipitous labor (a condition where labor progresses so rapidly that it becomes very difficult to arrive at a medical facility before delivery occurs), and out-of-hospital unattended birth.

NEONATAL/POSTNEONATAL FACTORS

Six premature infants (7 percent) had factors arising in the period soon after birth that contributed to their death. None of them were considered preventable. These factors consisted of complications of prematurity (particularly breathing problems), infections and intrauterine growth retardation.[e]

SUMMARY

Among infants who died of prematurity, pregnancy complications and health services problems were the major contributors their deaths. The elimination of these problems would not necessarily have changed the outcomes for all of these infants because of the uniqueness of each case and the complexity of mechanisms that lead to preterm labor. Nonetheless, efforts to reduce the occurrence of these factors have great potential to improve the health of pregnant women and infants in King County. The Review will examine all cases in which prematurity was the cause of death and issue recommendations for preventing such deaths in a future report.

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[e] Intrauterine growth retardation is the delayed development and maturation of the fetus due to genetic factors, infection, maternal disease, or fetal malnutrition caused by placental problems which result in an infant whose weight and size at birth is very small (below the tenth percentile).

PERINATAL CONDITIONS

Twenty nine of the infants included in the Review died of perinatal conditions, which are problems that cause the death of an infant during the first four weeks of life They included problems with the lungs, injuries, lack of oxygen during birth and infections. At least one contributing factor was identified in twenty of these cases (69 percent). Five broad categories of contributing factors emerged (Table 6.5). Health services problems, particularly during labor and delivery, and health problems during pregnancy were the largest groups.

TABLE 6.5
CONTRIBUTING FACTORS FOR PERINATAL CONDITIONS AS CAUSE OF DEATH (TOTAL CASE =29)

Factor Group	Cases with Factor Group	Percent of Cases with Factor Group
Health problems during pregnancy	10	34.5
Medical/Obstetrical pregnancy complications	10	34.5
Socioeconomic and behavioral factors during pregnancy	2	6.9
Health services problems	17	58.6
During pregnancy	6	20.7
During labor and delivery	12	41.4
During neonatal/ postneonatal period	3	10.3
Labor and delivery factors	4	13.8
Neonatal/Postneonatal factors	2	6.9

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

Twelve of these 29 infants (41 percent) had highly important and highly modifiable contributing factors. Table 6.6 summarizes the highly important and highly modifiable contributing factors among infants dying of perinatal conditions. Most of these factors were technical issues arising during the medical management of labor and delivery.

TABLE 6.6
HIGHLY MODIFIABLE AND HIGHLY IMPORTANT
CONTRIBUTING FACTORS FOR PERINATAL CONDITIONS (TOTAL CASES =29)

Factor Group	Factor	Cases with Factor	Percent of Cases with Factor
Health services		11	37.9
During pregnancy		3	10.3
	Inadequate management of pregnancy induced hypertension.		
	Lack of patient knowledge to report decreased fetal movement promptly[1]		
During labor and delivery		9	31.0
	Delayed diagnosis and treatment of fetal distress		
	Inappropriate management of labor leading to delayed cesarean section		
	Lack of recognition of abnormal course of labor resulting in fetal distress		
	Inadequate fetal monitoring during labor		
	Failure to follow reasonable protocol for using Pitocin for induction of labor.		
	Lack of timely intubation, suctioning, and ventilation of newborn with respiratory distress.		
	Emergency services (911) not called for transport of infant with respiratory compromise to hospital		
	Discontinuity of prenatal and labor & delivery care caused by involvement of multiple providers		
During Neonatal/Postneonatal Period		2	
	Inadequate diagnosis and management of infant with sepsis (severe infection)		

[1] DECREASED FETAL MOVEMENTS MAY INDICATE FETAL ILL HEALTH

The Obstetric Subcommittee reviewed of many of these cases and developed recommendations to prevent the future occurrence of these factors (Chapter IX). While preventing them might not have changed the outcome for all of these infants because of the complexity and interaction of the various mechanisms that contributed to these deaths, avoiding these circumstances would improve infant and maternal health in King County.

CONGENITAL ANOMALIES

Thirty three of the infants in the Review died of congenital anomalies (birth defects). At least one contributing factor was assigned for five (15 percent) of these cases. Three of these 33 infants (9 percent) had highly important and highly modifiable contributing factors. Five broad categories of contributing factors were identified (Table 6.7). The factors were not concentrated in one or two specific factor groups as they were in the other causes of death.

TABLE 6.7
CONTRIBUTING FACTORS FOR CONGENITAL ANOMALIES AS CAUSE OF DEATH (TOTAL CASES = 33)

Factor Group	Cases with Factor Group	Percent of Cases with Factor Group
Maternal health history and prior adverse pregnancy outcome	1	3.0
Complications during pregnancy	1	3.0
Medical/Obstetrical pregnancy complications	1	3.0
Socioeconomic and behavioral factors during pregnancy	1	3.0
Health services problems	3	9.1
During pregnancy	1	3.0
During labor and delivery	1	3.0
During neonatal/ postneonatal period	1	3.0
Neonatal/Postneonatal factors	2	6.1

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

Table 6.8 lists the highly important and highly modifiable contributing factors for infants dying of congenital anomalies.

TABLE 6.8
HIGHLY MODIFIABLE, HIGHLY IMPORTANT CONTRIBUTING FACTORS FOR CONGENITAL ANOMALIES CAUSE OF DEATH (TOTAL CASES = 33)

Factor Group	Factor	Cases with Factor Group	Percent of Cases with Factor Group
Health services		3	9.1
During pregnancy	Lack of genetic counseling and education regarding pregnancy options despite elevated maternal risk of delivering infant with anomalies		
During neonatal/ postneonatal period	High risk pediatric surgery performed at a level II hospital instead of a level III hospital.		
Neonatal/Postneonatal infection	Hospital acquired infection after surgical repair of congenital condition		

Very few cases had highly important and highly modifiable factors. Because of this low yield, the Review stopped considering deaths caused by congenital anomalies after mid 1993. In nearly all of the cases with congenital anomalies, we noted that appropriate and aggressive interventions were performed to improve infant survival. This observation supports the hypothesis that the declining death rate of infants with congenital anomalies was in part due to improved care of these newborns.

EXTERNAL (ACCIDENTAL) CAUSES OF DEATH

Nine infants died of external causes (accidents). External causes of death included suffocation and trauma due to motor vehicle accidents. At least one contributing factor was assigned for all of these cases. Two broad categories of contributing factors were identified (Table 6.9).

TABLE 6.9
FACTORS CONTRIBUTING TO EXTERNAL CAUSES OF DEATH (TOTAL CASES=9)

Factor Group	Cases with Factor Group	Percentage of Cases with Factor Group
Socioeconomic and behavioral factors	9	100.0
During pregnancy	4	44.4
During neonatal/Postneonatal Period	5	55.6
Health Services Problems	4	44.4
During pregnancy	2	22.2
During neonatal/postneonatal period	4	44.4

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

This group, though small, had a higher proportion of cases with highly important and highly modifiable factors than any other cause of death. Seven of these nine infants (78 percent) had highly important and highly modifiable contributing factors

Table 6.10 illustrates the highly important and highly modifiable contributing factors for infants dying of external causes. In most of these cases, the infants died from accidental asphyxia (suffocation) caused by sleeping in unsafe places. Examples of unsafe locations included cribs in poor repair, sleeping on soft adult bedding or couches, or being placed in reach of dangerous objects. Other studies have confirmed the importance of dangerous sleep environments in contributing to accidental infant deaths. A study of infant deaths from unintentional injuries in Kentucky identified mechanically unsafe sleeping situations as the largest contributor.[30]

TABLE 6.10
HIGHLY MODIFIABLE, HIGHLY IMPORTANT CONTRIBUTING FACTORS FOR EXTERNAL CAUSES OF DEATH (TOTAL CASES = 9)

Factor Group	Factor	Cases with Factor	Percent Cases with Factor
Socioeconomic and behavioral factors		6	66.7
	Drug use		
	Unsafe sleep environment: Crib in poor repair; infant in unsafe noncrib location; unsafe object in crib		
	Lack of car seat use resulting in death from motor vehicle accident		
Health Services		2	22.2
	Poor coordination of services between child protective services and public health nurse		
	Lack of parent education regarding child safety		
	Inadequate public health nurse services, resulting in lack of evaluation of sleep environment for the infant.		
	Lack of coordination of services between substance abuse treatment programs, child protective services and public health department		

In most cases, several factors interacted to cause the death. For example, substance abuse may have impaired a caretaker's ability to assure a safe sleep location. A breakdown in interagency communication between Public Health Nursing, a substance abuse treatment program, and Child Protective Services resulted in a lack of evaluation of the living circumstances of a family, including an assessment of the infant's sleep environment, which would have revealed safety issues.

Many of these deaths could have been prevented by simple measures to assure that infants sleep in safe conditions such as those described in the following recommendations:

SLEEP SAFETY RECOMMENDATIONS

- Every baby needs a safe place to sleep, every time it goes to sleep, no matter where or when. This includes naps during the day as well as night time sleeping. Infants should have a crib to sleep in which is in good repair with a firm mattress. No soft bedding such as fluffy comforters, sheepskins or pillows should be under the baby or in the crib. The number of objects in the crib should be limited.
- Infants should avoid sleeping in the prone (on the stomach) position. It is safer for babies to sleep on the side or back. This includes naps as well as night time sleeping.
- Infants should not sleep on beds, couches, and other places not designed for infant sleep safety. Additionally, sleeping on couches with multiple individuals is to be avoided.
- Rocking cradles are potentially dangerous, particularly those that may have defective mechanisms for stabilizing the cradle.
- Day care and foster care facilities should provide a safe sleeping environment for each infant at all times.
- Baby-sitters should be aware of safe sleeping practices for infants.

INFECTIONS IN THE POST-NEONATAL PERIOD

Five of the infants in the Review died of infections occurring after the first four weeks of life.[f] The most common infection was caused by the respiratory syncytial virus, which causes pneumonia. At least one contributing factor was assigned for three (60 percent) of these cases. Four broad categories of contributing factors were identified (Table 6.11). None had highly important and highly modifiable contributing factors.

TABLE 6.11
FACTORS CONTRIBUTING TO INFECTIOUS CAUSES OF DEATH (TOTAL CASES = 5)

Factor Group	Cases with Factor Group	Percent Cases with Factor Group
Complications during pregnancy	1	20.0
Medical/Obstetrical complications	1	20.0
Socioeconomic and behavioral factors	1	20.0
During pregnancy	1	20.0
Health services	2	40.0
During neonatal/postneonatal period	1	20.0
Neonatal/Postneonatal factors	3	60.0

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

No particular group of factors predominated for this cause of death.

[f] Perinatal infections are discussed in Chapter IX.

MISCELLANEOUS CAUSES OF DEATH

Ten infants died of miscellaneous causes of death. These miscellaneous causes of death included unexplained cardiac arrest, apnea (cessation of breathing), and brain and blood disorders. Only one case had a contributing factor, which was not considered to be highly important and highly modifiable.

CONCLUSIONS

The Infant Mortality Review identified modifiable contributing factors in twelve percent of the infant deaths reviewed. Health and social services issues, adverse social conditions and environmental safety concerns figured prominently alongside more traditional medical, biological, and behavioral risk factors. Highly important and highly modifiable factors were most likely to be found in deaths from perinatal conditions and external causes. The Review has developed recommendations, based on their review of the cases, for improving maternal and infant health in King County (see Chapter X). These recommendations are currently being implemented by a range of health and human service agencies, voluntary community organizations and professional groups. While implementing these recommendations might not have changed the outcome in all the cases considered by the Review, doing so would help to prevent many infant deaths and contribute to further reduction in the County's infant mortality rate. Ongoing case-by-case review to assess factors contributing to infant deaths, especially among ethnic groups and geographic areas with high infant death rates, is an important tool to decrease infant mortality to its lowest possible rate.

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CHAPTER VII. SOCIOECONOMIC AND BEHAVIORAL ISSUES IDENTIFIED THROUGH CASE-BY-CASE REVIEW

The association between low socioeconomic status, poor health and infant mortality is well-established.[4-9 11 12 23] Social, economic and political factors explain more of the differences in infant mortality than health service factors.[2] The context of socioeconomically deprived mothers' lives often includes low levels of education, lack of health insurance, and high levels of personal and environmental stressors associated with deprivation. These mothers are more likely than advantaged women to use substances during pregnancy, underutilize prenatal care, have housing problems and relationship problems, and experience domestic violence and other difficulties.

The most direct strategy to reduce infant mortality due to low socioeconomic status would be to guarantee a minimal standard of living for all and to improve living conditions, income, education and employment opportunities for the economically disadvantaged. However, this strategy requires far-reaching social change and is unlikely to occur in the short term. Additional strategies to mitigate the effects of social inequity are needed. To develop these strategies, a detailed understanding of the mechanisms through which social disadvantage produces poor health and infant death is needed. Once these mechanisms are understood, interventions can be designed to address them. The Infant Mortality Review is one tool to improve our understanding.

The Review collected information on a wide range of socioeconomic and behavioral factors including domestic relationships, social support of the mother, education, income and financial problems, stress, housing problems, lack of needed services, and substance use including smoking, alcohol and drug use. Problems with parenting, safety issues in the home, and involvement of Child Protective Service (CPS) were also studied.

The review committees often could not unequivocally determine that these factors were part of the chain of events leading an infant death. In part, this was due to the difficulty of concluding that these factors were causal in a specific case. The lack of research data concerning the role of socioeconomic and behavioral issues in causing health problems resulting in infant deaths added to this difficulty. Nonetheless, the occurrence of these factors was noteworthy because of their potential for causing adverse consequences for mothers and infants.

The high prevalence of these social factors and the interplay between the medical aspects of the cases and the social and behavioral issues uncovered by the Review raise important questions for further study.

Multiple social and behavioral factors often occurred in the same case, as the following vignette illustrates:

ILLUSTRATIVE VIGNETTE: Mary Jane had a history of abuse from childhood. She dropped out of school in tenth grade and became involved with alcohol and drugs. She was soon addicted to both. When she became pregnant, due to birth control failure, her boyfriend left her without any money. She tried working at minimum-wage job, but had to quit when she began to look pregnant on the job. She was homeless during her pregnancy, and had no family or friends to help her out. She delivered a premature infant when she was 26 weeks pregnant. Her only prenatal care had been one visit to a clinic. The baby died two hours after birth from complications of prematurity.

In this case the underlying cause of death was prematurity. Although a contributing factor was drug use, the associated factors were all socioeconomic or behavioral. They included: a history of abuse; low education; low income; substance use; unplanned pregnancy; unemployment; homelessness; and low social support. A health service related associated factor was inadequate prenatal care. As in many cases, the overwhelming daily stresses and unmet basic needs in Mary Jane's life combined to make her health and that of her fetus a low priority. The factors outlined in this vignette will be discussed in greater detail below.

The following sections describe the social, economic and behavioral issues found among women included in the Review. Table 7.17, at the end of this chapter, summarizes these issues.

LOW MATERNAL EDUCATION

Educational attainment is important as an indicator of the level of general knowledge of the mother and because of the relationship of education employment. Limited education has been found to be a risk factor for low birthweight, other poor birth outcomes,[10] and infant mortality.[23] Low education has been correlated with higher rates of smoking, less seat belt use, higher alcohol and drug abuse, failure to get children immunized, and lower incomes.[11] In an analysis of data from several countries, significantly elevated risks of dying throughout the first two years of life was associated with low maternal education.[12] In the Review, cases were considered "low education" if the education of the mother was eleven grades of schooling or less. A total of fifty-two cases (26 percent) met this criteria, a much higher number than among all King-County births (10.5 percent) .(See Table 7.1). This is highly significant.

TABLE 7.1
LEVEL OF MATERNAL EDUCATION: REVIEW CASES VS. ALL BIRTHS

Maternal Education	IMR Cases (%)	KC Births (%)*
≤11 Years	52 (25.7)	5,756 (10.5)
≥12 Years	150 (74.3)	49,163 (89.5)
Total	202 (100)	54,919 (100)
Unknown	45	12,415

THE ODDS RATIO FOR LOW EDUCATION FOR IMR CASES COMPARED TO ALL KC BIRTHS WAS 3.0 (95% CI: 2.1-4.1)
*DATA SOURCE: KING COUNTY BIRTH CERTIFICATES, 1992-1994

LOW INCOME

Income level is an important marker for determining the resources available to families not only for the basic needs of life such as food and housing but also for health care services. The growing number of infants and children in low income families in the United States has been an area of great concern in public health. These families are at risk for a variety of health problems, including increased risk of infant mortality and child death [1 2 4-9 11 12 23]. Women who are economically deprived are at risk for poor outcomes such as low birthweight and premature birth.[18] These two conditions account for approximately 75 percent of the nations' neonatal mortality.[19] Low income children have double the incidence of low birthweight compared to children of higher income.[4] Medicaid recipients have also been found to have higher rates of underweight birth and infant mortality than non-Medicaid sponsored women.[10] Low income pregnant women are nearly twice as likely as advantaged women to be uninsured and delay seeking prenatal care.[18]

In this report, low income was defined according to the Federal Poverty Guidelines. In 1994, 185 percent of Federal Poverty Level was $2,154 per month for a family of four. This threshold was used because in Washington pregnant women are considered Medicaid eligible at 185 percent of the federal poverty level. Eighty (46.5 percent) Infant Mortality Review cases had low incomes.

When compared with the King County population cases were much more likely to live in poverty. (Table 7.2)

TABLE 7.2
INCOME DIFFERENCES BETWEEN KING COUNTY POPULATION AND IMR CASES

Income Levels	IMR Cases (%)**	Total Population*
Less than or equal to 185% of Poverty	80(46.5)	259,615(17.6)
Greater Than 185% of Poverty	92(53.5)	1,217,447(82.4)
Total	172(100)	1,477,062(100)
Unknown	75	0

* SOURCE FOR KC TOTAL POPULATION IS THE 1990 CENSUS INCOME DATA
** INCOME INFORMATION FROM IMR CASE DATA SOURCES
THE ODDS RATIO FOR LOW INCOME FOR IMR CASES COMPARED TO KC TOTAL POPULATION WAS 4.1 (95% CI: 3.0-5.6).

LACK OF TRANSPORTATION

Transportation problems are more likely to be experienced with low income mothers, and difficulties with transportation have been cited as a major barrier to access to prenatal care.[8 9 18 20 21] Lack of transportation was listed as a factor when it was known to be a problem for the mother or affected the infant. For example, lack of transportation was noted when it interfered with accessing needed medical care. In this study, lack of transportation was under-reported, because only interviewed mothers were asked if transportation was a problem. Lack of transportation was cited as a known factor in only six cases (2.4 percent). In one case lack of transportation was considered to be contributory to the death because the infant was not taken for medical care soon enough. No car was available when the baby became ill.

LACK OF SOCIAL SUPPORT

Social support influences health seeking behaviors and may be a motivation for seeking prenatal care.[24] Social support also has a direct link with mental health because the unavailability of support when needed is strongly associated with depression in pregnant women.[24] Lack of social support and associated depression in pregnancy is increased in low income women.[25] Depression in pregnancy has been linked with poor outcomes such as low birthweight and prematurity.[25 26] Social support may also serve as a buffer against stress and help motivate women to adopt healthier behaviors. Social isolation and lack of social resources were recognized by the committee as important factors for the health and well-being of both mother and infant. An illustration of a family with low social support is described in the following example:

ILLUSTRATIVE VIGNETTE:
Irene and her family moved to King County during the pregnancy. They had moved frequently during the past few years and had lost contact with most of their relatives who lived on the East coast. The father worked long hours doing hard physical work. In the evening he usually liked to go out to play pool. He was often gone on weekends. He was unhappy about the pregnancy. The mother stayed at home all day with three small children. She had not made any friends in the neighborhood and did not belong to any organizations. When asked who were those that provided social support during the pregnancy, she cited her mother, with whom she spoke once or twice a month by phone, and her six year old daughter. The baby was healthy at birth but died of SIDS at three months of age.

