# Maternal Morbidity and Outcomes Including Mortality, California 2001-2006

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## TABLE OF ABBREVIATIONS

| | |
|---|---|
| ACS | Ambulatory-care Sensitive condition |
| AHRQ | Agency for Healthcare Research and Quality |
| CCS | Clinical Classification System |
| ELOS | Extended length of stay defined as 4 days or longer |
| FHOP | Family Health Outcomes Project, University of California, San Francisco |
| HCUP | Healthcare Cost and Utilization Project |
| MISA | Mental illness and/or substance abuse |
| MCAH | California Department of Public Health Maternal Child and Adolescent Health |
| NRD | Non-routine disposition, defined as any disposition other than return home |
| OOC | Out-of-county care. Patient county of residence differs from county of hospital |
| OSHPD | California Office of Statewide Health Planning and Development |
| PSI | Patient Safety Indicator as defined by AHRQ |
| RR | Relative risk |
| SSNC | Social Security Number, Encrypted with FHOP's algorithm |
| UCOD | Underlying Cause of Death |
| VBAC | Vaginal birth after a previous cesarean delivery |

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This research was funded through a contract from the Bay Area Data Collaborative to Rienks Consulting, with original funds through the California Department of Public Health, Maternal Child and Adolescent Health (MCAH) Branch, which instituted the Maternal Care Quality Improvement Project to address maternal morbidity and mortality.

**Human Subjects Protocol**

FHOP's research protocol is entitled "Longitudinal Study of Hospital Outcomes for California's Children." The protocol has been amended from time to time to add more years of data and datasets. In terms of age, the protocol now includes infants, children, youth, and the population of reproductive age. This work requires two protocols. The protocol through the Committee on Human Research, University of California San Francisco, is Number H6433-12769-13. The Protocol through the Committee for the Protection of Human Subjects, State of California, Health and Human Services Agency is Number 96-06-02.

**Dedication**

To Carol, a very competent Bay Area business professional and accomplished artist who suffered a sudden severe psychotic break a few weeks after the birth of her first child. This event profoundly affected her subsequent life, her marriage to her always-loyal husband, and her three children. She died while this study was being written.

**Suggested Citation**

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# MATERNAL MORBIDITY AND OUTCOMES INCLUDING MORTALITY, CALIFORNIA 2001-2006

## Background

In response to rising maternal mortality rates, the California Department of Public Health Maternal Child and Adolescent Health (MCAH) Branch instituted the Maternal Care Quality Improvement Project to address maternal morbidity and mortality. Under auspices of the Bay Area Data Collaborative, ten local MCAH jurisdictions in the San Francisco Bay Area applied as a group to do a regional analysis and plan. These jurisdictions are Alameda, Contra Costa, Marin, Napa, Santa Clara, San Francisco, San Mateo, Solano, and Sonoma counties, and the City of Berkeley. They entered into this joint project as an opportunity to do a more meaningful analysis and to develop a more comprehensive plan than they each could do independently.

In this context, the Family Health Outcomes Project at the University of California, San Francisco was asked to:

- Identify regional variations in maternal morbidity and mortality that are associated with poor outcomes, have a large population impact, and are amenable to intervention.
- Prepare local health jurisdiction databooks highlighting important conditions to monitor

Given these mandates, our basic questions were as follows:

1. Between 2001 and 2006, how many pregnant women age 10 to 60 sought care in California hospitals? A delivery outcomes study done as part of OSHPD's California Hospital Outcomes Project used the age range 10 to 55 years,[1] while Hornbrook used the range 12 to 60 to study maternal outcomes.[2] These age frames are wider than the range 15 to 44 traditionally used to study maternal indicators for public health surveillance. We broadened the age frame to address question 113A in the California death certificates. Specifically, if the deceased woman is between age 10 and 60, the physician completing the death certificate is supposed to report if she was pregnant in the last year.

2. How many women had an adverse pregnancy outcome or died within 1 year of a pregnancy-related discharge? This attempts to answer question 113A. In essence, the first question gives a denominator. The second question gives numerators for patient safety indicators including mortality.

3. What differentiated women who had adverse outcomes or died? The primary comparison was between the Bay Area and elsewhere in the state. Analyses included differences in demographics, comorbid and obstetric diagnoses, procedures, and other measures for women who had adverse outcomes including death.