Information concerning maternal social support systems was available primarily on the one hundred seventy-three cases (70.0 percent) who were interviewed. Assessment was done during the home interview to gather information on the number of people involved with the mother, frequency of the contacts or type of support available. A mother was considered to have low social support when she had only one or two people that she could list as friends or family who were supportive, and/or if contacts with these people were infrequent. Inadequate social support to assist with the duties of life and lend emotional support to the mother during the pregnancy and parenting was identified in 40 cases (24 percent of those for whom data were available).

DOMESTIC RELATIONSHIP PROBLEMS

Pregnancy is often a time when domestic violence begins or escalates,[27] and low income women are particularly at risk for verbal or physical abuse during pregnancy, as are pregnant women with health problems.[28] Nearly one in six of all adult pregnant women report abuse during pregnancy. Women who are abused during pregnancy have been found to be at risk for low birth weight, infections, anemia, smoking, use of alcohol or drugs and late entry into prenatal care.[10 28]

Problems in relationships between mothers and their spouses or partners during the pregnancy were frequent in cases reviewed, with a total of 75 reported occurrences. These problems included marital difficulties and poor relationships with partners (identified in 12 cases); uninvolved father of the infant (22 cases); mental, physical, sexual or emotional abuse (20 cases); and other related behavioral factors of the father including alcoholism, drug abuse, and abuse of other family members (3 cases). Marital difficulties and poor relationship with the father of the baby were most frequently evidenced by frequent arguments causing stress during the pregnancy. These numbers may be significantly underreported, as information was obtained only from interviewed women and some mothers may not have admitted to abuse during the interview.

Uninvolvement of the father was considered important because of the loss of social and financial support to the family. Fathers were absent from the household for several reasons. In three cases the father was unknown or uncertain. Additionally fifteen fathers were uninvolved with the mother and another four fathers were absent during the pregnancy.

TABLE 7.3
DOMESTIC RELATIONSHIP PROBLEMS (TOTAL IMR CASES = 247)

Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Marital difficulties/Poor relationship with partner	12	1	13	5.26%
Abusive relationship (mental/physical/sexual/emotional)	20	0	20	8.10%
Previous Mental/physical/sexual/emotional abuse	13	0	13	5.26%
Previous Domestic violence	3	0	3	1.21%
Previous Sexual assault	1	0	1	0.40%
Uncertain/unknown father of infant	3	0	3	1.21%
Father of infant uninvolved	15	0	15	6.07%
Father absenteeism	4	0	4	1.62%
Father: Alcoholic	1	0	1	0.40%
Father: Substance abuse: heroin	1	0	1	0.40%
Abuse of child by family member	1	0	1	0.40%
Total	74	1	75	30.33%

CHAOTIC LIVING CONDITIONS

Families with multiple social problems, disorganized lifestyles, evidence of social distress, and lack of resources were classified as having chaotic living conditions. A combination of unstable housing, domestic relationship problems (multiple partners, family arguments and fights) drug use in the home, and fragmentation of the family (including such factors as foster home placements and incarceration of the mother or absent partners) were typical of these cases. Because of the chaos, these families found it difficult to prioritize health and infant care. The effect on the infant death was often unknown, but the pattern of social distress was notable for its potential to affect maternal and infant health. Little is known of the interactions of these factors with infant mortality, although low birth weight and prematurity have been reported as significantly associated with maternal life events and stress.[29]

CHILD ABUSE AND NEGLECT

The Review did not consider cases where homicide was the suspected cause of death. The decision to exclude homicides from the Review was based on two facts. The first was that homicides comprise a very small number of King County infant deaths, averaging 1.4 annually. The second was a resource issue. Staff working on the Review could not be involved in the lengthy litigation and potential legal issues surrounding these cases. During the course of the Review of all other infant deaths in King County, we did not uncover any cases of substantiated abuse and neglect not already under the care of CPS.

CHILD PROTECTIVE SERVICE (CPS) INVOLVEMENT

The protection of children from abuse and neglect is the responsibility of Child Protective Services. The agency is designated to deal with the assessment and management of suspected and actual neglect and abuse of children.

Those families that had been reported to CPS in relation to the infant who died or other children in the family were classified as “involved with CPS.” It should be noted that systems for communication

between the Review and the CPS have emerged over time and data are unavailable for many of the early cases in the Review. The following numbers therefore underreport the occurrence of cases known to CPS.

A total of thirty-seven cases were known to have been involved with CPS. Twenty four of these were identified during the Review by the TRC. Ten of these were prior to the pregnancy with other children, four were during the pregnancy, and twelve were during the infants' life. Thirteen more cases of infant death were subsequently identified as having CPS involvement.

INCARCERATION

A total of six mothers were known to be incarcerated either during the pregnancy or following the birth of their infant. The incarceration separated the mothers from their families and support systems during pregnancy, and from their infants following delivery. The impact of incarceration on health services is discussed in Chapter VIII.

PROSTITUTION

The health and safety risks of prostitution for women of child bearing age are many. However gathering information from mothers concerning this activity is difficult due to the stigma associated with illegal activities. Documented prostitution was known in three cases, although a number of other mothers had a history of prostitution prior to this pregnancy and infant death. In one of the three cases, prostitution was considered contributory to the death of the infant because the baby died of sepsis due to infections acquired by the mother.

SUBSTANCE USE/ABUSE

Substance use and abuse during pregnancy including smoking, alcohol and illicit drug use has been associated with poor outcomes and elevated infant mortality rates.[30 31 32 33 34] Substance use is often difficult to document due to the social stigma associated with the use of alcohol and tobacco during pregnancy and the legal ramifications of the use of illicit drugs. Cases were identified as substance users if any amount of alcohol, drugs, or cigarette smoking occurred during pregnancy.

Ninety two mothers (38.2 percent) actively smoked during pregnancy and after birth, some exceeding two packs of cigarettes a day. Only 14.3 percent of the comparison group of all King County Births reported smoking cigarettes.

TABLE 7.4
MATERNAL SMOKING DURING PREGNANCY AND AFTER BIRTH (N=247)

Tobacco Use	IMR Cases (%)
Yes	92 (38.2)
No	149 (61.8)
Total	241 (100)
Unknown	6

We identified alcohol use during pregnancy in 63 (26.7 percent) cases. This number is much higher than that reported on birth certificates (3.9%), but birth certificate data on alcohol use in pregnancy are considered to substantially under-report alcohol use.

TABLE 7.5
MATERNAL ALCOHOL CONSUMPTION DURING PREGNANCY AND AFTER BIRTH (N=247)

Alcohol Consumption During Pregnancy	IMR Cases (%)
Yes	63 (26.7)
No	173 (73.3)
Total	236 (100)
Unknown	11

Illicit drug use was documented for 35 cases. No comparison group could be found for illicit drug use due to the lack of reporting and statistics available.

TABLE 7.6
MATERNAL ILLICIT DRUG USE DURING CURRENT PREGNANCY (N=247)

Drug Use	IMR Cases (%)
Yes	35 (14.8)
No	201 (85.2)
Total	236 (100)
Unknown	11

UNINTENDED PREGNANCY

Almost all women are at risk for unintended pregnancy during their reproductive years. However those at greatest risk of unintended pregnancies are women of low socioeconomic status, adolescents, and formerly married women. These women are at greater risk for both contraceptive non-use and for contraceptive failure.[35 36] Although the relationship of the intendedness of the pregnancy to pregnancy outcomes and infant death has not been well studied, it is known that an equal proportion of unintended pregnancies end in abortion (44 percent) as with birth (43 percent).[35] Maternal attitudes concerning intendedness of the pregnancy have been correlated with a two fold risk of the infant dying within the first 28 days of life.[37] A subsequent report will provide additional information concerning contraceptive use and intendedness of pregnancy in our cases compared to a control group of living infants.

Pregnancies were considered unintended if they were mistimed or unwanted. This information was gathered from mothers, either by interview or as available from records for non-interviewed mothers. Some pregnancies occurred due to lack of birth control use. Other unintended pregnancies were due to ineffective birth control methods or birth control failure. Unplanned pregnancy was present in one hundred twelve cases, (56.9 percent), compared 43.2 percent among all Washington births.

TABLE 7.7
PREGNANCY INTENTION

Pregnancy Intention	IMR Cases(%)	All Washington Births (%)*
Intended	85 (43.1)	701 (57.7)
Unintended	112 (56.9)	513 (42.3)
Total	197 (100)	1,214 (100)
Unknown	50	

THE ODDS RATIO FOR UNINTENDED PREGNANCY FOR IMR CASES COMPARED TO ALL WASHINGTON BIRTHS WAS = 1.8 (95% CI: 1.3-2.5)
* SOURCE: THE PREGNANCY RISK ASSESSMENT MONITORING SYSTEM (PRAMS) CONDUCTED BY THE WASHINGTON STATE DEPARTMENT OF HEALTH (PRELIMINARY DATA, APRIL 1995.)

HOUSING PROBLEMS

Housing difficulties during pregnancy have been linked with depression which in turn is related to prematurity and low birth weight.[25] Homelessness has been linked with poor birth outcomes for pregnant women, including low birth weight and higher rates of infant mortality.[38]

Families experienced multiple problems with housing. A total of 40 instances of housing difficulties were identified by the Review. These included homelessness during the pregnancy (21 cases), history of homelessness (3 cases), crowded housing (12 cases), home in unsafe condition (2 cases), unsafe neighborhood (4 cases) and being forced to move during pregnancy (1 case). While in most instances these were considered associated with the infant death, there were two instances in which crowded housing was assessed as contributing to the death. In both of these cases, the infant died accidentally from suffocation because the crowded living conditions precluded space for a crib in the residence.

TABLE 7.8
HOUSING PROBLEMS (TOTAL IMR CASES = 247)

Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Housing Problems	1	0	1	0.40%
Homelessness/frequent moves:	21	0	21	8.50%
Previous Homelessness	4	0	4	1.62%
Crowded housing	11	1	12	4.86%
Home unsafe/in poor repair	2	0	2	0.81%
Neighborhood unsafe	4	0	4	1.62%
Forced move in pregnancy	1	0	1	0.40%
Total	44	1	45	18.21%

PERCEIVED STRESS

The effects of stress on health and pregnancy outcomes are important but not well understood. Researchers have found that chronic stressors such as financial problems, parental worries and interpersonal conflicts are the most influential factors of poor mental health in low income women.[25] Links have been made in the literature between premature labor and stress.[39 40] A possible physiological mechanism for stress leading to premature labor is the stimulation by stress of the production of certain substances (corticosteriods and oxytocin) which can increase premature contractions of the uterus.[41] Stress may also cause the body to produce substances (corticosteroids) that make women more vulnerable to uterine infections such as chorioamnionitis.

The effects of stress on other birth outcomes are less well understood and may depend on the type, timing and duration of the stressful event. Chronic stressors appear to be more damaging than time limited stress.[25] The measurement of the degree of stress caused by certain life experiences is difficult because of individual differences in personality, life preferences, and economic and social resources.[42]

Because of the subjective nature of the perception of circumstances as stressful, we classified an event as stressful only if it was identified as such by the mother during the interview. Two thirds of all mothers were interviewed reported stressful events. Not all those who experienced difficulties cited these as stressful events. Stressful issues identified by mothers included concerns related to their pregnancy, economic worries, personal relationships, and violence . They have been clustered for discussion under the following categories: Domestic/Family Relationships; Financial; Occupational/Job Related; Medical/Pregnancy Related; Housing Related; Violence/Trauma; and Miscellaneous.

STRESS: DOMESTIC/FAMILY RELATIONSHIPS

This group of stressors is discrete from those cases where domestic and family relationship problems occurred. These cases are those where the mother stated she perceived stress due to the domestic and family relationship problems. Of all sources of stress, this was the single largest group with 74 occurrences. Relationship problems with partner or boyfriend (cited 29 times) were the single largest stressor in this grouping. Other factors in this group were general social situation/non-specified, stressful relationships with the mother, roommates, fear of abuse, partner absenteeism, and living away from home. Eight mothers cited the death of family or close friends. These losses are significant from a grief assessment standpoint, as they added additional loss close to the death of the infant.

TABLE 7.9
STRESS: DOMESTIC/FAMILY RELATIONSHIPS (TOTAL IMR CASES = 247)

STRESS: Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Domestic/Family Relationships	7	0	7	2.83%
History of abuse	3	0	3	1.21%
Partner absenteeism(away from home)	3	0	3	1.21%
Relationship (with partner/boyfriend)	33	0	33	13.36%
Social situation	5	0	5	2.02%
Death of friends/family	8	0	8	3.24%
Roommates	3	0	3	1.21%
Father alcoholic	1	0	1	0.40%
Visitors	1	0	1	0.40%
Poor social support	1	0	1	0.40%
Father drug use	1	0	1	0.40%
Drug use	2	0	2	0.81%
Substance abuse in household	1	0	1	0.40%
Caring for ill grandmother	1	0	1	0.40%
Parenting infant	1	0	1	0.40%
People moving in & out of household	1	0	1	0.40%
Total	72	0	72	29.15%

STRESS: FINANCIAL

A total of thirty instances of economic stress were identified by the interviewed mothers. Financial stress was identified by twenty-eight mothers. Two others identified insurance payment and a lawsuit as financial stressors.

TABLE 7.10
STRESS: FINANCIAL (TOTAL IMR CASES = 247)

STRESS: Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Financial	25	0	25	10.12%
Insurance	2	0	2	0.81%
Lawsuit	1	0	1	0.40%
Total	28	0	28	11.34%

STRESS: OCCUPATIONAL/JOB RELATED

Mothers cited their work as a major source of stress. Thirty four women felt that their jobs caused considerable stress. Four of these cases identified specific issues: long hours at work, high physical demands, conflicts with employers, and employer discrimination against a mother due to the pregnancy.

TABLE 7.11
STRESS: OCCUPATIONAL/JOB RELATED (TOTAL IMR CASES = 247)

STRESS: Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Job-related:	29	0	29	11.74%
Job-related: Long hours	1	0	1	0.40%
Job-related: High physical demands	1	1	2	0.81%
Job-related: Conflict with employer	1	0	1	0.40%
Job-related: Employer discrimination against pregnant woman	1	0	1	0.40%
Total	33	1	34	13.77%

STRESS: MEDICAL/PREGNANCY RELATED

A variety of concerns related to the pregnancy and medical or health related issues were identified, twenty-one in total. The largest group was mothers who had had long periods of bedrest due to preterm labor during their pregnancy. Additional pregnancy related stressors identified by mothers were twin pregnancies and self-monitoring of preterm labor. A range of other issues had single occurrences.

TABLE 7.12
STRESS: MEDICAL/PREGNANCY RELATED (TOTAL IMR CASES = 247)

STRESS: Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Lack of sleep	1	0	1	0.40%
Illness	1	0	1	0.40%
Bedrest for pregnancy	7	0	7	2.83%
Teen pregnancy	1	0	1	0.40%
Twin pregnancy	3	0	3	1.21%
Unwanted pregnancy	1	0	1	0.40%
Anxiety disorder	1	0	1	0.40%
Major depression	1	0	1	0.40%
Family history of ureter abnormalities	1	0	1	0.40%
Preterm Labor(PTL)	1	0	1	0.40%
Self-monitoring of PTL therapy	1	0	1	0.40%
Total	19	0	19	7.69%

STRESS: HOUSING ISSUES

Stress related to housing situation was cited during the interviews thirteen times. Issues identified ranged from homelessness/unstable housing, threatened eviction, and searching for a place to live, to moving during pregnancy, and remodeling the house.

TABLE 7.13
STRESS: HOUSING RELATED (TOTAL IMR CASES = 247)

STRESS: Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Moving	6	1	7	2.83%
Threatened eviction	2	0	2	0.81%
Search for housing, jobs	1	0	1	0.40%
Unstable housing/homelessness	2	0	2	0.81%
House remodel	3	0	3	1.21%
Total	14	1	15	6.07%

STRESS: VIOLENCE/TRAUMA

This group of stressors included: robbery, trial and sentencing of a mother, incarceration, street violence, gang activity , and sexual assault of a daughter. In a recent study, women who lived in violent neighborhoods were significantly more likely to experience pregnancy complications than women living in low violence neighborhoods.[45] Motor vehicle accidents occurring to pregnant mothers were also included in this group. These traumatically stressful events occurred ten times.

TABLE 7.14
STRESS: VIOLENCE/TRAUMA (TOTAL IMR CASES = 247)

STRESS: Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Robbery	2	0	2	0.81%
Trial and sentencing	1	0	1	0.40%
Incarceration	1	0	1	0.40%
Street violence	1	0	1	0.40%
Motor vehicle accident	2	0	2	0.81%
Gang activity	1	0	1	0.40%
Sexual assault of daughter/stepdaughter	2	0	2	0.81%
Total	10	0	10	4.05%

It was apparent during the interviews that mothers perceived that they had experienced significant stress during their pregnancies. The relationships among stress and infant mortality merit further study.

SOCIAL FACTORS FOLLOWING BIRTH

While all of the factors described thus far occurred both during pregnancy and after the birth of the infant, additional factors presented only during the infancy period. These factors were especially noteworthy because many of them were highly preventable. Issues and problems identified during the infant's life were in the areas of parenting skills, knowledge of caring for infants, and infant safety.

PARENTING SKILLS/KNOWLEDGE/SUPPORT

The three areas concerning parent knowledge and support were: general parenting skills, language barriers, and poor understanding of medical and health issues. General parenting issues included lack of involvement and maternal "bonding" with the infant following birth (2 cases). These were due to mental illness or drug use. Inadequate parenting skills were identified in three cases. Two of these were considered contributory to the infant deaths due to their relationship to health and inadequate safety of the infant. Lack of understanding of medical and infant health issues was associated with two infant deaths where the parents failed to recognize infant needs. Lack of parenting assistance was contributory in one case where fatigue of the parent resulted in inattentiveness to infant safety needs and the baby died an accidental death.

TABLE 7.15
PARENTING FACTORS (TOTAL IMR CASES = 247)

Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Inadequate parenting skills	1	2	3	9.09%
Lack of bonding/(lack of involvement with baby after birth)	2	0	2	6.06%
Poor patient (parent) medical understanding/knowledge	2	0	2	6.06%
Infant placed in foster care(Transgenerational foster care)	3	0	3	9.09%
Lack of parenting assistance	1	1	2	6.06%
Reckless driving	0	1	1	3.03%
Total	21	12	33	100.00%

INFANT SAFETY

Infant safety is the key issue in preventing unintentional injuries. Households contain many potential threats to infant safety. Unintentional injury, while comprising a small proportion of all infant deaths in King County, is preventable. Although much has been written about unintentional injury in children, few studies have examined these deaths in infants.[43] Since babies under 1 year are less mobile, hazards in the surrounding environment may be overlooked.[43] Prevention strategies should address safety issues for low income families living in substandard housing conditions; one study found resources, not lack of motivation, to be the limiting issue for economically deprived parents.[44]

Lack of safety in the home was manifested by a variety of problems. In some homes where safety concerns due to parenting were present; risk assessment was done by Child Protective Services. These were cases where excessive risks had been identified and reported to the agency as referenced in the above discussion on CPS. Additionally three cases were known to be in foster care following removal from the home due to parenting and infant safety concerns. A discussion of other identified infant safety concerns follows.

TABLE 7.16
INFANT SAFETY (TOTAL IMR CASES = 247)

Factored by the Technical Review Committee	Associated	Contributing	TOTAL	Percentage of All IMR Cases
Unsafe sleep environment	0	6	6	2.43%
Fall of Infant	2	0	2	.81%
Lack of car seat use	0	2	2	.81%
Total	2	8	10	4.05%

SLEEP ENVIRONMENT SAFETY

An unsafe sleep location has been identified as a major contributor to accidental infant deaths in the US. A study of infant deaths from unintentional injuries in Kentucky identified mechanically unsafe sleeping situations as the largest contributor.[43] In the Review, unsafe sleep environment was a contributing factor in four cases of accidental asphyxia in which the baby suffocated while asleep in dangerous locations, including defective cribs, adult beds and mattresses, and couches. Recommendations for sleep safety are contained in chapter VI.

AUTOMOBILE SAFETY

Placement of infants in car seats reduces motor vehicle related injuries and deaths among infants. Four of the infant deaths reviewed were due to automobile accidents and two of these infants were not in car seats. Lack of car seat use was considered contributory to these two deaths. In addition to the lack of a car seat, reckless driving was also contributory in one case.

FALLS

Undocumented accidental falls were known by the committee to occur among infants with some unknown frequency. However, infant falls were identified in two cases, where the baby was taken for emergency treatment.

SAFETY RECOMMENDATIONS

Recommendations for sleep safety are contained in chapter VI. Other recommendations to assure the safety of infants are to:

- Plastic bags should be out of the reach of infants at all times.
- Window blind cords should be out of reach of infants at all times and cords should have no loops.
- An approved infant car seat should be used at all times when transporting the baby by car. We support the current Washington State law that requires that infants be placed in car seats when in a vehicle.

CONCLUSIONS

The association between low socioeconomic status, poor health and increased infant mortality has been documented in both scientific literature and this Infant Mortality Review. Compared to all King County births, women who suffered infant deaths were more likely to be socioeconomically deprived and have low educational attainment. Many of these women experienced a broad range of stressors coupled with domestic relationship problems, chaotic living conditions and low social support. Fathers were uninvolved or absent in many cases. The high rate of unintended pregnancy found in this study indicates that women are still experiencing a lack of control over their lives.

The dynamics and interrelatedness of socioeconomic issues such as low income and education, unstable or unsafe housing and living conditions, unintended pregnancy, lack of social support, domestic relationship and violence problems, substance use, and chronic stress appear to be important contributors to adverse outcomes for mothers and their infants and warrant further study. In this report, we have reviewed these factors as discrete factors, but in reality they are interrelated steps in the path to poor health outcomes. More study of socioeconomic inequity and behavioral issues as important risk factors in infant mortality is needed to guide future prevention strategies.

TABLE 7.17
SUMMARY TABLE OF ASSOCIATED AND CONTRIBUTORY SOCIOECONOMIC AND BEHAVIORAL ISSUES IDENTIFIED BY THE INFANT MORTALITY REVIEW(TOTAL IMR CASES = 247)

Factored By The Technical Review Committee	Associated	Contributing	TOTAL	% of IMR Cases
Lack of transportation	6	0	6	2.43%
Lack of social support	40	0	40	16.19%
Domestic relationship problems	74	1	75	30.36%
Chaotic living conditions	15	0	15	6.07%
Incarceration	6	0	6	2.43%
Prostitution	2	0	2	0.81%
Housing problems	43	1	44	17.81%
Stress: Domestic/Family relationships	72	0	72	29.15%
Stress: Financial	28	0	28	11.34%
Stress: Occupational/Job related	33	1	34	13.77%
Stress: Medical/Pregnancy related	19	0	19	7.69%
Stress: Housing related	14	1	15	6.07%
Stress: Violence/Trauma	10	0	10	4.05%
Stress: Miscellaneous	7	0	7	2.83%
Parenting factors	21	12	33	13.36%
Infant safety	2	8	10	4.05%
Total	386	24	410	

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CHAPTER VIII. IMPROVING SUPPORT SERVICES FOR PREGNANT WOMEN AND INFANTS

INTRODUCTION

The Infant Mortality Review identified a group of 27 (11%) infant deaths from among the 247 cases reviewed for this report in which support services during pregnancy and infancy were inadequate. Support services are forms of assistance offered to clients to help them address nonmedical concerns which arise during the course of pregnancy and caring for their infants. Examples of support services include public health nursing, nutrition assistance through the Women, Infants and Children Food Supplementation Program (WIC), counseling and health education, substance abuse services, etc. In some cases, the lack of support services was considered to have contributed to the chain of events leading to the death of the infant (i.e. contributing factor) while in other cases, the lack of services was judged to have the potential to result in harm (i.e. associated factor).

Cases in which the Technical Review Committee identified problems with support services were collected and referred to a subcommittee for more detailed review. These problems included a lack of referral to public health nursing for high risk pregnant women; lack of follow-up by public health nurses; lack of follow-up by Child Protective Services (CPS); breakdown in inter-agency and intra-agency communications; client resistance to services offered; inadequate tracking of high-risk clients and/or case management issues; and problems with emergency personnel who first responded to these infant deaths.

This chapter begins with a general description of the 27 cases in the group, followed by a description of the problems identified, illustrative vignettes, and solutions proposed by the Review. The vignettes are composite examples incorporating details of several similar cases and were written to preserve the privacy of the individuals involved. The names that appear are not the actual names of women in the Review.

The Review found that women receiving inadequate support services tended to be at higher risk of poor birth outcomes than the average pregnant King County woman. While these women therefore had a greater need for support services, they also faced greater difficulties in receiving them.

Abbreviations Used In This Chapter	
CPS	Child Protective Services
CWS	Child Welfare System
DSHS	Department of Social and Health Services
PHN	Public Health Nurse
SIDS	Sudden Infant Death Syndrome

This suggests that the occurrence of inadequate support services results from a complex interplay of social, individual and service delivery factors.

DESCRIPTION OF CASES

The infants died from a wide variety of causes, with SIDS being the most common condition (Table 8.1).

TABLE 8.1
CAUSES OF DEATH AMONG CASES WITH INADEQUATE SUPPORT SERVICES

Cause of Death[1]	Number of Cases (%)
SIDS	8 (29.6)
SIDS with additional circumstances	3 (11.1)
Positional Asphyxia	1 (3.7)
Prematurity	7 (25.9)
Disseminated Herpes Infection and Complications due to Prematurity	1 (3.7)
Sepsis	1 (3.7)
Respiratory Failure due to RSV[2] Pneumonia	1 (3.7)
Neonatal Appendicitis	1 (3.7)
Perinatal Asphyxia	1 (3.7)
Apnea, Unknown Etiology	1 (3.7)
Trauma, Motor Vehicle Accident	1 (3.7)
Undetermined	1 (3.7)
Total	**27 (100)**

[1] CAUSE OF DEATH AS DETERMINED BY REVIEW
[2] RSV=RESPIRATORY SYNCYTIAL VIRUS

The 27 cases included in this discussion had a high concentration of risk factors associated with poor birth outcomes. The high prevalence of risk factors in this group lacking adequate support services is concerning because these women may have been among those who would have benefited most from such services. The risk factors found in this group are described below and summarized in Table 8.2 .

- Three-quarters of the mothers were single compared to slightly less than one quarter of all King County mothers giving birth.

- The majority of the mothers were of low socioeconomic status. Even though only seven percent were under age eighteen, more than half had not finished high school. In contrast, only ten percent of all King County mothers had not completed high school. Nearly three-quarters of the cases (compared to one quarter of all King County births) lived in households with incomes low enough to qualify for Medicaid.

- Most of these pregnancies had been unplanned (91 percent as compared to 42 percent among all births in Washington State).

- Three-fifths of the mothers in this group smoked during pregnancy, compared to fifteen percent of all King County births. Although information on alcohol consumption and illicit drug use was often difficult to obtain, the Review found that 52 percent of the mothers used alcohol and other drugs during pregnancy.

- The mothers had high levels of stress, and social disorganization, and low social support.

- Whereas 62 percent of cases had two or more living children at the time of birth of the infant who was the subject of the Review, only 21 percent of all King County births did so. Women who have previously raised several children may still be at risk of not receiving needed support services.

- Many of these women were found to lack adequate support services despite receiving care from PHNs and CPS during their pregnancies. PHNs were involved with 42 percent and CPS with 52 percent of these cases.

TABLE 8.2
RISK FACTORS IN CASES WITH INADEQUATE SUPPORT SERVICES COMPARED TO ALL BIRTHS IN KING COUNTY (1991-1993)

Risk Factor	Cases with Inadequate Support Services[a] (percent) (N=27)	All King County Births (percent) (N=68178)
African or Native American race	11(42.3)	5432(8.4)
Mother less than 18 years	2(7.4)	1177(2.6)
Mother not completing high school	8(61.5)	3672(10.1)
Single marital status	20(74.1)	15173(22.3)
Low income (Medicaid eligible)[b]	13(72.2)	10147(25.3)
Unintended pregnancy	21(91.3)	513(42.3[g])
Inadequate prenatal care	10(66.7)	17621(29.0)
Prematurity	12(46.1)	4733(7.2)
Smoking during pregnancy[b]	14(60.9)	6413(15.0)
Alcohol use during pregnancy[b]	2(10.0)	1567(3.9)
Illicit drug use during pregnancy	13(52.0)	---[c]
High level of psychosocial stressors[d]	22(88.0)	---[c]
Low level of social support[e]	22(84.6)	---[c]
Social disorganization[f]	24(88.9)	---[c]

A. SOURCE OF INFORMATION FOR CASES WAS BIRTH CERTIFICATE DATA, IN ORDER TO FACILITATE COMPARISON WITH ALL KING COUNTY BIRTHS. DATA DERIVED FROM THE MULTIPLE SOURCES OBTAINED FROM THE CASE REVIEW SUGGESTED SOMEWHAT HIGHER PREVALENCES OF RISK FACTORS AMONG CASES THAN THOSE OBTAINED FROM THE BIRTH CERTIFICATES.
B. ALCOHOL USE DURING PREGNANCY AS ASCERTAINED FROM MULTIPLE CASE REVIEW DATA SOURCES WAS SUBSTANTIALLY HIGHER THAN THAT REPORTED ON BIRTH CERTIFICATES: 52 PERCENT OF CASES USED ALCOHOL DURING PREGNANCY BASED ON CASE REVIEW DATA. BIRTH CERTIFICATE DATA ALSO APPEARED TO UNDER-REPORT RATES OF MEDICAID ELIGIBILITY AND MATERNAL SMOKING,
C. DATA ON THESE RISK FACTORS WERE AVAILABLE ONLY FROM CASE REVIEW DATA, NO DATA ARE AVAILABLE ON ALL KING COUNTY BIRTHS.
D. HIGH STRESS WAS DEFINED AS THE PRESENCE OF SEVERAL SIGNIFICANT STRESSORS AS INDICATED BY RESPONSES TO KATHERINE BARNARD'S "DIFFICULT LIFE CIRCUMSTANCE" SCALE. SOME AREAS OF INQUIRY WERE HOMELESSNESS, PARTNER CONFLICT, PHYSICAL/EMOTIONAL ABUSE, FINANCIAL DIFFICULTIES, SUBSTANCE ABUSE, ETC. THE NUMBER AND IMPACT OF MAJOR LIFE CHANGES WAS ALSO CONSIDERED, INCLUDING RECENT LOSS THROUGH THE DEATH OF A FRIEND OR RELATIVE.
E. THE ASSESSMENT OF LOW SOCIAL SUPPORT WAS BASED ON A GLOBAL ASSESSMENT BY THE CASE INTERVIEWER. INTERVIEWERS ASKED MOTHERS TO NAME PEOPLE WHO THEY SPENT THE MOST TIME WITH OR WHO WERE THE CLOSEST TO THEM JUST BEFORE AND DURING THE PREGNANCY. THE NATURE OF THE RELATIONSHIP (E.G. HUSBAND, CO-WORKER) AS WELL AS THE EXTENT OF CONTACT (E.G. AT LEAST ONCE A DAY) WERE OBTAINED. NAMES OF NON-SUPPORTIVE PEOPLE (IF ANY) WERE ALSO SOLICITED. ADDITIONALLY, FOUR SCENARIOS RELATED TO SUPPORT WERE RANKED BY THE MOTHERS. NOTES FROM SOCIAL WORKERS AND PHNS WERE ALSO CONSIDERED. AN EXAMPLE OF LOW SOCIAL SUPPORT WOULD BE A MOTHER WHO COULD LIST ONE OR TWO PEOPLE WHOM SHE RATED AS SUPPORTIVE, WITH SPORADIC CONTACT. IN ADDITION, SHE WAS UNABLE TO IDENTIFY ANYONE TO HELP WITH SUCH THINGS AS TRANSPORTATION DIFFICULTIES, MONEY SHORTAGES OR CHORES IF BEDREST BECAME NECESSARY.
F. SOCIAL DISORGANIZATION WAS CHARACTERIZED BY HOUSEHOLDS WITH ONE OR MORE OF THE FOLLOWING CHARACTERISTICS: UNSTABLE HOUSING, CHAOTIC RELATIONSHIPS (MULTIPLE PARTNERS, FIGHTS, ETC.) DRUG USE IN THE HOME, RECURRENT FOSTER HOME PLACEMENT FOR CHILDREN, OR A FRAGMENTED FAMILY.
G. NO KING COUNTY DATA ARE AVAILABLE; THIS PROPORTION IS FOR WASHINGTON STATE, AS DETERMINED BY THE PREGNANCY RISK ASSESSMENT MONITORING SYSTEM (PRAMS).
NOTE: UNKNOWN VALUES WERE NOT INCLUDED IN PERCENT CALCULATIONS

PUBLIC HEALTH NURSING

All of the 27 cases reviewed in this group had at least one criteria making them high priority for Public Health Nursing (PHN) home visits, but a PHN was involved with only 42 percent of them. Therefore, lack of appropriate referrals to PHNs by other agencies and providers was identified as an issue. In other cases in which a PHN was involved, issues with nursing services were identified. In five of the 27 cases, these problems were considered to have contributed to the infant's death and in nine cases, the problems had the potential to adversely affect the infant's health.

REFERRAL PROBLEMS (6 cases)

In some cases, providers and agencies did not refer clients to PHNs, who could have helped them obtain services. In other cases, the referral did not contain sufficient information to enable the PHN to locate the client.

Several high risk mothers did not receive a referral for Public Health Nursing services.

ILLUSTRATIVE VIGNETTE: Sharon, a teenage, single mother was living with an unsupportive extended family in a low income area. During her pregnancy, she was injured and made a hospital emergency room visit. At the hospital, a referral was made to CPS. However, no referral was made for PHN services. Sharon later went into labor prematurely and delivered an infant who died within minutes. She was discharged home, without receiving a PHN referral or follow-up. A PHN could have monitored the mother's health, provided her with educational materials, and assisted her with obtaining referrals for help with domestic violence and grief following the death.

PROBLEMS WITH PHN SERVICES (*6 cases*)

In other cases, issues concerning the services provided by PHNs emerged. These issues included insufficient tracking of cases by the PHN and inadequate communication with CPS by the PHN.

Timeliness of service and lack of persistent follow-up by the PHNs were an issue in several cases.

ILLUSTRATIVE VIGNETTE: The Sherman family moved from out-of-state after being "on the road" for several months during Leslie's pregnancy. Her first local prenatal visit was delayed, with reported sporadic visits out-of-state. At her first prenatal visit, she was placed on Maternity Case Management. However, she received no subsequent PHN follow-up despite a failed prenatal appointment and a hospitalization for medical complications. Her baby also received no PHN services despite delayed illness care and treatment. The infant died of a condition which, if detected sooner, may have been treatable. Teaching parents the signs and symptoms of illness in infants and linking families to appropriate sources of health care are important functions of public health nursing. In this case, inadequate PHN services and case management were considered to have contributed to the infant's death.

Issues concerning poor coordination of services and lack of communication were identified in several cases.

ILLUSTRATIVE VIGNETTE: Jennifer lived with an abusive partner and received erratic care during her pregnancy. A toxicology screen was positive for cocaine at birth. A contract was drawn up by CPS which included follow-up for drug evaluation and treatment, and PHN visits. Mother and baby were discharged home together. Two visits were made by the PHN without establishing contact because Jennifer was never home. She was then considered lost to follow-up. No notification was made to CPS. The infant died an accidental death related to sleeping in an unsafe location. Careful tracking and regular communication by both agencies may have enabled PHNs to provide Jean with the help she needed to care for her infant, including assuring her infants attendance at medical appointments and maintaining a safe environment while the infant was sleeping.

RECOMMENDATIONS

1. Identify high risk women before and during pregnancy, including women with no other children, for referral to support services prior to delivery of the infant.
2. Meet with providers and agencies to promote better understanding of public health nursing and how to make referrals.
3. Improve the referral process with options such as electronic transfer of referral, single phone number for all referrals, and/or secure fax machines.
4. Encourage providers to make a PHN referral for women and infants when:
    - A referral to CPS is made or when CPS is involved
    - For women with mental health, substance abuse, or homelessness problems
    - For pregnant women being released from incarceration
    - For those who have had no prenatal care
5. Increase capacity within the Health Department to consistently respond to referrals in a timely manner and to provide service for sufficient periods of time to monitor each infant's well-being.
6. Create a mechanism for internal Health Department review of infant deaths where coordination of care problems have been identified to promote region-specific problem solving.

OTHER PUBLIC HEALTH AND COMMUNITY SERVICES

A broad range of community health care and support services for pregnant and parenting women and infants are offered through a complex, interrelated system of public and private agencies and hospitals throughout Seattle and King County. Examples of services available throughout the county are:

- Family planning
- Prenatal care[a]
- WIC (nutrition screening and food supplements for income-eligible pregnant women and young children)
- Well child care (including immunizations, screening, and preventive services)
- Medical care for the diagnosis and treatment of illness

[a] This report includes only a sub-set of all cases in which inadequate prenatal care was identified. A subsequent report will review all cases in which the mother received inadequate prenatal care. Factors contributing to inadequate prenatal care will be reviewed and recommendations on improving use of prenatal care will be presented.

There are a variety of entry points into this system of services. Providers in settings such as family planning, WIC, emergency departments, mental health sites, clinics, physicians' offices, and a variety of other sites for delivery of health and social services have the opportunity to provide needed referrals for services. When a woman accesses any part of this system at any point during the continuum of pregnancy and parenting, an opportunity exists to connect her with other services that meet her needs. Of key importance is knowledge and awareness on the part of staff at all agencies of what services are available to women and families and how to connect them to these crucial aspects of the system. Interagency communication is another key to successful service delivery.

The client may only seek care from one provider or agency. If referrals for other services such as prenatal care are not made at that first agency contact, an opportunity has been missed to provide women and families with the broad scope of services available. In some cases, the women lost all contact with potentially helpful services.

For a portion of these cases, the client knew of the availability of services but did not use them. These included prenatal care, WIC during pregnancy, and well child care (including immunizations following birth). There appeared to be indifference or even resistance to using the services among some of the highest risk women. While some of these women seemed to be uninterested in receiving services, others may have gone without them because of fears, mistrust, or competing needs. Therefore, this group presents a unique challenge for the community to offer services that will reach this hard-to-reach sub-population of women.

ISSUES CITED WITH OTHER PUBLIC HEALTH AND COMMUNITY SERVICES

WIC services were not obtained by several income-eligible women. Accessing WIC services could have also linked clients with other services. (5 cases)

ILLUSTRATIVE VIGNETTE: Sandy, a low income, single mother with other children living at home was eligible for food supplements and WIC services. With a history of inpatient substance abuse treatment, she had positive drug screens during her pregnancy and intermittent homelessness. She used food banks, but no referral for WIC services was made during the pregnancy. WIC services not only provide vouchers for food for pregnant and parenting mothers and their infants, but also offer the support of nutritionists and nurses, who frequently refer their clients to PHNs.

There was poor utilization of community health care and social services by families despite familiarity with these services. (4 cases)

ILLUSTRATIVE VIGNETTE: Linda, a young mother with a history of substance and alcohol abuse and homelessness, received little prenatal care. The prenatal team tried to assist her with her problems, but she failed to keep appointments and did not follow through with recommendations. She rejected shelter and low income housing, and was described as "very picky." Even Linda's family stopped assisting her because they felt overused. The potential for intervention is cases such as this seems limited.

Referrals from one community agency to another for needed services during pregnancy were lacking in several cases. (2 cases)

ILLUSTRATIVE VIGNETTE: Heidi had a history of substance abuse, incarceration and CPS involvement with her other children. She made only a single prenatal visit. At that visit a toxicology screen was positive and she acted inappropriately with her children during the visit. A nurse recommended that CPS be involved, but no one actually made the referral. At birth the infant was noted to be jittery (a sign of drug exposure), but Heidi denied drug or CPS involvement. The hospital social worker did not verify the information, no hospital providers referred to CPS, and the baby was discharged home with the mother. Referral to CPS may have resulted in a drug and alcohol evaluation, assessment of the safety of the infant and perhaps removal of the infant to a safer environment.