Relying on the research reported here and other activities (literature review, interviews with health providers, and gap analysis activities) conducted by Rienks Research, that organization developed a proposal for the Bay Area Data Collaborative. Guidelines from the Maternal Care Quality Improvement Project directed applicants to focus on one or more of the following: improve prevention, recognition, and response to obstetric hemorrhage; improve accuracy and usefulness of administrative data; reduce fragmentation of maternity care; inform and educate the public and families about maternal issues related to reducing morbidity and mortality. The proposal goal is to decrease the incidence of maternal mortality and morbidity in the Bay Area by focusing on mental illness and co-occurring substance abuse disorders (MISA) during the perinatal period through one-year post pregnancy.

## Methods

Data used in this report are from hospital discharge abstracts, emergency department visits, and ambulatory care center data maintained by the California Office of Statewide Health Planning and Development (OSHPD). In this document, we refer to licensed OSHPD facilities as "hospitals". Unless otherwise explicitly stated, we use the terms "admission" or "discharge" to describe both outpatient and inpatient encounters. We use the term "woman" to describe data summarized to the person level using Social Security Number (SSNC), sex, and birthdate.

Between 2001 to 2006, 3,014,039 California women received pregnancy-related care in hospitals, emergency departments, or ambulatory centers. For the 2,112,752 women whose records included a SSNC, we identified 3,421,224 admissions including 163,685 that were not pregnancy-related. These admissions plus those of the remaining 901,297 women whose pregnancy-related admissions lacked SSNC (and thus are not linkable to other admissions) adds to the total of 4,322,521 records used in these analyses.

Details on data sources and methods to create analysis datasets and variables are described in the appendix to this report, with statistics on linkage reliability. Because of the large number of cases, nearly all analyses were statistically significant ($p < 0.0001$). We report two statistics: percents or rates, and relative risk (RR) and we omit confidence intervals to simplify the report.

## Demographic Differences

Compared with other California women, Bay Area residents had different profiles for demographic characteristics, provider characteristics, comorbid conditions, pregnancy diagnoses and procedures, delivery methods, and outcomes. Table 1 summarizes demographic differences for our primary population, California women with SSNC who had at least one pregnancy-related discharge.

| Table 1. | Demographic characteristics (%) | | |
|---|---|---|---|
| Variable | Category | Bay Area | Rest of CA |
| Number | Women | 397,231 | 1,701,487 |
| Age | 15 to 24 | 18.5 | 29.6 |
| | 25 to 34 | 52.2 | 49.2 |
| | 35 to 44 | 29.3 | 21.2 |
| Race/Ethnicity | White | 47.4 | 41.9 |
| | Black | 8.1 | 7.1 |
| | Hispanic | 21.3 | 42.1 |
| | Asian | 23.1 | 8.7 |
| Payor | Private | 73.8 | 54.3 |

Overall, the Bay Area contributed about 18% of hospital care for California women who had been pregnant between 2001 and 2006. Compared with women who lived elsewhere, Bay Area residents were less likely to be age 15 to 24, more likely to be White or Asian, and less likely to be Hispanic. Almost 3 in 4 Bay Area women had at least one discharge with private insurance, compared with about half of women who lived elsewhere.