Coordination/communication between community and health services agencies was inadequate in several cases. (2 cases)

ILLUSTRATIVE VIGNETTE: Carol spoke with a social worker sometime during her pregnancy. When questioned about her lack of prenatal care she replied that she was too tired and didn't like doctors. No referral was made by the social worker nor did the mother access any prenatal care. At delivery, she was described as listless, depressed and evasive. A social worker made a PHN referral and requested pediatric follow-up, but no PHN, sick or well child services were documented anywhere. Lack of prenatal care and routine health services for infants increases the risk of infant death. If the referral to a PHN had been completed, this infant might have received better health services.

Prenatal care was inadequate or totally lacking in several cases. (19 cases)

ILLUSTRATIVE VIGNETTE: Sophie, an older single mother, described her recent life as being on the run, lonely and homeless with heavy use of alcohol and illegal drugs. Seen once for a pregnancy diagnosis but had no prenatal care. She was diagnosed with a disease, but never returned for treatment. Her pre-term infant died of a congenital infection. Sophie was very depressed. Routine prenatal care could have detected this infection and might have prevented the preterm delivery and infection.

RECOMMENDATIONS

1. Every pregnant woman should receive early and continuous prenatal care.
2. Ensure that all community health and social service providers are familiar with the range of support services available for pregnant and parenting women, are prepared to make appropriate referrals, and assist the client by motivating and facilitating their use of these services.
3. Develop innovative methods for motivating high risk women to seek available services for pregnancy and infant care and for making those services more accessible and acceptable to high risk families. Examples of incentives could include gifts, money, gift certificates, assistance with childcare, transportation, and convenient evening hours for services.
4. Improve inter-agency communication. Provide coordination of care for pregnant and parenting women who need multiple service providers by linking these women with a case manager and community outreach services. These services should assist with setting service priorities and tracking client response to various referrals and services.
5. Increase awareness among women of childbearing age and providers who serve them concerning availability of food and nutrition programs for pregnant women and infants.
6. Address legal barriers which inhibit exchange of information between prenatal care providers on the one hand and drug and alcohol treatment and mental health providers serving pregnant women on the other. (Note: Access to records is currently made possible only by obtaining a mother's signature on a nine part release form.)

CHILD PROTECTIVE SERVICES (CPS)

Slightly more than half (52 percent) of the 27 cases with inadequate support services were known to CPS. Issues related to CPS were considered to have contributed to the infant death in five cases and had the potential to result in adverse outcomes in nine additional cases. Dealing with high risk cases such as these presents many challenges to this agency designated to deal with the assessment and management of suspected and actual child abuse and neglect. While this Review cannot conclude that the concerns raised about CPS services caused the deaths of these infants, addressing these concerns has great potential to improve the well-being of infants in King County.

PROBLEMS WITH REFERRALS AND LEVEL OF SERVICE

Barriers to early referral and appropriate level of service were identified in several cases.

ILLUSTRATIVE VIGNETTE: Angela, a mother who had received inpatient substance abuse treatment, had a history of alcohol, illicit drug and mental health problems. CPS had been contacted during her pregnancy. However, according to agency policy, since the contact was made during her second trimester, it was considered an "information only" referral and no investigation was done. Angela and her baby were discharged the day after delivery. She had no place to live, and despite her plans to move to a shelter, did not. The baby's crying and needs became increasingly difficult for her to cope with. CPS was again contacted, this time by a hospital Emergency Room. The baby was removed from Angela's custody and placed elsewhere. The delay in CPS action may have resulted in less than adequate care of the infant by her caretakers.

Lack of capacity to follow-through and monitor CPS contracts was identified for mothers/babies with positive toxicology screens at birth. (5 cases)

ILLUSTRATIVE VIGNETTE: Maggie, a single mother of several children, had no prenatal care with any of her pregnancies. Her partner was unsupportive and was incarcerated during pregnancy. At delivery, the infant had a positive toxicology screen. An evaluation was done by CPS and the baby was released to Maggie under the supervision of a relative. A PHN visited and found Maggie highly stressed with little help. CPS received "conflicting" reports that she was abusing drugs and alcohol again and was not properly caring for her children. CPS staff assessed the situation by phone, but made no home visit. The baby subsequently died, in part due to ongoing substance abuse and neglect by his mother. Lack of a home assessment and of coordination between CPS and PHN staff were considered to have contributed to the infant's death. Following the death, a multidisciplinary case conference was held to assess the mother's ability to care for her other living children.

The system for monitoring cases in custody was ineffective in several cases. (6 cases)

ILLUSTRATIVE VIGNETTE: In several cases, high risk infants were placed in the custody of a relative. For example, an infant's mother was a chronic IV drug user. Toxicology screen was positive at birth. Following birth, the baby was observed for withdrawal and discharged home. By court order, custody was given to a relative. The baby was staying with his mother when he died from an accident caused by inadequate attention to safety precautions. Closer monitoring by CPS and PHNs would have revealed that the baby continued to live with his mother in violation of the CPS contract and may have resulted in more effective drug treatment for the mother.

PROBLEMS WITH LEVEL OF INTERVENTION

Infants were retained in the family despite evidence of inability to care for the baby. (6 cases)

ILLUSTRATIVE VIGNETTE: Luanne had a history of alcoholism, homelessness and depression and was known to CPS. She moved frequently and was hard to track. Her latest pregnancy was unwanted. She failed to show up for appointments with her physician. CPS unsuccessfully continued to work with her on housing and alcohol treatment. CPS was notified of the birth of her child. Luanne continued to abuse alcohol. She wanted to attend an alcohol treatment facility where she could keep her children. When one was finally found, she canceled appointments.

Children were returned to family prior to completion of rehabilitation. (2 cases)

ILLUSTRATIVE VIGNETTE: An infant was the first born to Carmen, a single mother with a long history of mental illness, coupled with alcohol and drug abuse. Although she denied using alcohol and other drugs during her pregnancy, a CPS worker documented otherwise. At birth, CPS put a hold on the infant but was unable to persuade the court to rule for continued custody. The baby was then released to Carmen. After trying to cope with motherhood, she threatened to harm the baby and her infant was placed elsewhere. More timely action would have removed her infant from this dangerous situation.

ADMINISTRATIVE PROBLEMS

Coordination between workers from CPS and Child Welfare System (CWS) was poor.

ILLUSTRATIVE VIGNETTE: Lucy had a long history of substance abuse. All of her other children were released from the hospital after birth with a CPS contract. The children were in long term care with CWS. After the mother gave birth again, she handed the baby over to a relative. CPS was not notified of the birth. The mother was eventually incarcerated, but she still retained custody of her infant until she died from an accident. Although CPS and CWS are sister programs within the Division of Family Services, their lack of communication and coordination put this baby at risk.

There were breakdowns of communication within CPS and between CPS and other agencies, even when agencies have contracted to work together. (4 cases)

ILLUSTRATIVE VIGNETTE: Laticia was a victim of physical and mental abuse. Her baby's toxicology test at birth was positive despite her vehement denial of drug use. CPS drew up a contract and Laticia was referred for treatment as well as to the CPS-PHN Project.[b] The nurse found the family living in very crowded conditions with relatives, and the baby was missing medical appointments. Other providers were concerned about the infant's health and welfare and notified the nurse. The PHN tried to visit several times unsuccessfully and then notified CPS, but no action was taken.[c] The infant died from an accident.

[b] This Project serves families who are at moderate to high risk for child abuse with no geographical or financial restrictions. A CPS social worker refers the clients to a public health nurse who provides in-home assessment, teaching, and referrals as indicated for health related parenting and safety concerns. There is active coordination between the CPS worker and PHN for ongoing case management and coordination with community agencies. The goals are to provide a comprehensive collaborative service to families with greater continuity of care and to prevent further child abuse through education, support, and resources.

[c] Since this case was reviewed, monthly meetings have been established between PHNs on the CPS project and the CPS intake supervisor to improve communications.

Appropriate action by case workers were sometimes lacking. (2 cases)

ILLUSTRATIVE VIGNETTE: Maria had a history of substance abuse which included incarceration. She was being followed by CPS for her other children and felt overwhelmed with the pregnancy. She had no prenatal care. A toxicology test was positive at delivery. CPS was notified and a contract to refrain from substance abuse and obtain treatment was written. The PHN from the CPS-Public Health Nurse Project noted extreme difficulty working with the family. She documented many visits over several months and found someone at home only twice. She communicated her concerns to CPS. A joint CPS/PHN visit was made a few days prior to the death of Maria's baby. At the visit, it became apparent that the mother had not complied with the provisions of her contract. The infant died accidentally because of inadequate safety measures while the mother was intoxicated.

RECOMMENDATIONS

1. Increase capacity within Child Protective Services to consistently respond to referrals in a timely manner and to keep families open to service for sufficient periods of time. This will allow workers to adequately monitor infant well-being so that intervention may be made when necessary.
2. Assign a high priority to referrals made by mandated reporters and establish strong communication links with those providers through both regular and case-specific interaction.
3. Educate providers about the mechanism for review and mediation of cases when agencies and providers involved do not agree with the disposition of the case by CPS. (Progress Note: In place now is an appeals system consisting first of the child protective team, then up the chain of supervision in the agency. A 1-800 notification telephone number is also available.)
4. Continue to improve tracking of families within CPS to clarify which worker is accountable and facilitate monitoring of cases by CPS supervisors.
5. Increase accountability within the agency by implementing review by supervisors of individual worker's decisions, family progress and outcomes. (Progress Note: A manual is in development which includes legal citations and grids on shared decision making by workers or supervisors. Also, there is now a quality assurance unit for the division)
6. Improve tracking of families across the various programs and sites within DSHS (Foster Care, Family Reconciliation Services) so CPS can be informed when a family known to the agency has had another child or is experiencing family distress.
7. Improve community-wide tracking and communication so that families with children at risk are followed across agencies. Develop electronic tracking capabilities.
8. Focus on primary prevention of child injury by broadening the conditions under which children receive CPS services and interventions.
9. Expand the Alternate Response System to all of King County. This program serves families at low risk for child abuse who are referred to CPS. PHN services, transportation, childcare, parenting education, counseling and emergency assistance are available.
10. Review the agency policy of using voluntary service plans with substance abusing parents. (Voluntary Service Plan: A written plan drafted by CPS worker and signed by parent; dependent on voluntarily cooperation.)
11. Implement review of all deaths among infants in CPS and CWS care to identify problems and take subsequent remedial action. (Note: State law SHB 1035 requires that a consistent process be developed for child death reviews.)
12. CPS should evaluate cases for substance abuse and consult with substance abuse professionals when designing a case management plan.
13. In cases where decisions concerning custody of children are being made, limit dependency status (custody of children by DSHS) to the date of the 6 month court hearing. If parents have not met the conditions of the order by that time they will be held accountable.

14. Create a dialogue among the Bar Association, health care providers, CPS, and other agencies to promote understanding of CPS services and operations.

JAIL HEALTH SERVICES

Pregnant and parenting women who are jailed are often at very high risk from the consequences of prostitution, substance abuse or other illegal and risky activities. During incarceration they are also involuntarily separated from their families and health care providers. This population presents both unique challenges and opportunities for jail health providers and the community health care system, since a jail stay may be the conduit into care. At a minimum, continuation of care needs to be provided during the stay. Jail health professionals often have only brief contact with these women because of the short duration of stay of many inmates. During this time, they not only have the responsibility for screening for health problems, but also for treatment and referral for additional care.

Adding to this challenge are the problems that result when some pregnant women conceal their pregnancies or do not know that they are pregnant. Continuity of care and ensuring appropriate follow-up after discharge are important links for the health and social well-being of incarcerated mothers and their infants.

EXAMPLES OF PROBLEMS CITED IN CASES (*4 cases)*

Many jail clients are in for short stays (less than 24 hours), making provision of prenatal services or referral into on-going care difficult.

ILLUSTRATIVE VIGNETTE: Cassandra had a long history of cocaine use and had been jailed several times over the past few years. She had one prenatal visit with a positive toxicology screen. The PHN referred Cassandra to CPS after she missed appointments. Cassandra was admitted to the jail in her second trimester of pregnancy and was seen by a nurse on admission. Cassandra was briefly screened and referred to the obstetrical team, but was never seen by them as she went to court early in the morning and was released.

Some clients may try to conceal their pregnancy or labor.

ILLUSTRATIVE VIGNETTE: A pregnant mother did not notify jail health service personnel of her impending labor, resulting in a rushed trip to the hospital. A precipitous delivery has the potential for harming both mother and infant.

RECOMMENDATIONS

1. Provide the patient with a "passport" which contains a brief history of obstetrical data, provider's name and other relevant medical information.

2. Increase collaboration between Jail Health Services, other Health Department primary care providers and Harborview Medical Center Women's Clinic in order to access obstetrical records on shared patients.

3. Expand outreach programs for clients of Jail Health Services so that outreach workers can expand their services to include alcohol and drug treatment programs (such as MOMS) and establish liaisons with the courts and PHNs. Currently, Jail Health Services works with outreach workers from Yesler Terrace Clinic to care for prenatal patients.

4. Clarify the relationship of Jail Health Services with Child Protective and Child Welfare Services to prevent communication breakdowns. Specify what types of referrals to CPS/CWS are appropriate and what follow-up action can be expected.

5. Establish a women's resource center in the jail. Educational materials and group classes are needed on subjects such as domestic violence, parenting and survival skills (food, shelter, legal, medical and job training).

6. Obtain a menstrual history on admission to the psychiatric unit to rule out pregnancy for all female inmates housed on the unit. An initial assessment and pregnancy test should be done if indicated and if the patient consents, and a referral should made for obstetrical care. The psychiatric unit admission form should include a brief health history.

7. Coordinate County and state agency obstetrical care, mental health and substance abuse programs for pregnant women who have a dual diagnosis of substance abuse. Jail Health Services cares for a number of patients who need mental illness, substance treatment and obstetrical care in an inpatient setting. These women are too ill to care for themselves and are adversely affected by homelessness, drug use and mental illness.

The Health Department is responsible for Jail Health Services and has included them in the new division of Community Oriented Primary Care. This reorganization will strengthen the linkages of Jail Health Services to other primary care services within the Department and facilitate implementation of these recommendations.

EMERGENCY MEDICAL SERVICES / FIRST RESPONDERS

The citizens of Seattle and King County are fortunate in having a sophisticated system of well-trained responders to contact in case of the death or serious illness of an infant. The system consists of a network of emergency medical system providers and private ambulance companies throughout the county. Police also often respond when an infant has died in the home. Families are often in a state of severe shock and grief when these services arrive. They are extremely vulnerable, often feeling guilty, frightened, and distraught. Additionally, first responders often feel a strong emotional response to the death, such as grief or anger. These feelings, if unrecognized, can influence their actions and attitudes when responding to the family. While training has been offered for first responders to infant deaths, the scope of the training continues to be a challenge because of the large number and turnover of police officers, firefighters and emergency medical services personnel in King County.

EXAMPLES OF PROBLEMS CITED IN CASES

Inappropriate behavior by first responders (police) at the scene of SIDS deaths was an issue for several families. (2 cases)

ILLUSTRATIVE VIGNETTE: Families felt they were treated like "criminals" by first responders when their babies died. They were locked out of their houses for interrogation and/or taken to the police station when their babies died unexpectedly at home.

Delays in Emergency Medical Services arrival at infant's home were infrequent but significant for the families. (2 cases)

ILLUSTRATIVE VIGNETTE: Ambulance arrival was delayed because no street signs were installed in a new housing development and in another because parents' directions on how to find the house were ignored by EMS staff.

Inconsistent actions at the scene of infants dying at home was sometimes a problem. This is difficult to address due to the large number of first responders who are supervised by multiple jurisdictions . (2 cases)

ILLUSTRATIVE VIGNETTE: While most infants dying at home from SIDS were not transported, several cases were removed to area hospitals before arrival of the Medical Examiner's staff. This unnecessarily disrupted the Medical Examiner's scene investigations of those cases and hindered the determination of an accurate cause of death.

RECOMMENDATIONS

1. Require developers to put up street signs as soon as roads are in. Signs must be maintained.
2. Develop interagency cooperation to assist the Medical Examiner's Office with gathering information for the scene investigation. This includes coordination of first responder activities with the Medical Examiner on cases in which the cause of death is unknown or appears to be SIDS. In these cases, paramedics and police are called to the scene long before the Medical Examiner's Office is able to conduct the standard scene investigation, which is an essential element in determining the infant's cause of death.
3. Provide ongoing training to paramedics responding to infant deaths to complete appropriate sections of the standardized infant scene investigation protocol for the Medical Examiner's Office.
4. Ensure ongoing training for all first responders(police, firemen, and paramedics) to promote sensitivity regarding issues of personal and family grief related to infant's death.

SUBSTANCE ABUSE

The pregnant or parenting substance abusing women described in these cases were usually living stressful lives, sometimes with chaotic living conditions and limited coping skills. Such circumstances placed these women and their children at risk of poor health outcomes. Professionals were often frustrated in keeping them in prenatal care and linking them to community resources because of the high priority they placed on their addictions.

Drug and alcohol screening of pregnant women is not routine in King County. Furthermore, the concept of screening for substance abuse is not well understood by many providers and policy makers who believe using toxicology screens to detect drug use is sufficient. Research has shown that evaluation which includes physical assessment for signs and symptoms of substance abuse and a careful history for social and clinical indicators of abuse are more effective than relying solely on drug testing.

The following problems and recommendations are limited to the issues of substance abuse as related to the 27 cases reviewed in the report discussed in this chapter. More general recommendations for substance abuse issues will be made in a subsequent report which will examine all cases of infant deaths where there was evidence of maternal substance abuse.

EXAMPLES OF PROBLEMS CITED IN CASES

Drug and alcohol screening of pregnant women/newborns is inconsistent. Ongoing tracking of substance abuse is difficult for providers. (7 cases)

ILLUSTRATIVE VIGNETTE: Some mothers with positive toxicology screens during prenatal care were not given toxicology screening at the time of delivery. In these cases, the babies were not tested either. They were discharged in the care of their mothers, with no follow-up plan for assessment and treatment. In some cases, impairment due to substance abuse limited the abilities of the mothers to safely care for their infants. An example would be an infant who was placed in an unsafe location to sleep and died an accidental death.

Resources such as inpatient programs for parenting women are lacking to meet the needs of substance abusing women.

ILLUSTRATIVE VIGNETTE**:** Anita drank daily during her pregnancy, was homeless, and delivered an infant with possible fetal alcohol syndrome. CPS was notified of the birth and the baby was discharged in Anita's custody to stay with relatives. Her caseworker and social worker made appointments for alcohol treatment, but she canceled them because she could not take her children with her.

CPS contracts for substance abusing women are not well monitored and sometimes ineffective. (6 cases)

ILLUSTRATIVE VIGNETTE: Raylinn, a single mother with several living children, had a prior history of intravenous drug and alcohol abuse. She was followed by several health providers during her pregnancy. Her chaotic housing situation, with stays in hotels, cars, and shelters, led her providers to call CPS. She relinquished the children during this pregnancy, was referred for alcohol treatment, and was given help with housing. When she gave birth, the toxicology report was negative and her infant was discharged to her care at seven days. They moved into housing approved by CPS. A PHN notified CPS of her concerns regarding household crowding and poor parent-infant interaction after a home visit six weeks after birth. Meanwhile, both Raylinn and her baby missed their clinic appointments. CPS was notified again, but the baby remained in the home until death.

RECOMMENDATIONS

1. Routine screening by providers should include recognition and documentation of signs and symptoms of substance abuse, a careful history for substance abuse, and monitoring of indicators of substance abuse.

2. Standardize protocols for providers on recognition and documentation of substance abuse, including client assessment and toxicology screening for mothers and babies.

3. Perform risk assessment on all families where substance abuse is found and refer to CPS as mandated and to public health nursing as appropriate.

4. Develop procedures and protocols for CPS contracts for substance abusing women that ensure that they are individualized, enforceable, carefully monitored and evaluated.

5. Provide ongoing training for professionals in detection and management of substance abusing clients.

6. Expand primary prevention efforts, such as health education, regarding substance abuse.

7. Provide additional resources for detection, treatment, and rehabilitation of substance abusing mothers.

8. Address legal barriers which inhibit the exchange among prenatal care providers of crucial information concerning patient alcohol and other drug problems

CONCLUSIONS

Ideally, all women with medical and/or psychosocial risks would have early, consistent prenatal care. This care would include outreach, maternity screening and arrangements for appropriate and available medical care. It would also utilize interdisciplinary support services, including nursing, nutrition, social work, CPS and on-going coordinated case management. Referral to other community resources and health education such as childbirth classes would also be available. Tracking of pregnant and parenting women would assure follow-up on failed appointments and coordination between service providers. Comprehensive and standardized screening and treatment for substance abuse would be the norm. Infants at risk of abuse or neglect would be promptly identified, assessed and assured a safe and nurturing home. All providers, including emergency first responders, would offer sensitive and compassionate care to the families of infants who have died.

While many of these services are available in the community, review of these cases indicated that not all women are referred into the system and that services are not always appropriately delivered. Additionally, some referrals are not made early enough in pregnancy to yield maximum benefits. The system does not always respond in an adequate or timely way. Women who are hard to serve are inconsistently tracked, and communication between service providers can be inadequate.

Implementation of the recommendations contained in this chapter would help move us towards the goal of comprehensive and coordinated services for pregnant women and families.

CHAPTER IX. IMPROVING CARE DURING LABOR AND DELIVERY

This chapter contains three sections, each of which addresses aspects of medical care received by mothers and infants during labor and delivery. The first section discusses 39 cases in which the Review identified issues regarding care during labor and delivery. The second describes fifteen cases whose cause of death was perinatal asphyxia (inadequate oxygen supply to the fetus around the time of birth) and explores issues related to fetal monitoring during labor. Of these fifteen cases, eight were also included in the discussion of labor and delivery management cases in the first section. In the last section, we reviewed cases where perinatal infection either contributed to or caused the infant death.

Information on these cases is presented in both statistical summaries as well as illustrative vignettes. The vignettes are based on a compilation of several cases and do not describe any single case. The names used in the vignettes are not those of cases.

Each of these three sections contains conclusions and recommendations based on information from the Review, a review of relevant medical literature and the consensus of the expert opinions of the Technical Review and Obstetrical Care Subcommittee members. A draft of these findings and recommendations was reviewed by representatives of the major hospitals in King County and other clinicians (nurses, midwives, family practitioners, pediatricians and obstetricians) involved in the management of labor, delivery and care of newborns. Comments received from the reviewers were considered by the Obstetrical Subcommittee before finalizing these recommendations.

Each case was reviewed by both the Technical Review Committee and a more specialized Obstetrical Care Subcommittee. This subcommittee included:

- Perinatologists
- Obstetrician/Gynecologists
- Geneticists
- Midwives
- Family Practitioners
- Epidemiologists
- Pediatricians
- Nurses and other Health Department staff.

OVERVIEW OF CASES WITH ISSUES REGARDING CARE DURING LABOR AND DELIVERY

Of 247[a] cases examined by the Infant Mortality Review between 1992 to 1994, 39[b] (16%) involved issues concerning the medical management of labor and delivery. Two broad categories of issues emerged: those related to the care of the mother and fetus during labor and those pertaining to the care of the newborn immediately following birth. Issues arising before birth included:

- delay in cesarean section
- inadequate fetal assessment during labor
- delay in diagnosis of fetal distress
- delay in maternal transport
- inappropriate indications for procedures.

Concerns related to the immediate care of the newborn included delays in pediatric care and questions regarding techniques used in resuscitating sick infants. Table 1 summarizes these issues, which will be described in more detail below.

TABLE 9.1
OBSTETRICAL AND NEONATAL CARE ISSUES(N=39 CASES)

Description of Issue	Number of Cases*
Labor and Delivery Management Delay in c-section, Inappropriate indication for procedures (i.e. forceps), Delay in diagnosis of fetal distress, Inadequate intrapartum fetal assessment	13
Maternal Transfer & Level of Care	6
Other Aspects of Pregnancy Management GBS prophylaxis, Lack of herpes cultures, Poor patient-provider communication	14
Delay in Pediatric Care Delay in arrival of pediatric care provider, Delay in notifying pediatric care provider of the need for attendance at delivery	4
Neonatal Care Issues Prolonged esophageal intubation, Non-standard of care protocols, Failure to suction below cords	13

* EACH CASE CAN INVOLVE MORE THAN ONE ISSUE

The 39 cases were more likely to be of African American race and not to have graduated from high school when compared to all women giving birth in King County between 1991 to 1993, but did not differ in age, marital status or source of payment for hospital care. The cases were also more likely to be born to mothers having higher numbers of prior births, to be low birthweight and to be born prematurely. In addition, there was no concentration of these cases at any one hospital.

[a] Because there were 68,178 births during this period of time in King County, the cases reviewed in this report comprise only a small fraction of all births.
[b] 39 single births and one twin birth (40 infants)

MATERNAL TRANSFER & LEVEL OF FACILITY ISSUES

During the course of complicated labors, it is sometimes in the best interest of the mother and fetus to transfer them to a more specialized ("higher level") hospital for more intensive care. The Review identified six cases in which the transfer was delayed or did not occur. Delay or lack of transfer was considered an issue only if there were no contraindications to transport and there were clear maternal or pediatric indications for care at a higher level facility.[1] The vignette below illustrates several of the issues that were present in the cases reviewed.

ILLUSTRATIVE VIGNETTE: Patty, who was 21 at the time, entered a Level I hospital at 31 weeks gestation because of labor contractions. She also had chronic high blood pressure. In the labor and delivery unit, she was found to be in early labor, and an ultrasound confirmed that she was 31 weeks gestation. She was monitored for the next three hours and her labor continued to progress. Plans were made to transfer Patty to a Level II facility, but the labor progressed quickly and an ill infant was delivered with Apgars of 2 and 4[c]. A pediatrician was present at delivery. Thirty minutes later, the neonatologist arrived and made plans to transfer the infant to a Level III hospital. The transport team arrived 90 minutes later and placed the infant on a respirator. The baby was transported to a Level III hospital, where he died three days later.

Several potential factors may have contributed to the delay (or lack of) maternal transport in these cases. In some, when it seemed clear early in the course of labor that moving the mother was indicated so that a potentially sick newborn could be delivered in a higher level facility, the decision to transfer was not addressed until after the labor had progressed too far. A second less common problem was an inappropriate decision made by transport personnel to take the mother to the closest hospital rather than to a higher level facility better suited to care for a potentially ill newborn.

RECOMMENDATIONS FOR MATERNAL TRANSFER & LEVEL OF FACILITY ISSUES

- Consider transporting a mother in labor promptly if either pediatric or maternal indications for care at a higher level hospital are present.
- Expedite transfer through early communication with staff at the receiving hospital.

NEONATAL CARE ISSUES

When a sick infant is born, the presence of a pediatric care provider with specialized skills in the care of ill newborns and the provision of appropriate resuscitative care may be important to assure the good health of the infant.[2 3] However, in 13 cases compromised infants were born without the benefit of timely care from a pediatric care provider[d] or they did not receive adequate resuscitation. The following vignette illustrates these concerns:

[c] "Apgar" scores assess the newborn's status at one and five minutes after birth. A score of 7-10 signifies good health while a score of 0-2 indicates severe compromise.

[d] In this report, we use the term pediatric care provider to mean a health care provider trained in pediatric resuscitation and newborn care such as a pediatrician, many family practitioners or neonatologists.

ILLUSTRATIVE VIGNETTE: Charlene, a mother of four, came into the labor and delivery room suite for induction of labor[e] because she was past her delivery date. When the fetal monitor started to show a lowered fetal heart rate (decelerations), the obstetrician was paged. Charlene's labor continued for several hours until her membranes ruptured, revealing meconium-stained fluid. The fetal heart monitoring strip also revealed fetal distress and the decision was made to proceed with a rapid delivery by cesarean section. During preparations for surgery, a neonatologist was called but did not arrive until one hour later. Charlene's infant was ill at delivery. As no neonatologist was present, the anesthesiologist attempted intubation in the next few minutes but was unsuccessful. The baby died of respiratory complications the following day.

In each of these cases, indications for pediatric support were present at least thirty minutes prior to delivery. There were two common causes for delay in the arrival of pediatric support. In some instances, the pediatricians involved appeared to be given adequate notification but failed to arrive in a timely fashion; in others, obstetrical providers delayed summoning the pediatric care provider. Finally, in other cases, the time at which pediatric support was requested was not documented in the medical records, making it difficult to determine what caused the delay in the arrival of the pediatric care provider.

Another common issue which emerged in thirteen of these 39 cases was the appropriateness of the resuscitation procedures[f] performed on very sick infants. Examples of questionable management included lack of fluid resuscitation and prolonged esophageal intubation. In ten of these thirteen cases, the questionable care received on the labor floor did not appear to contribute to the infant death. These cases will be discussed in more detail in a subsequent report on neonatal and pediatric care.

RECOMMENDATIONS FOR NEONATAL CARE ISSUES

Increase timely communication among obstetrical, pediatric and nursing providers in clinical situations that might require pediatric back-up:

- Emphasize early communication between pediatric and obstetrical care providers
- Increase awareness among staff of the desired time interval between the summoning and arrival of pediatric support for deliveries at each hospital handling deliveries
- Consider using a "quick check list" of medical staff to be notified in case of fetal distress to assure that all members of the team are summoned in a timely fashion. Consider including possible 'back-up' staff who could be notified if a first call provider were unavailable.

LABOR & DELIVERY MANAGEMENT ISSUES - INTRAPARTUM FETAL DISTRESS

Fifteen of the infant deaths considered by the Review between 1992 to 1995 were attributed to perinatal asphyxia. These cases have been reviewed by both the Technical Review and the Obstetrical Care Subcommittee. In addition to standard Infant Mortality Review examination of the medical records, the fetal monitoring strips were examined in detail in 14 of the 15 cases. In some cases, there was limited documentation of fetal monitoring by both nurses and physicians. Our recommendations are based both on the documentation and the lack thereof.

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[e] "Induction of labor" refers to medical treatment to initiate and sustain labor in a pregnant woman.

[f] Resuscitation procedures refer to techniques used to support infants with difficulties breathing or circulating blood to essential body organs.

The diagnosis of perinatal asphyxia was based on the four American College of Pediatrics and American College of Obstetrics and Gynecology criteria:[4 5 6 7]

- Evidence of neonatal end-organ dysfunction
- Neurologic dysfunction
- Apgar scores of three or less beyond five minutes
- Umbilical cord acidemia[g] of less than pH 7.2

If one of the four pieces of information was not known, then the diagnosis was confirmed if the other criteria were met and the clinical scenario was consistent with perinatal asphyxia. Umbilical cord gases were not performed[h] in many (9 out of 15) cases and this was the most frequently absent piece of information.

For the most part, these cases involved uncomplicated term pregnancies in white women who had good prenatal care. No individual hospital or obstetrical provider was associated with a disproportionate number of cases. Selected features of these cases are listed in Table 6.2. Infants dying from asphyxia were more likely to be born prematurely and by cesarean section.

TABLE 9.2
CHARACTERISTICS OF ASPHYXIA CASES COMPARED WITH ALL KING COUNTY BIRTHS

Characteristic	Asphyxia Cases(%) N=15	All King County Births*(%) N=68,178
Gestational Age at Birth		
Less than 37 weeks	3(20)	4,733(7)
37-41 weeks	12(80)	60,957(93)
Unknown	0	2,488
Mode of Delivery		
Vaginal	9(60)+	51,514(82)
Cesarean Section	6(40)^	11,220(18)
Unknown	0	5,444
Race		
White	13(87)	49,705(77)
African-American	1(6)	4,510(7)
Other	0	10,661(16)
Unknown	1(6)	3302

* 1991-1993 KING COUNTY BIRTHS
^ ALL SIX CESAREAN SECTIONS WERE EMERGENT
\+ 7 VERTEX AND 2 BREECH DELIVERIES

Three of these infant deaths were attributable to unpreventable maternal-fetal hemorrhages which were undetected prior to labor. In twelve cases, however, the review committees raised concerns about the adequacy of fetal monitoring during labor or the responses to signs of fetal distress detected through such monitoring. The following two vignettes are representative of these cases.

[g] A high level of acid ("acidemia") in the infant's blood indicates inadequate oxygen supply to the infant
[h] Umbilical cord gases were either not performed or performed at a time too distant from delivery to be used in establishing the diagnosis of perinatal asphyxia.

ILLUSTRATIVE VIGNETTE: Sandy was admitted in active labor at term to the facility where she had received comprehensive and uncomplicated prenatal care. Electronic external fetal monitoring was used intermittently. The fetal heart tracing was initially reassuring but later developed intermittent late decelerations with decreased variability and repeated episodes of moderate and severe bradycardia (which are signs of potential fetal compromise). The nursing and medical staff made minimal documentation of their assessment of the baby during labor. After a 3 1/2 hour labor, Sandy gave birth to a 3400 gram (7 1/2 pounds) baby with Apgars of zero and one. Although no pediatrician was present at delivery, one arrived within a few minutes. The baby died two days later with the diagnosis of asphyxia.

This vignette illustrates several patterns which recurred in these cases. First, all but one of these pregnancies appeared uncomplicated until labor. Second, in eleven of the fifteen cases, fetal assessment or monitoring appeared inadequate given the clinical circumstances. For example, despite indications of possible fetal distress, intermittent external fetal monitoring was used when a fetal scalp electrode would have provided better fetal assessment. In addition, fetal monitoring was often intermittent (rather than continuous) despite worrisome fetal heart tracings.[8]
In ten cases, there also appeared to be a clinically significant delay in the diagnosis of fetal distress. The Review diagnosed fetal distress by the combination of clinical parameters (e.g. thick meconium) and significant abnormalities in the fetal heart tracing[i]. In several cases it was not clear if the nursing and medical staff recognized these signs of potential fetal distress.

Finally, documentation by the staff of fetal status (e.g. recording of the interpretation of fetal heart tracings) was often inadequate in these cases. In several cases, neither the nursing nor medical staff medical record notes address the persistence of fetal tachycardia and/or recurrent late decelerations on the fetal heart tracing (both signs of potential fetal compromise).

ILLUSTRATIVE VIGNETTE: The births of Anna's several other children had all been normal. This pregnancy was uneventful and included 12 prenatal visits. At term, she noticed her baby's movement had decreased and she was seen in clinic the following morning. A fetal heart tracing was non-reactive (which is abnormal) and she was admitted to Labor and Delivery where external fetal monitoring revealed fetal distress. An emergency cesarean section was performed well within 30 minutes of her arrival to the labor floor. A neonatologist was present at delivery and assigned Apgars of one, two and four at one, five and ten minutes after birth, respectively. The infant died four days later with a diagnosis of asphyxia and meconium aspiration. Thorough documentation was present regarding both maternal, fetal and pediatric care.

It is important to remember that asphyxia can occur despite the best obstetrical care, as the above vignette illustrates. In four of the fifteen cases reviewed, death from asphyxia occurred despite obstetrical care that met or exceeded treatment standards.[9 10 11] These tragedies highlight the need for continued research into the etiology and detection of intrauterine fetal distress.

[i] e.g. decreased variability with either fetal tachycardia [heart rate greater than or equal to 170 beats per minute] or recurrent late decelerations

RECOMMENDATIONS FOR LABOR AND DELIVERY MANAGEMENT: MANAGING INTRAPARTUM FETAL DISTRESS

Management of possible intrapartum fetal distress[j] remains a challenging issue. The review of these fifteen cases of perinatal asphyxia raised three main concerns:

- Delay in response to indications of fetal compromise during labor
- Delay in notification of obstetrical providers by nursing staff of an abnormal fetal heart tracing
- Lack of documentation of interpretation of fetal status during labor and of care provided in response to indications of fetal distress.

We suggest that the following measures will contribute to improved outcomes for distressed fetuses during labor and delivery:

- Increase efforts that will assure thorough communication among the team of providers that cares for women during labor and delivery. In these cases described above, there were several areas where communication appeared to breakdown:
  - Among staff during transfer of care and change of shift
  - Between nurses and obstetrical providers during labor regarding the fetal heart strips
  - Between pediatric and obstetrical care providers during complicated labors

- Encourage hospitals and birth centers to adopt standardized guidelines or establish institution-specific guidelines, if they have not already done so, for:
  - Nursing staff to contact obstetrical care providers regarding fetal heart strips
  - Obstetrical providers to contact obstetrical and pediatric back-up as appropriate

- Promote regular professional education about fetal monitoring, signs of fetal compromise and methods of fetal assessment and resuscitation during labor by encouraging hospitals, birth centers and professional associations to provide obstetrical providers and nursing staff with continuing education and updated guidelines.

- Encourage hospitals and birth centers to concentrate quality improvement programs on:
  - Adequate communication among providers during labor and delivery
  - Fetal monitoring guidelines for both nurses and obstetrical care providers
  - Adequate documentation of care provided by nursing and obstetrical providers during labor

- Increase efforts by providers to educate pregnant women about the signs and symptoms of fetal compromise such as lack of fetal movement.

INFANT DEATHS CAUSED BY INFECTIONS

Perinatal infection was noted as the underlying cause of death in 12 of the 247 cases of infant death examined by the Review. Four deaths were attributable to disseminated Herpes Simplex Virus II (HSV) infection, four to Group B Strep (GBS) sepsis (bacterial invasion of the body), three to sepsis caused by other organisms, and one to a congenital viral syndrome. Those caused by HSV and GBS are discussed in more detail in the following sections of this chapter.

[j] Intrapartum fetal distress refers to compromise of the fetus during labor and delivery.

The mothers of infants who died of these infections were more likely to be young, to have at least one prior birth, to be African American or Native American, to live in low income households and to deliver prematurely than all mothers in King County.(see Table B.31 in Appendix B).

In twenty other infant deaths, infection was judged to be an important factor contributing to death but not the underlying cause of death[k]. Eighteen of these were deaths due to complications of prematurity in which chorioamnionitis (infection of the placental membranes) was identified as having contributed to the premature birth. In most instances, no specific cause (etiologic agent) of the chorioamnionitis was identified. These cases will be addressed in a future report on infant deaths related to prematurity.

HERPES SIMPLEX VIRUS INFECTION (HSV)

In the four cases of death due to neonatal HSV, none of the mothers had a known history of genital HSV[l]. HSV was considered as a diagnosis in only one case, when a maternal herpes lesion was noted at the time of delivery. In the three unrecognized cases, the mother presented with a significant fever (102°F or greater) during or just prior to labor and a low or normal white blood cell count. Maternal evaluation for bacterial infection, including blood, urine and amniotic fluid cultures, was negative. All four patients had clinical and/or pathological evidence of chorioamnionitis. The majority of deliveries were by cesarean section, occurring between 3 and 20 hours after rupture of membranes. Infants became ill between zero and thirteen days after delivery. Diagnoses were made by cultures from each infant.

ILLUSTRATIVE VIGNETTE: Rosa, a young woman who had been pregnant three times and given birth twice, found herself pregnant again as a result of unprotected sex. She had a history of multiple sexual partners and had been treated twice in the past for a sexually transmitted disease but she had no history of genital herpes. During her pregnancy she had sporadic prenatal care. At 38½ weeks gestation she felt like she had the flu. When her membranes ruptured she went to the hospital. On admission she had a fever of 102º. Her white blood cell count was 5000 cell/mm^3, and antibiotic therapy was initiated. Urine and blood cultures were done and subsequently returned negative. Her labor failed to progress, so the baby was delivered by cesarean section. Rosa's baby weighed 3300 grams (7½ pounds) and was discharged with her mother three days after birth. He was well until the fifth day of life when he began to feed poorly and suffered a seizure. He was readmitted to the hospital and treated with antibiotics for presumed sepsis. Acyclovir was later added after results of nasopharyngeal culture were positive. Despite treatment, Rosa's baby died of overwhelming herpes simplex virus infection.

It is now known that the infants at greatest risk for significant neonatal HSV infection are those born to mothers with a primary infection during pregnancy. This is particularly true if the infection occurs at or near term. We know from epidemiological studies that risk factors for HSV include prior or current sexually transmitted diseases, young maternal age, and multiple partners. Although there are insufficient data (i.e. lack of maternal viral serology[m]) in these cases to establish that they were in fact primary maternal HSV infections, the lack of prior history of HSV and the presence of fever suggests that this is likely. The presence of fever in the mother at or near the onset of labor has not previously been described as a risk factor for neonatal HSV infection. A more definitive study would be needed to demonstrate that this sign is indeed a clinically useful predictor of neonatal HSV infection.

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[k] The underlying cause of death is the disease or injury which initiated the events resulting in death. For example, the underlying cause of death in an infant born at 28 weeks would be classified as prematurity. If an infection did occur, it would have contributed to the infant's death, but the underlying cause would remain prematurity.

[l] Infants with HSV infection usually acquire the virus during birth when they come into contact with an HSV infection in the mother's birth canal.

[m] blood tests indicating the presence and duration of herpes infection

RECOMMENDATIONS FOR HERPES SIMPLEX VIRUS INFECTION

Recognition and management of maternal and neonatal HSV infections are difficult and guidelines are changing.[12 13] Primary HSV infection should be considered as a possible cause of maternal febrile (fever) illness at or near the onset of labor, particularly if no other cause is identified (including negative amniotic fluid cultures) and the peripheral white blood cell count is low or normal.

For all patients in whom HSV infection is suspected, the following are recommended:

- Careful labial and cervical exam to identify lesions
- Genital HSV cultures using an appropriately "vigorous" technique to obtain samples in order to avoid false negative results
- Notification of the pediatric care provider of the suspicion of maternal HSV infection and of the presence of a maternal genital HSV culture

GROUP B STREP INFECTION (GBS)

There were four cases in which the GBS infection was the underlying cause of death, fewer than expected given the average incidence in the United States.[14] This implies that efforts in King County to reduce perinatal death due to GBS have been partly successful.

However, these four cases demonstrate that additional steps are needed to further reduce the incidence of GBS. In two cases, the mother had vaginal cultures showing GBS infection prior to delivery, while in the two additional cases her GBS status was unknown. Risk factors for invasive neonatal GBS infection (see below) were present in two cases. Intrapartum antibiotic prophylaxis was not given in any of the cases. The committee identified several management issues which may have contributed to the lack of prophylaxis: failure to recognize a risk factor for GBS infection and lack of effective communication between providers about positive GBS cultures or GBS risk factors.

Developing general recommendations for the prevention of GBS infection in neonates has been difficult because of the high (up to 40 percent) rate of colonization in pregnant women and the relatively low incidence (1.5 per 1000 births) of invasive GBS disease in neonates. The intermittent nature of shedding of GBS, the resulting low sensitivity of routine cultures for detecting infection, and the lack of a reliable rapid test for screening women during labor also contribute to this difficulty. Ampicillin or penicillin prophylaxis during labor is known to significantly reduce (although not eliminate) deaths due to GBS, but widespread use raises the problems of creating antibiotic resistance as well as causing illness in mothers from antibiotic reactions.[15 16]

Guidelines aimed at the prevention of neonatal GBS disease have been issued by organizations including the American Academy of Pediatrics,[17] American College of Obstetricians and Gynecologists,[18] and the Centers for Disease Control and Prevention[19]. There is general agreement that risk factors for invasive neonatal GBS infection include the following:

- Preterm birth (<37 weeks)
- Prolonged (12-18 hours) rupture of membranes
- Fever during labor (100° F or greater)
- Previous sibling with invasive GBS
- GBS bacteriuria (indicates heavier vaginal colonization).

The guidelines differ as to advisability and timing of screening cultures, and indications for intrapartum prophylaxis. Antepartum cultures performed late (35-37 weeks) in pregnancy are most predictive of maternal GBS status at term. It is agreed that the use of selective media cultures and simultaneous vaginal and rectal specimens greatly improve the predictability of antepartum cultures. Rapid intrapartum screening by optical immunoassay has much improved sensitivity over previous rapid test methods but it is unclear whether even this newest assay has sufficient sensitivity to replace routine antepartum screening.[20]

Because of the cost and lack of reliability of early testing to predict GBS status at delivery, some advocate doing no cultures and treating all patients that have risk factors. Although the majority of cases of invasive neonatal GBS have evidence of one or more risk factors, a significant minority of cases do not. In this particular sample, two of the four deaths did not have identified risk factors. One of these was known to be GBS positive, and the other might have been identified as a GBS carrier had testing been done. Intrapartum prophylaxis may have prevented these deaths. The benefit of treating all mothers with positive GBS cultures must be weighed against the problems of serious reactions (e.g. anaphylactic shock) to antibiotic therapy and development of antibiotic-resistant organisms.[15] [21]Despite these uncertainties, the recent Center for Disease Control (CDC) recommendations suggest treatment of all mothers with positive GBS cultures.

RECOMMENDATIONS TO PREVENT NEONATAL GBS INFECTION

Because management of GBS infection remains an area of controversy, we cannot recommend one specific strategy for prevention of neonatal GBS disease. However, we strongly recommend that providers consider the following:

- In-depth discussion with patients concerning the issues involved in screening and prophylaxis of GBS
- Treatment of all patients with risk factors, regardless of GBS status.
- Treatment of all mothers with positive GBS cultures, regardless of gestational age or other risk factors.
- Adoption and adherence to site-specific screening protocols by all providers. Factors to consider in developing such protocols include:
  - Using selective media cultures and obtaining simultaneous vaginal and rectal specimens when screening cultures are performed
  - Formalizing a system for communicating both pending cultures and culture results to labor and delivery staff and all other providers involved in caring for the mother and newborn
  - Establishing a system to verify that treatment has been carried out for all positive cultures.

CONCLUSIONS

In summary, the Review revealed that in several important areas, efforts in King County to reduce perinatal deaths have been successful. We also observed that perinatal asphyxia and other poor outcomes can occur despite the best obstetrical and pediatric care.

Although in many of the cases reviewed, the care provided met or exceeded the standard of care in this region, the Review process revealed several areas of concern. For example, we identified cases in which labor management strayed substantially from practice guidelines established by the American College of Obstetricians and Gynecologists and the American Academy of Pediatrics.[2] The departure from recommended practice may have contributed to fetal compromise in several of these cases. On the

other hand, it is likely that care often varies from these guidelines without adverse consequences, and how often this variation occurs is not known. This is an important area for further investigation. Despite this uncertainty, it seems reasonable to meet certain standards for obstetrical and pediatric care, such as the prompt diagnosis and treatment of fetal distress and adequate communication among the team of health professionals providing care during labor and delivery.

To further these goals, we have developed recommendations for improving obstetrical care in King County in four major areas, based on the findings of the Review:

- Maternal transfer and level of delivery facility
- Labor and delivery management issues concerning fetal monitoring and possible fetal compromise
- Perinatal infections
- Neonatal care immediately following birth

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CHAPTER X. RECOMMENDATIONS

The ultimate goal of the Infant Mortality Review is developing recommendations to improve the health of mothers and infants. This chapter is a compilation of all the recommendations contained throughout this report. They were developed by the Review and incorporate the comments we solicited from community agencies and providers. While this compilation may be a useful summary, it lacks the context of the cases in which recommendations were developed. In order to more fully understand them, the reader should consult the chapter referenced in each section.

INFANT SAFETY (CHAPTERS VI AND VII)

Infant safety is a key approach to preventing unintentional injuries. Unintentional injuries, while comprising a small proportion of all infant deaths in King County, are usually preventable. Since babies under 1 year of age have limited mobility, hazards in the surrounding environment are usually responsible. One of the most important environments affecting the well being of infants is their sleep location, since they spend so much time sleeping.

SLEEP SAFETY RECOMMENDATIONS (CHAPTER VI)

- Every baby needs a safe place to sleep, every time it goes to sleep, no matter where or when. This includes naps during the day as well as nighttime sleeping. Infants should have a crib to sleep in which is in good repair with a firm mattress. No soft bedding such as fluffy comforters, sheepskins or pillows should be under the baby or in the crib. The number of objects in the crib should be limited.
- Infants should avoid sleeping in the prone (on the stomach) position. It is safer for babies to sleep on the side or back. This includes naps as well as night time sleeping.
- Infants should not sleep on beds, couches, and other places not designed for infant sleep safety. Additionally, sleeping on couches with multiple individuals is to be avoided.
- Rocking cradles are potentially dangerous, particularly those that may have defective mechanisms for stabilizing the cradle.
- Day care and foster care facilities should provide a safe sleeping environment for each infant at all times.
- Baby-sitters should be aware of safe sleeping practices for infants.

OTHER SAFETY RECOMMENDATIONS (CHAPTER VII)

- Plastic bags should be out of the reach of infants at all times.
- Window blind cords should be out of reach of infants at all times and cords should have no loops.
- An approved infant car seat should be used at all times when transporting the baby by car. We support the current Washington State law that requires that infants be placed in car seats when in a vehicle.

SUPPORT SERVICES (CHAPTER VIII)

Ideally, all women with medical and/or psychosocial risks should have early, consistent prenatal care. This care should include outreach, maternity screening and arrangements for appropriate and available medical care. It should also utilize interdisciplinary support services, including nursing, nutrition, social work, CPS and on-going coordinated case management. Referral to other community resources and health education such as childbirth classes should also be available. Tracking of pregnant and parenting women should be available as needed to assure follow-up on failed appointments and coordination between service providers. Comprehensive and standardized screening and treatment for substance abuse should be the norm for all pregnant women. Infants at risk of abuse or neglect should be promptly identified, assessed and assured a safe and nurturing home. All providers, including emergency first responders, should offer sensitive and compassionate care to the families of infants who have died.

To attain these service objectives, the Review developed recommendations to improve the quality of support services for pregnant women and infants.

PUBLIC HEALTH NURSING (CHAPTER VIII)

Providing services to the high risk families described in the report is challenging. For most of the cases considered by the Review, Public Health Nursing (PHN) services were not identified as a problem. Among some high risk cases, however, we found several areas for improvement of services. Issues identified related to PHN included lack of referral for nursing services by other agencies and providers and difficulty in locating referred families, lack of timely PHN follow-up with family for services, poor documentation of services, and problems with coordination with other agencies.

PUBLIC HEALTH NURSING RECOMMENDATIONS

- Identify high risk women before and during pregnancy, including women with no other children, for referral to support services prior to delivery of the infant.
- Meet with providers and agencies to promote better understanding of public health nursing and how to make referrals.
- Improve the referral process with options such as electronic transfer of referral, single phone number for all referrals, and/or secure fax machines.
- Encourage providers to make a public health nurse referral for women and infants when:
  - A referral to CPS is made or when CPS is involved.
  - For women with mental health, substance abuse, or homelessness problems
  - For pregnant women being released from incarceration
  - For those who have had no prenatal care
- Increase capacity within the Health Department to consistently respond to referrals in a timely manner and to provide service for sufficient periods of time to monitor each infant's well-being.
- Create a mechanism for internal Health Department review of infant deaths where coordination of care problems have been identified to promote region-specific problem solving.

OTHER PUBLIC HEALTH AND COMMUNITY SERVICES (CHAPTER VIII)

A broad range of community health care and support services of pregnant and parenting women and infants are offered through a complex, interrelated system of public and private agencies and hospitals. Providers of support services have an opportunity to provide needed referrals for services but sometimes miss opportunities to do so. Additionally some women may not have used services offered to them. Services that were needed but not received included WIC (a nutrition program for Women, Infants and Children), prenatal care and other health and social services. Lack of coordination between services and lack of referrals between agencies were also identified as issues.

OTHER PUBLIC HEALTH AND COMMUNITY SERVICES RECOMMENDATIONS

- Every pregnant woman should receive early and continuous prenatal care.
- Ensure that all community health and social service providers are familiar with the range of support services available for pregnant and parenting women, are prepared to make appropriate referrals, and assist the client by motivating and facilitating their use of these services.
- Develop innovative methods for motivating high risk women to seek available services for pregnancy and infant care and for making those services more accessible and acceptable to high risk families. Examples of incentives could include gifts, money, gift certificates, assistance with childcare, transportation, and convenient evening hours for services
- Improve inter-agency communication. Provide coordination of care for pregnant and parenting women who need multiple service providers by linking these women with a case manager and community outreach services. These services should assist with setting service priorities and tracking client response to various referrals and services.
- Increase awareness among women of childbearing age and providers who serve them concerning availability of food and nutrition programs for pregnant women and infants.
- Address legal barriers which inhibit exchange of information between prenatal care providers on the one hand and drug and alcohol treatment and mental health providers serving pregnant women on the other.

CHILD PROTECTIVE SERVICES (CHAPTER VII)

Child Protective Services (CPS) is the agency designated to deal with the assessment and management of suspected and actual child abuse and neglect. The agency faces considerable challenges in dealing with these cases and the Review identified several areas where services might be improved. These included barriers to early referral, lack of capacity to monitor contracts made with clients, problems monitoring cases, problems with infant removal from an unsafe home, premature return of infant to unsafe conditions, and administrative concerns.

CHILD PROTECTIVE SERVICES RECOMMENDATIONS

- Increase capacity within Child Protective Services to consistently respond to referrals in a timely manner and to keep families open to service for sufficient periods of time. This will allow workers to adequately monitor infant well-being so that intervention may be made when necessary.
- Assign a high priority to referrals made by mandated reporters and establish strong communication links with those providers through both regular and case-specific interaction.
- Educate providers about the mechanism for review and mediation of cases when agencies and providers involved do not agree with the disposition of the case by CPS. (Progress Note: In place now is an appeals system consisting first of the child protective team, then up the chain of supervision in the agency. A 1-800 notification telephone number is also available.)

- Continue to improve tracking of families within CPS to clarify which worker is accountable and facilitate monitoring of cases by CPS supervisors.
- Increase accountability within the agency by implementing review by supervisors of individual worker's decisions, family progress and outcomes. (Progress Note: A manual is in development which includes legal citations and grids on shared decision making by workers or supervisors. Also, there is now a quality assurance unit in each division)
- Improve tracking of families across the various programs and sites within DSHS (Foster Care, Family Reconciliation Services) so CPS can be informed when a family known to the agency has had another child or is experiencing family distress.
- Improve community-wide tracking and communication so that families with children at risk are followed across agencies. Develop electronic tracking capabilities.
- Focus on primary prevention of child injury by broadening the conditions under which children receive CPS services and interventions.
- Expand the Alternate Response System to all of King County. This program serves families at low risk for child abuse who are referred to CPS. PHN services, transportation, childcare, parenting education, counseling and emergency assistance are available.
- Review the agency policy of using voluntary service plans with substance abusing parents. (Voluntary Service Plan :A written plan drafted by CPS worker and signed by parent; dependent on voluntarily cooperation.)
- Implement review of all deaths among infants in CPS and CWS care to identify problems and take subsequent remedial action. (Note: Child Death Reviews are now mandated by state law SHB 1035.)
- CPS should evaluate cases for substance abuse and consult with substance abuse professionals when designing a case management plan.
- In cases where decisions concerning custody of children are being made, limit dependency status (custody of children by DSHS) to the date of the 6 month court hearing. If parents have not met the conditions of the order by that time they will be held accountable.
- Create a dialogue among the Bar Association, health care providers, CPS, and other agencies to promote understanding of CPS services and operations.

JAIL HEALTH SERVICES (CHAPTER VII)

Pregnant and parenting women who are jailed are often at very high risk from the consequences of prostitution, substance abuse or other risky behaviors. Many jail clients are in jail for short stays , making provision of prenatal services or referral for ongoing care difficult. Additionally, some clients may try to conceal their pregnancy.

JAIL HEALTH SERVICES RECOMMENDATIONS

- Provide the patient with a "passport" which contains a brief history of obstetrical data, provider's name and other relevant medical information.
- Increase collaboration between Jail Health Services, the Seattle King County Department of Public Health and Harborview Medical Center Women's Clinic in order to access obstetrical records on shared patients
- Expand outreach programs for clients of Jail Health Services so that outreach workers can expand their services to include alcohol and drug treatment programs (such as MOMS) and establish liaisons with the courts and public health nurses. Currently, Jail Health Services works with outreach workers from Yesler Terrace Clinic to care for prenatal patients.

- Clarify the relationship of Jail Health Services with Child Protective and Child Welfare Services to prevent communication breakdowns. Specify what types of referrals to CPS/CWS are appropriate and what follow-up action can be expected.
- Establish a women's resource center in the jail. Educational materials and group classes are needed on subjects such as domestic violence, parenting and survival skills (food, shelter, legal, medical and job training).
- Obtain a menstrual history on admission to the psychiatric unit to rule out pregnancy for all female inmates housed on the unit. An initial assessment and pregnancy test should be done if indicated and if the patient consents, and a referral should made for obstetrical care. The psychiatric unit admission form should include a brief health history.
- Coordinate County and state agency obstetrical care, mental health and substance programs for pregnant women who have a dual diagnosis of substance abuse. Jail Health Services cares for a number of patients who need mental illness, substance treatment and obstetrical care in an inpatient setting. These women are too ill to care for themselves and are adversely affected by homelessness, drug use and mental illness.

EMERGENCY MEDICAL SERVICES/ FIRST RESPONDERS (CHAPTER VIII)

When an infant dies outside of a hospital, one of several agencies may be the first to arrive to provide assistance and assess the situation. Usually, the first responder is a police officer or an Emergency Medical Services provider. Information gathered at the scene of the death is often essential in determining the cause of the infant death. Several issues were identified with these services including difficulty in locating the scene, inappropriate behavior of responders towards family members, and inconsistent information gathering at the scene of death.

EMERGENCY MEDICAL SERVICES/FIRST RESPONDERS RECOMMENDATIONS

- Require developers to put up street signs as soon as roads are in. Signs must be maintained.
- Develop interagency cooperation to assist the Medical Examiner's Office with gathering information for the scene investigation. This includes coordination of first responder activities with the Medical Examiner on cases in which the cause of death is unknown or appears to be SIDS. In these cases, paramedics and police are called to the scene long before the Medical Examiner's Office is able to conduct the standard scene investigation, which is an essential element in determining the infant's cause of death.
- Provide ongoing training to paramedics responding to infant deaths to assist with completion of appropriate sections of the standardized infant death scene investigation protocol for the Medical Examiner's Office.
- Ensure ongoing training for all first responders (police, firemen, and paramedics) to promote sensitivity regarding issues of personal and family grief related to infant deaths.

SUBSTANCE ABUSE (CHAPTER VIII)

The use of alcohol and illicit substances by pregnant and parenting women put both the mother and infant at risk for health and safety problems. Drug and alcohol screening is not routinely completed for pregnant women and screening for substance abuse is not well understood by many providers and policy makers. Issues identified were inconsistent drug and alcohol screening, lack of resources to meet service needs of substance abusing women, and inadequate CPS monitoring of contracts with substance users.

SUBSTANCE ABUSE RECOMMENDATIONS

- Routine screening by providers should include recognition and documentation of signs and symptoms of substance abuse, a careful history for substance abuse, and monitoring of indicators of substance abuse.
- Standardize protocols for providers on recognition and documentation of substance abuse, including client assessment and toxicology screening for mothers and babies.
- Perform risk assessment on all families where substance abuse is found and refer to CPS as mandated and to public health nursing as appropriate.
- Develop procedures and protocols for CPS contracts for substance abusing women that ensure that they are individualized, enforceable, carefully monitored and evaluated.
- Provide ongoing training for professionals in detection and management of substance abusing clients.
- Expand primary prevention efforts, such as health education, regarding substance abuse.
- Provide additional resources for detection, treatment, and rehabilitation of substance abusing mothers.
- Address legal barriers which inhibit the exchange among prenatal care providers of crucial information concerning patient alcohol and other drug problems

IMPROVING CARE DURING LABOR AND DELIVERY (CHAPTER IX)

Recommendations were developed for improving obstetrical care in King County in four major areas, based on the findings of the Review:

- Maternal transfer and level of delivery facility
- Neonatal care immediately following birth
- Labor and delivery management issues concerning fetal monitoring and possible fetal compromise
- Perinatal infections

MATERNAL TRANSFER & LEVEL OF FACILITY ISSUES (CHAPTER IX)

During the course of complicated labors, it is sometimes in the best interest of the mother and fetus to transfer the mother to a more specialized hospital for more intensive care. Several cases were identified during the Review in which transfer was delayed.

MATERNAL TRANSFER & LEVEL OF FACILITY RECOMMENDATIONS

- Consider transporting a mother in labor promptly if either pediatric or maternal indications for care at a higher level hospital are present.
- Expedite transfer through early communication with staff at the receiving hospital.

NEONATAL CARE ISSUES (CHAPTER IX)

The presence of a pediatric care provider with specialized skills in the care of ill newborns may be important when a sick infant is born. Several infants in the Review did not have the benefit of timely care from a pediatric care provider or they did not receive adequate resuscitation.

NEONATAL CARE ISSUES RECOMMENDATIONS

- Increase timely communication among obstetrical, pediatric and nursing providers in clinical situations that might require pediatric back-up:
- Emphasize early communication between pediatric and obstetrical care providers
- Increase awareness among staff of the desired time interval between the summoning and arrival of pediatric support for deliveries at each hospital handling deliveries
- Consider using a "quick check list" of medical staff to be notified in case of fetal distress to assure that all members of the team are summoned in a timely fashion. Consider including possible 'back-up' staff who could be notified if a first call provider were unavailable.

LABOR & DELIVERY MANAGEMENT ISSUES- FETAL DISTRESS (CHAPTER IX)

Perinatal asphyxia (suffocation of the fetus during labor and birth) was the cause of death among a number of cases. Asphyxia is usually preceded by fetal distress as the circulation of blood and oxygen to the fetus is compromised. Detection of fetal distress is an important and often challenging issue in labor and delivery management. The review of fifteen cases of perinatal asphyxia raised three main concerns:

- Delay in response to indications of fetal compromise during labor
- Delay in notification of obstetrical providers by nursing staff of an abnormal fetal heart tracing
- Lack of documentation of interpretation of fetal status during labor and of care provided in response to indications of fetal distress.

LABOR AND DELIVERY MANAGEMENT ISSUES- FETAL DISTRESS RECOMMENDATIONS

The following measures were made to improve outcomes for distressed fetuses during labor and delivery:

- Increase efforts that will assure thorough communication among the team of providers that cares for women during labor and delivery. In these cases described above, there were several areas where communication appeared to breakdown:
  - ♦ Among staff during transfer of care and change of shift
  - ♦ Between nurses and obstetrical providers during labor regarding the fetal heart strips
  - ♦ Between pediatric and obstetrical care providers during complicated labors
- Encourage hospitals and birth centers to adopt standardized guidelines or establish institution-specific guidelines, if they have not already done so, for:
  - ♦ Nursing staff to contact obstetrical care providers regarding fetal heart strips
  - ♦ Obstetrical providers to contact obstetrical and pediatric back-up as appropriate
- Promote regular professional education about fetal monitoring, signs of fetal compromise and methods of fetal assessment and resuscitation during labor by encouraging hospitals, birth centers and professional associations to provide obstetrical providers and nursing staff with continuing education and updated guidelines.

- Encourage hospitals and birth centers to concentrate quality improvement programs on:
  - ♦ Adequate communication among providers during labor and delivery

  - Fetal monitoring guidelines for both nurses and obstetrical care providers
  - Adequate documentation of care provided by nursing and obstetrical providers during labor
- Increase efforts by providers to educate pregnant women about the signs and symptoms of fetal compromise such as lack of fetal movement.

INFANT DEATHS CAUSED BY INFECTIONS(CHAPTER IX)

Perinatal infections were noted as the underlying cause of death in several cases. Issues with detection and treatment of infections varied according to the causative organism. Recommendations were made separately for each of the following types of infection.

RECOMMENDATIONS FOR HERPES SIMPLEX VIRUS INFECTION (HSV)

Recognition and management of maternal and neonatal HSV infections is difficult and guidelines are changing. Primary HSV infection should be considered as a possible cause of maternal fever occurring at or near the onset of labor, particularly if no other cause for the fever is identified (including negative amniotic fluid cultures) and the peripheral white blood cell count is low or normal.

For all patients in whom HSV infection is suspected, the following are recommended:

- Careful labial and cervical exam to identify lesions
- Genital HSV cultures using an appropriately "vigorous" technique to obtain samples in order to avoid false negative results
- Notification of the pediatric care provider of the suspicion of maternal HSV infection and of the presence of a maternal genital HSV culture

RECOMMENDATIONS TO PREVENT NEONATAL GROUP B STREP INFECTION (GBS)

Because management of GBS infection remains an area of controversy, one specific strategy for prevention of neonatal GBS disease cannot be recommended. It is strongly recommend that providers consider the following:

- In-depth discussion with patients concerning the issues involved in screening and prophylaxis of GBS
- Treatment of all patients with risk factors, regardless of GBS status.
- Treatment of all mothers with positive GBS cultures, regardless of gestational age or other risk factors.
- Adoption and adherence to site-specific screening protocols by all providers. Factors to consider in developing such protocols include:
  - Using selective media cultures and obtaining simultaneous vaginal and rectal specimens when screening cultures are performed
  - Formalizing a system for communicating both pending cultures and culture results to labor and delivery staff and all other providers involved in caring for the mother and newborn
  - Establishing a system to verify that treatment has been carried out for all positive cultures.

APPENDIX A

TABLE OF CONTENTS

Births 119
Race/Ethnicity 119
Validity of Vital Records Data 119
Confidentiality 119
Socioeconomic Status 120
Federal Poverty Level 120
Medicaid 120
Kotelchuck Index 120
Health Planning Areas of King County 121
The Four Regions of King County 122
The National Infant Mortality Survey Classification of Causes of Infant Death 123
The Infant Mortality Review Classification of Causes of Infant Death 123
ICD-9 Codes for Perinatal Conditions as Underlying Cause of Death 124

BIRTHS

Information on births is collected through birth certificates by the Washington State Department of Health and Vital Statistics section at the Center for Health Statistics. Birth certificates include information on mother's age and race, as well as a variety of other subjects, varying by year of the birth, such as birthweight, mother's smoking status, method of delivery, method of payment for the delivery, census tract of mother's residence, and others. Birth rates are calculated through the combination of birth certificate and population estimates.

RACE/ETHNICITY

We use the Federal Office of Management and Budget Directive 15 to define race and ethnicity. A person may belong to one of four racial groups: White, African American, Asian, or Native American. In addition, a person of any race may be identified as Hispanic.

VALIDITY OF VITAL RECORDS DATA

The Washington State birth certificate has contained a check-box format for recording data since 1980, which has been shown to provide more complete reporting of birth complications. Frost et al., in 1984, estimated the completeness of reporting of selected birth complications and congenital malformation on the Washington State birth certificate by comparing the total occurrences reported on birth certificates to the totals reported in hospital records.[1] The authors reported a dramatic increase in reporting of pregnancy complications, such as C-Section, pre-eclampsia and breech presentation, upon adoption of the check box format. The rates improved from 33% to 90%, 50% to 97%, and 52% to 91%, respectively. This experience was validated by a Finish controlled trial that determined that forms with open-ended questions lacked information on 29% of the most common procedures versus only 9% for forms with a check-box format.[2] Additionally, Parrish et al. abstracted a sample of 7,536 hospital medical records to validate the accuracy of the coding of obstetric information on birth certificates, a statewide computerized hospital discharge abstract data system, and a linked file of birth certificates and the hospital abstract data for Washington State deliveries occurring in 1989.[3] The authors reported that 99.8% of women noted to have cesarean delivery recorded on birth certificates also had that delivery method noted on the hospital chart. It has been reported that the overall accuracy of information in the Washington State Birth Record is excellent, with an error rate of <4% as determined by comparison with hospital records.[4] Furthermore, over 40 studies using Washington State Birth Certificate data have been conducted through the University of Washington and the Fred Hutchinson Cancer Research Center, and published in peer reviewed journals, since 1984.

CONFIDENTIALITY

Confidentiality and anonymity were maintained for each case in the review, in addition to the comparison group. All records with identifying information were locked in file cabinets accessible only to the infant mortality review team. Records were purged of identifying information and handled in an anonymous confidential manner when presented to the various committees for case review. Computer files were password protected and accessible only to the infant mortality review team. The project was approved through the University of Washington Human Subjects Review Board .

SOCIOECONOMIC STATUS

Information on percent below poverty in census tracts was drawn from the 1990 U.S. Census. The federal poverty level (FPL) is a the household annual income level used to determine poverty status for statistical purposes and determining eligibility for programs targeting low-income families. The federal poverty level is adjusted for family size and composition and is keyed to the Consumer Price Index. In February, 1993, the Federal Poverty Level was as follows:

TABLE A.1
ANNUAL INCOME LEVEL FOR 100%, AND 185% FPL, FEBRUARY, 1993

Family Size	100% FPL	185% FPL
1	$6,972	$12,900
2	$9,432	$17,448
3	$11,892	$21,996
4	$14,352	**$26,544**

MEDICAID

Title XIX of the Social Security Act, known as Medicaid, became law in 1965. Medicaid provides health insurance for the economically disadvantaged in the United States. Individuals must meet certain eligibility criteria for Medicaid benefits, such as having to be on welfare, have dependent children, or receive the supplemental security income for the aged, blind, and disabled. Each state determines the eligibility criteria for welfare program participation. Therefore, eligibility for the Medicaid program is controlled principally by the state. However, the federal government establishes guidelines that must be met before federal funds are made available.

KOTELCHUCK INDEX

The Kotelchuck Index measures the adequacy of the initiation and quantity of prenatal care visits. This index considers initiation of prenatal care, number of prenatal care visits and gestational age in determining an Expected Visit Ratio [(number of visits/expected visits)*100]. If this ratio is 0, then no prenatal care was received. A ratio of <50% means inadequate prenatal care, ≥50-<80% means intermediate, ≥80-<110% means adequate, and ≥110% means more than adequate prenatal care.

HEALTH PLANNING AREAS OF KING COUNTY

Health Planning Areas as defined by the Seattle-King County Health Department are used for small-area analysis in this report. Below is a list of the census tracts that are aggregated into each Health Planning Area:

Auburn:	296.00, 298.02, 299.00, 304.00 - 312.02
Bellevue:	230.00 - 242.00
Bothell/Woodinville:	217.00 - 219.01, 220.01, 221.00, 323.01, 323.02
Central Seattle:	75.00, 77.00 - 92.00
East/Northeast County:	324.00 - 330.00
Eastgate/Issaquah:	247.00 - 250.00, 321.01 - 322.02
Federal Way:	300.01 - 303.04
Highline/Burien:	262.00, 276.00, 278.00 - 282.00, 284.01 - 290.00
Kent:	283.00, 291.00 - 295.00, 297.00, 298.01
Kirkland/Redmond:	219.02, 220.02, 222.00 - 229.00, 323.03 - 323.05
Mercer Island:	243.00 - 246.00
North Central Seattle:	55.00 - 74.00, 76.00
North County:	201.00 - 216.00
North of Canal Area:	15.00 - 54.00
North Seattle:	1.00 - 14.00
Renton:	251.00 - 259.00, 319.01, 319.02
Southeast County:	313.00 - 318.00, 320.01 - 320.03, 331.00
Southeast Seattle:	89.00, 90.00, 93.00 - 95.00, 100.00 - 104.00, 109.00 - 112.00, 117.00 - 119.00
Vashon Island:	277.01, 277.02
West Seattle:	96.00 - 99.00, 105.00 - 108.00, 113.00 - 116.00, 120.00, 121.00
White Center/Skyway:	260.01 - 261.00, 263.00 - 275.00

FOUR REGIONS OF KING COUNTY

The Health Planning Areas of King County can be aggregated into four major groups. These regions consist of the following areas:

EAST KING COUNTY

- Bothell/Woodinville
- Kirkland/Redmond
- Bellevue
- Mercer Island
- Eastgate/Issaquah
- East/Northeast County

SOUTH KING COUNTY

- White Center/Skyway
- Renton
- Kent
- Auburn
- Federal Way
- Highline/Burien

NORTH KING COUNTY/NORTH SEATTLE

- North of Canal Area
- North County
- North Seattle,
- North Central Seattle

SOUTH SEATTLE

- West Seattle
- Southeast Seattle
- Central Seattle

THE NATIONAL INFANT MORTALITY SURVEY CLASSIFICATION OF CAUSES OF INFANT DEATH

The National Infant Mortality Survey (NIMS) classified infant's causes of death into 11 categories, based on the International Classification of Diseases, 9th revision, (ICD-9) [5]. These categories were:

1. Prematurity/low birthweight
2. Respiratory distress syndrome/bronchopulmonary dysplasia
3. Other perinatal respiratory
4. Birth trauma, hypoxia, asphyxia
5. Other perinatal conditions (excluding perinatal infections)
6. Infections:
   a. Perinatal infections
   b. Other infections
7. Congenital anomalies
8. External causes
9. Sudden Infant Death Syndrome (SIDS)
10. Nonspecific (includes cardiac/respiratory arrest) and unknown causes
11. All others

THE INFANT MORTALITY REVIEW CLASSIFICATION OF CAUSES OF INFANT DEATH

We regrouped the NIMS categories of causes of infant death into 7 groups in order to simplify analysis. These groups were:

1. Prematurity (including prematurity, low birthweight, respiratory distress syndrome, bronchopulmonary dysplasia, and necrotizing enterocolitis)
2. SIDS
3. Congenital anomalies
4. Perinatal conditions [including other perinatal respiratory, birth trauma, hypoxia, perinatal/neonatal asphyxia, other perinatal conditions (excluding perinatal infections), and perinatal infections].
5. Other infections (e.g., pneumonia, meningitis)
6. External causes (e.g., positional/accidental asphyxia, motor vehicle accident, trauma, burns, etc.)
7. Other miscellaneous (e.g., cardiac arrythmia, cardiopulmonary arrest, and umbilical cord compression)

Respiratory distress syndrome and bronchopulmonary dysplasia have been merged with prematurity/low birth weight group, since respiratory distress syndrome and bronchopulmonary dysplasia almost always occur due to prematurity. Separating these two illnesses from the prematurity group will underestimate the number of infants who died due to prematurity. A new group has been formed, namely "perinatal conditions", which combined other perinatal respiratory, such as meconium aspiration pneumonia, birth trauma, hypoxia, and birth asphyxia (including perinatal/neonatal asphyxia), other perinatal conditions, and perinatal infections groups. All of these categories occurred in the peri/neonatal period. Additionally, joining these categories ensured a larger number, so that meaningful conclusions could be made. Both groups of all others and nonspecific causes of death have been merged together into an "other miscellaneous group", since no specific cause of death was identified and to ensure adequate number for analysis.

THE NATIONAL INFANT MORTALITY SURVEY CLASSIFICATION OF CAUSES OF INFANT DEATH

The ICD-9 Codes included in each NIMS cause-of-death group are listed in this section.

A) OTHER PERINATAL RESPIRATORY

770	**Other respiratory conditions of thefetus and newborn**
770.0	CONGENITAL PNEUMONIA - Infective pneumonia acquired prenatally (excludes pneumonia from infection acquired after birth)
700.1	MECONIUM ASPIRATION SYNDROME - Aspiration of contents of birth canal.
770.2	INTERSTITIAL EMPHYSEMA AND RELATED CONDITIONS - pneumomediastinum, pneumopericardium, pneumothorax - originating in the perinatal period.
770.3	PULMONARY HEMORRHAGE - hemorrhage: alveolar (lung); intra-alveolar (lung); massive pulmonary - originating in the perinatal period.
770.5	OTHER AND UNSPECIFIED ATELECTASIS - partial, secondary Pulmonary collapse (originating in the perinatal period)
770.6	TRANSITORY TACHYPNEA OF NEWBORN - Idiopathic tachypnea of newborn , Wet lung syndrome.
770.8	OTHER RESPIRATORY PROBLEMS AFTER BIRTH - apneic spells, Cyanotic attacks, Respiratory distress, Resp failure (originating in the perinatal period)
770.9	UNSPECIFIED RESPIRATORY CONDITION OF FETUS AND NEWBORN

B) BIRTH TRAUMA, HYPOXIA, ASPHYXIA

763 Fetus or newborn affected by other complications of labor and delivery

763.0 BREECH DELIVERY AND EXTRACTION
763.1 OTHER MALPRESENTATION, MALPOSITION & DISPROPORTION DURING LABOR & DELIVERY - Fetus or newborn affected by: Abnormality of bony pelvis, contracted pelvis, persistent occipitoposterior position, shoulder presentation, transverse lie.
763.2 FORCEPS DELIVERY
763.3 DELIVERY BY VACUUM EXTRACTION
763.4 CESAREAN DELIVERY
763.5 MATERNAL ANESTHESIA & ANALGESIA - Reactions and intoxications from maternal opiates and tranquilizers during labor and delivery (excludes drug withdrawal syndrome in newborn)
763.6 PRECIPITATE DELIVERY - Rapid 2nd Stage
763.7 ABNORMAL UTERINE CONTRACTIONS - fetus or newborn affected by: contraction ring, hypertonic labor, hypotonic uterine dysfunction, uterine inertia or dysfunction.
763.8 OTHER SPECIFIED COMPLICATIONS OF LABOR AND DELIVERY AFFECTING FETUS OR NEWBORN - Fetus or newborn affected by: abnormality of maternal soft tissues, destructive operation on live fetus to facilitate delivery, induction of labor (medical), previous surgery to uterus or pelvic organs, other procedures used in labor and delivery
763.9 UNSPECIFIED COMPLICATION OF LABOR AND DELIVERY AFFECTING FETUS OR NEWBORN

767 Birth Trauma

767.0 SUBDURAL AND CEREBRAL HEMORRHAGE
767.1 INJURIES TO SCALP
767.2 FRACTURE OF CLAVICLE
767.3 OTHER INJURIES TO SKELETON
767.4 INJURY TO SPINE AND SPINAL CORD
767.5 FACIAL NERVE INJURY
767.6 INJURY TO BRACHIAL PLEXUS
767.7 OTHER CRANIAL AND PERIPHERAL NERVE INJURIES
767.8 OTHER SPECIFIED BIRTH TRAUMA
767.9 BIRTH TRAUMA, UNSPECIFIED

768 Intrauterine hypoxia and birth asphyxia

768.0 FETAL DEATH FROM ASPHYXIA OR ANOXIA BEFORE ONSET OF LABOR OR AT UNSPECIFIED TIME
768.1 FETAL DEATH FROM ASPHYXIA OR ANOXIA DURING LABOR
768.2 FETAL DISTRESS BEFORE ONSET OF LABOR, IN LIVEBORN INFANT
768.3 FETAL DISTRESS FIRST NOTED DURING LABOR, IN LIVEBORN INFANT
768.4 FETAL DISTRESS, UNSPECIFIED AS TO TIME OF ONSET, IN LIVEBORN INFANT
768.5 SEVERE BIRTH ASPHYXIA.
768.6 MILD OR MODERATE BIRTH ASPHYXIA
768.9 UNSPECIFIED BIRTH ASPHYXIA IN LIVEBORN INFANT

C) OTHER PERINATAL CONDITIONS (EXCLUDING PERINATAL INFECTION)

760 Fetus or newborn affected by maternal conditions which may be unrelated to present pregnancy

760.0 MATERNAL HYPERTENSIVE DISORDERS
760.1 MATERNAL RENAL AND URINARY TRACT DISEASES
760.3 OTHER CHRONIC MATERNAL CIRCULATORY AND RESPIRATORY DISEASES
760.4 MATERNAL NUTRITIONAL DISORDERS
760.5 MATERNAL INJURY
760.6 SURGICAL OPERATION ON MOTHER
760.7 NOXIOUS INFLUENCES AFFECTING FETUS VIA PLACENTA OR BREAST MILK
760.70 UNSPECIFIED NOXIOUS SUBSTANCE
760.71 ALCOHOL
760.72 NARCOTICS
760.73 HALLUCINOGENIC AGENTS
760.74 ANTI-INFECTIVES
760.75 COCAINE
760.76 DIETHYLSTILBESTROL (DES)
760.79 OTHER - Fetus or newborn affected by immune sera, medicinal agents, toxic substance (transmitted via placenta or breast milk)
760.8 OTHER SPECIFIED MATERNAL CONDITIONS AFFECTING FETUS OR NEWBORN
760.9 UNSPECIFIED MATERNAL CONDITIONS AFFECTING FETUS OR NEWBORN

761 Fetus or newborn affected by maternal complications of pregnancy

761.0 INCOMPETENT CERVIX
761.1 PREMATURE RUPTURE OF MEMBRANES
761.2 OLIGOHYDRAMNIOS
761.3 POLYHYDRAMNIOS
761.4 ECTOPIC PREGNANCY
761.5 MULTIPLE PREGNANCY
761.6 MATERNAL DEATH
761.7 MALPRESENTATION BEFORE LABOR
761.8 OTHER SPECIFIED MATERNAL COMPLICATIONS OF PREGNANCY AFFECTING FETUS OR NEWBORN
761.9 UNSPECIFIED MATERNAL COMPLICATION OF PREGNANCY AFFECTING FETUS OR NEWBORN

762 Fetus or newborn affected by complications of placenta, cord, and membranes

762.0 PLACENTA PREVIA
762.1 OTHER FORMS OF PLACENTAL SEPARATION AND HEMORRHAGE
762.2 OTHER AND UNSPECIFIED MORPHOLOGICAL AND FUNCTIONAL ABNORMALITIES OF PLACENTA
762.3 PLACENTAL TRANSFUSION SYNDROMES
762.4 PROLAPSED CORD
762.5 OTHER COMPRESSION OF UMBILICAL CORD
762.6 OTHER AND UNSPECIFIED CONDITIONS OF UMBILICAL CORD
762.7 CHORIOAMNIONITIS
762.8 OTHER SPECIFIED ABNORMALITIES OF CHORION AND AMNION
762.9 UNSPECIFIED ABNORMALITY F CHORION AND AMNION

766 Disorders relating to long gestation and high birthweight

766.0 EXCEPTIONALLY LARGE BABY (BIRTHWEIGHT > OR = 4500 GRAMS)
766.1 OTHER “HEAVY -FOR-DATES” INFANTS
766.2 POST-TERM INFANT, NOT “HEAVY -FOR-DATES”

772 Fetal and neonatal hemorrhage

772.0 FETAL BLOOD LOSS
772.1 INTRAVENTRICULAR HEMORRHAGE
772.2 SUBARACHNOID HEMORRHAGE
772.3 UMBILICAL HEMORRHAGE AFTER BIRTH
772.4 GASTROINTESTINAL HEMORRHAGE
772.5 ADRENAL HEMORRHAGE
772.6 CUTANEOUS HEMORRHAGE
772.8 OTHER SPECIFIED HEMORRHAGE OF FETUS OR NEWBORN
772.9 UNSPECIFIED HEMORRHAGE OF NEWBORN

773 Hemolytic disease of fetus or newborn, due to isoimmunization

773.1 HEMOLYTIC DISEASE DUE TO ABO ISOIMMUNIZATION
773.2 HEMOLYTIC DISEASE DUE TO OTHER AND UNSPECIFIED ISOIMMUNIZATION
773.3 HYDROPS FETALIS DUE TO ISOIMMUNIZATION
773.4 KERNICTERUS DUE TO ISOIMMUNIZATION
773.5 LATE ANEMIA DUE TO ISOIMMUNIZATION

774 Other perinatal jaundice

774.0 PERINATAL JAUNDICE FROM HEREDITARY HEMOLYTIC ANEMIAS
774.1 PERINATAL JAUNDICE FROM OTHER EXCESSIVE HEMOLYSIS
774.2 NEONATAL JAUNDICE ASSOCIATED WITH PRETERM DELIVERY
774.3 NEONATAL JAUNDICE DUE TO DELAYED CONJUGATION FROM OTHER CAUSES
774.30 NEONATAL JAUNDICE DUE TO DELAYED CONJUGATION, CAUSE UNSPECIFIED
774.31 NEONATAL JAUNDICE DUE TO DELAYED CONJUGATION IN DISEASES CLASSIFIED ELSEWHERE
774.39 OTHER
774.4 PERINATAL JAUNDICE DUE TO HEPATOCELLULAR DAMAGE
774.5 PERINATAL JAUNDICE FROM OTHER CAUSES
774.6 UNSPECIFIED FETAL AND NEONATAL JAUNDICE
774.7 KERNICTERUS NOT DUE TO ISOIMMUNIZATION

775 Endocrine and metabolic disturbances specific to the fetus and newborn

775.0 SYNDROME OF “INFANT OF A DIABETIC MOTHER”
775.1 NEONATAL DIABETES MELLITUS
775.2 NEONATAL MYASTHENIA GRAVIS
775.3 NEONATAL THYROTOXICOSIS
775.4 HYPOCALCEMIA AND HYPOMAGNESEMIA OF NEWBORN
775.5 OTHER TRANSITORY NEONATAL ELECTROLYTE DISTURBANCES
775.6 NEONATAL HYPOGLYCEMIA
775.7 LATE METABOLIC ACIDOSIS OF NEWBORN
775.8 OTHER TRANSITORY NEONATAL ENDOCRINE AND METABOLIC DISTURBANCES
775.9 UNSPECIFIED ENDOCRINE AND METABOLIC DISTURBANCES SPECIFIC TO THE FETUS AND NEWBORN

776 Hematological disorders of fetus and newborn

776.0 HEMORRHAGIC DISEASE OF NEWBORN
776.1 TRANSIENT NEONATAL THROMBOCYTOPENIA
776.2 DISSEMINATED INTRAVASCULAR COAGULATION IN NEWBORN
776.3 OTHER TRANSIENT NEONATAL DISORDERS OF COAGULATION
776.4 POLYCYTHEMIA NEONATORUM
776.5 CONGENITAL ANEMIA
776.6 ANEMIA OF PREMATURITY
776.7 TRANSIENT NEONATAL NEUTROPENIA
776.8 OTHER SPECIFIED TRANSIENT HEMATOLOGICAL DISORDERS
776.9 UNSPECIFIED HEMATOLOGICAL DISORDER SPECIFIC TO FETUS OR NEWBORN

777 Perinatal disorders of digestive system

777.1 MECONIUM OBSTRUCTION
777.2 INTESTINAL OBSTRUCTION DUE TO INSPISSATED MILK
777.3 HEMATEMESIS AND MELENA DUE TO SWALLOWED MATERNAL BLOOD
777.4 TRANSITORY ILEUS OF NEWBORN
777.5 NECROTIZING ENTEROCOLITIS IN FETUS OR NEWBORN
777.6 PERINATAL INTESTINAL PERFORATION
777.8 OTHER SPECIFIED PERINATAL DISORDERS OF DIGESTIVE SYSTEM
777.9 UNSPECIFIED PERINATAL DISORDER OF DIGESTIVE SYSTEM

778 Conditions involving the integument and temperature regulation of fetus and newborn

778.0 HYDROPS FETALIS NOT DUE TO ISOIMMUNIZATION
778.1 SCLEREMA NEONATORUM
778.2 COLD INJURY SYNDROME OF NEWBORN
778.3 OTHER HYPOTHERMIA OF NEWBORN
778.4 OTHER DISTURBANCES OF TEMPERATURE REGULATION OF NEWBORN
778.5 OTHER AND UNSPECIFIED EDEMA OF NEWBORN
778.6 CONGENITAL HYDROCELE
778.7 BREAST ENGORGEMENT IN NEWBORN
778.8 OTHER SPECIFIED CONDITIONS INVOLVING THE INTEGUMENT OF FETUS AND NEWBORN
778.9 UNSPECIFIED CONDITION INVOLVING THE INTEGUMENT AND TEMPERATURE REGULATION OF FETUS AND NEWBORN

779 Other and ill-defined conditions originating in the perinatal period

779.0 CONVULSIONS IN NEWBORN
779.1 OTHER AND UNSPECIFIED CEREBRAL IRRITABILITY IN NEWBORN
779.2 CEREBRAL DEPRESSION, COMA, AND OTHER ABNORMAL CEREBRAL SIGNS
779.3 FEEDING PROBLEMS IN NEWBORN
779.4 DRUG REACTION AND INTOXICATIONS SPECIFIC TO NEWBORN
779.5 DRUG WITHDRAWAL SYNDROME IN NEWBORN
779.6 TERMINATION OF PREGNANCY (FETUS)
779.8 OTHER SPECIFIED CONDITIONS ORIGINATING IN THE PERINATAL PERIOD
779.9 UNSPECIFIED CONDITION ORIGINATING IN THE PERINATAL PERIOD

D) PERINATAL INFECTIONS

760.2 MATERNAL INFECTIONS - Fetus or newborn affected by maternal infectious disease classifiable to 001-136 and 487, but fetus or newborn not manifesting that disease. Excludes congenital infectious diseases (771.0-771.8); maternal genital tract and other localized infections (760.8)

771 Infections specific to the perinatal period

771.0 CONGENITAL RUBELLA
771.1 CONGENITAL CYTOMEGALOVIRUS INFECTION
771.2 OTHER CONGENITAL INFECTIONS
771.3 TETANUS NEONATORUM
771.4 OMPHALITIS OF THE NEWBORN
771.5 NEONATAL INFECTIVE MASTITIS
771.6 NEONATAL CONJUNCTIVITIS AND DACRYOCYSTITIS
771.7 NEONATAL CANDIDA INFECTION
771.8 OTHER INFECTION SPECIFIC TO THE PERINATAL PERIOD

E) EXTERNAL CAUSES (INJURY AND POISONING)

800-829	FRACTURES
830-839	DISLOCATIONS
840-848	SPRAINS AND STRAINS OF JOINTS AND ADJACENT MUSCLES
850-854	INTRACRANIAL INJURY, EXCLUDING THOSE WITH SKULL FRACTURE
860-869	INTERNAL INJURY OF THORAX, ABDOMEN, AND PELVIS
870-879	OPEN WOUND OF HEAD, NECK AND TRUNK
880-887	OPEN WOUND OF UPPER LIMB
890-897	OPEN WOUND OF LOWER LIMB
900-904	INJURY TO BLOOD VESSELS
905-909	LATE EFFECTS OF INJURIES, POISONINGS, TOXIC EFFECTS, AND OTHER EXTERNAL CAUSES
910-919	SUPERFICIAL INJURY
920-924	CONTUSION WITH INTACT SKIN SURFACE
925-929	CRUSHING INJURY
930-939	EFFECTS OF FOREIGN BODY ENTERING THROUGH ORIFICE
940-949	BURNS
950-957	INJURY TO NERVES AND SPINAL CORD
958-959	CERTAIN TRAUMATIC COMPLICATIONS AND UNSPECIFIED INJURIES
960-979	POISONING BY DRUGS, MEDICINAL AND BIOLOGICAL SUBSTANCES
980-989	TOXIC EFFECTS OF SUBSTANCES CHIEFLY NONMEDICINAL AS TO SOURCE
990-995	OTHER AN UNSPECIFIED EFFECTS OF EXTERNAL CAUSES
996-999	COMPLICATIONS OF SURGICAL AND MEDICAL CARE, NOT ELSEWHERE CLASSIFIED

F) SUPPLEMENTARY CLASSIFICATION OF EXTERNAL CAUSES OF INJURY AND POISONING (E800-E999)

E800-E848	TRANSPORT ACCIDENTS (Railway, Motor Vehicle, Watercraft, Aircraft and Spacecraft, and Other Road Vehicles)
E849	PLACE OF OCCURRENCE (Place where the accident or poisoning occurred)
E850-E858	ACCIDENTAL POISONING BY ANALGESICS, ANTIPYRETICS, AND ANTIRHEUMATICS
E860-E869	ACCIDENTAL POISONING BY OTHER SOLID AND LIQUID SUBSTANCES, GASES, AND VAPORS
E870-E876	MISADVENTURES TO PATIENTS DURING SURGICAL AND MEDICAL CARE
E878-E879	SURGICAL AND MEDICAL PROCEDURES AS THE CAUSE OF ABNORMAL REACTION OF PATIENT OR LATER COMPLICATION, WITHOUT MENTION OF MISADVENTURE AT THE TIME OF PROCEDURE
E880-E888	ACCIDENTAL FALLS
E890-E899	ACCIDENTS CAUSED BY FIRE AND FLAMES
E900-E909	ACCIDENTS DUE TO NATURAL AND ENVIRONMENTAL FACTORS
E910-E915	ACCIDENTS CAUSED BY SUBMERSION, SUFFOCATION, AND FOREIGN BODIES
E916-E928	OTHER ACCIDENTS
E929	LATE EFFECTS OF ACCIDENTAL INJURY
E930-E949	DRUGS, MEDICINAL AND BIOLOGICAL SUBSTANCES CAUSING ADVERSE EFFECTS IN THERAPEUTIC USE
E950-E959	SUICIDE AND SELF-INFLICTED INJURY
E960-E969	HOMICIDE AND INJURY PURPOSELY INFLICTED BY OTHER PERSONS
E970-E978	LEGAL INTERVENTION
E980-E989	INJURY UNDETERMINED WHETHER ACCIDENTALLY OR PURPOSELY INFLICTED
E990-E999	INJURY RESULTING FROM OPERATIONS OF WAR

G) NONSPECIFIC (INCLUDES CARDIAC/RESPIRATORY ARREST) AND UNKNOWN CAUSES

427.5	CARDIAC ARREST
798.2	DEATH OCCURRING IN LESS THAN 24 HRS FROM ONSET OF SYMPTOMS, NOT OTHERWISE EXPLAINED
798.9	UNATTENDED DEATH
799.8	OTHER ILL-DEFINED CONDITIONS
799.9	OTHER UNKNOWN AND UNSPECIFIED CAUSE

H) OTHER INFECTIONS

1.00-139.8	INFECTIOUS AND PARASITIC DISEASES - Such as Cholera, Candidiasis, and Herpes Zoster
320-383.9	DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS - Such as Bacterial Meningitis, Conjunctivitis, and Otitis Media
420.0-422.9	DISEASES OF THE CIRCULATORY SYSTEM - Such as Acute Pericarditis, Acute and Subacute Endocarditis, and Acute Mycocarditis
460-513.1	DISEASES OF THE RESPIRATORY SYSTEM - Such as Acute Sinusitis, Peritonsillar Abscess, and Viral Pneumonia
566.0-577.0	DISEASES OF THE DIGESTIVE SYSTEM - Such as Peritonitis, Diseases of Pancreas, and Other Disorders of Liver
590.0-595.0	DISEASES OF THE GENITOURINARY SYSTEM - Such as Infections of Kidney and Cystitis
680.0-686.9	DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE Such as Acute Lymphadenitis., Cellulitis, and Impetigo
711.0-730.9	DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE - Such as Arthropathy associated with infection, Infective Myositis, and Osteomyelitis, periostitis, and other infections involving bone
790.7-790.8	SYMPTOMS, SIGNS AND ILL-DEFINED CONDITIONS - Such as Bacteremia, Viremia, unspecified, and Abnormality of red blood cells

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APPENDIX B: SUPPLEMENTAL TABLES

TABLE B.1
INFANT MORTALITY RATES U.S., WASHINGTON, KING COUNTY, SEATTLE, 1980-1994

	WASHINGTON			UNITED STATES		
YEAR	NO. OF INFANT DEATHS	NO. OF LIVE BIRTHS	INFANT MORT. RATE	NO. OF INFANT DEATHS	NO. OF LIVE BIRTHS	INFANT MORT. RATE
1980	801	67,996	11.8	45,514	3,612,258	12.6
1981	734	69,985	10.5	43,188	3,629,238	11.9
1982	754	69,684	10.8	42,326	3,680,537	11.5
1983	642	68,795	9.3	40,756	3,638,933	11.2
1984	702	69,061	10.2	39,627	3,669,141	10.8
1985	748	70,355	10.6	39,862	3,760,561	10.6
1986	676	69,572	9.7	39,068	3,756,547	10.4
1987	683	70,407	9.7	38,475	3,809,394	10.1
1988	656	72,660	9.0	39,095	3,909,510	10.0
1989	693	75,595	9.2	39,601	4,040,958	9.8
1990	622	79,464	7.8	38,256	4,158,212	9.2
1991	603	79,967	7.5	36,587	4,110,907	8.9
1992	540	79,884	6.8	34,553	4,065,014	8.5
1993	495	78,763	6.3	33,466	4,000,240	8.4
1994	479	77,315	6.2	31,400	3,979,000	7.9

	SEATTLE			KING COUNTY		
YEAR	NO. OF INFANT DEATHS	NO. OF LIVE BIRTHS	INFANT MORT. RATE	NO. OF INFANT DEATHS	NO. OF LIVE BIRTHS	INFANT MORT. RATE
1980	79	6,115	12.9	185	17,696	10.5
1981	76	6,260	12.1	186	18,560	10.0
1982	65	6,506	10.0	173	18,860	9.2
1983	67	6,411	10.5	155	18,627	8.3
1984	79	6,550	12.1	198	19,016	10.4
1985	74	6,752	11.0	197	19,790	10.0
1986	71	6,807	10.4	194	19,957	9.7
1987	78	6,766	11.5	188	20,431	9.2
1988	84	6,909	12.2	190	21,205	9.0
1989	65	7,193	9.0	180	22,386	8.0
1990	56	7,118	7.9	156	22,951	6.8
1991	64	7,204	8.9	166	22,799	7.3
1992	41	6,957	5.9	138	23,036	6.0
1993	40	6,536	6.1	123	22,326	5.5
1994	31	6,480	4.8	138	21,972	6.3

NOTE: RATES ARE PER 1,000 LIVE BIRTHS.
SOURCE: BIRTH AND DEATH CERTIFICATES.

TABLE B.2
INFANT MORTALITY RATES BY HEALTH PLANNING AREA IN KING COUNTY
FIVE YEAR AVERAGE, 1990-1994

PLACE	AVE. # OF INFANT DEATHS PER YEAR	AVE. # OF LIVE BIRTHS PER YEAR	INFANT MORT. RATE
AUBURN	11	1,552	7.1
BELLEVUE	4	917	4.8
BOTHELL/WOODINVILLE	4	926	4.1
CENTRAL SEATTLE	6	534	11.2
EAST/NE COUNTY	2	538	3.7
EASTGATE/ISSAQUAH	4	1,081	4.1
FEDERAL WAY	8	1,370	5.6
HIGHLINE/BURIEN	9	1,171	7.5
KENT	11	1,492	7.4
KING COUNTY	144	22,617	6.4
KIRKLAND/REDMOND	10	2,021	5.1
MERCER ISLAND	<1	178	2.2
N. CENTRAL SEATTLE	3	810	4.0
NORTH COUNTY	5	876	5.5
NORTH OF CANAL AREA	10	1,934	5.1
NORTH SEATTLE	5	799	6.3
RENTON	10	1,242	7.9
SEATTLE	46	6,859	6.8
SOUTHEAST COUNTY	9	1,100	8.6
SOUTHEAST SEATTLE	16	1,596	10.0
VASHON	<1	88	4.5
WEST SEATTLE	6	1,185	5.4
WHITE CENTER/SKYWAY	7	1,053	6.3

NOTE: RATES ARE PER 1,000 LIVE BIRTHS.
SOURCE: BIRTH AND DEATH CERTIFICATES.