Figure 1. Fertility per 1,000 Women Age 15 to 44 - 1994-2005

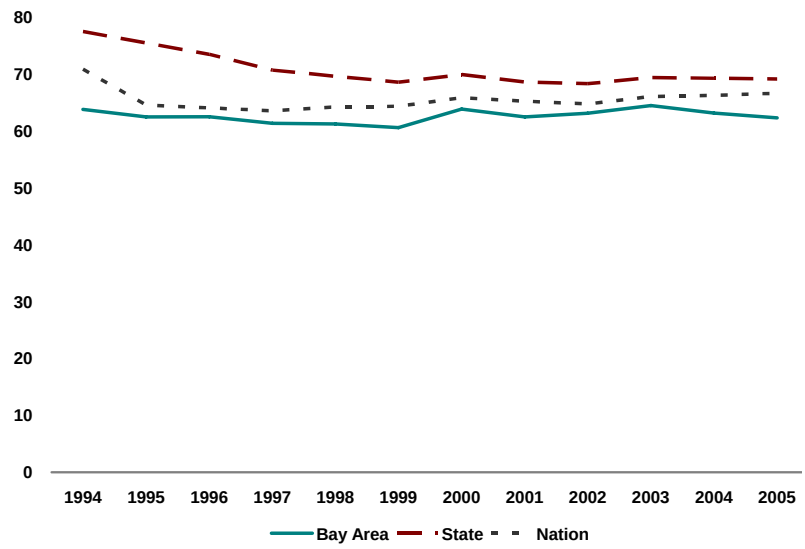
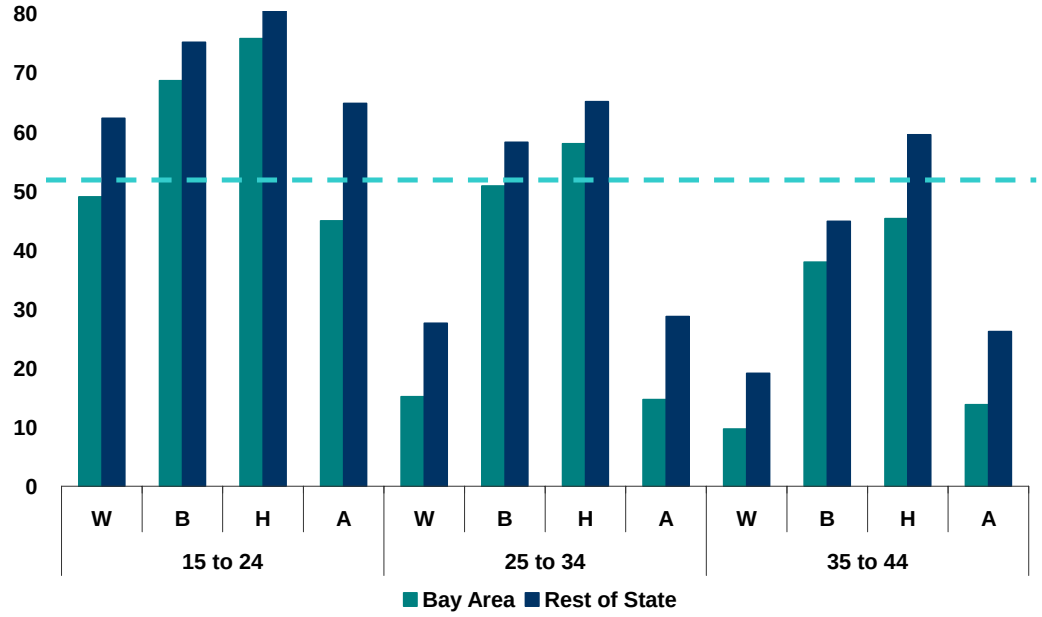



Figure 1 compares fertility trends for Bay Area women age 15 to 44 to California and the nation for the period 1994-2005. Throughout the period, Bay Area women had lower fertility rates and relatively flat trends compared with the State and nation. Although rates were highest for Hispanic women, trends were generally equivalent with a modest decrease for Hispanic and Black women.

Figure 2 compares the percent of discharges by public payor (MediCal or uninsured). The dashed horizontal line is the discharge level state average. Women age 15 to 24 of all race/ethnic groups were more likely to have care paid by the public, and race/ethnic disparities were narrower at this age. Nonetheless, at every age, White and Asian women were less likely to have a public payor than Hispanic and Black women. Across all age and race combinations, Bay Area women were less likely to have admissions covered by public payors.

Figure 2. Public Payor by Age and Race/Ethnicity (%)




## Provider Differences

The Bay Area is a closed healthcare system. Over the 6-year study period, 97% of ever-pregnant women living in the Bay Area and seeking any hospital care for any reason received all their care in the Bay Area. Only 10,879 ever-pregnant women (2.6%) who lived outside the Bay Area received hospital care in the Bay Area. Only 3,155 (0.07%) who lived in the Bay Area received any hospital care outside the Bay Area.

Although the Bay Area is closed overall, about 10% of admissions (and 13% of individuals) statewide were out of the woman's county of residence (OOC). Women coming into and out of the Bay Area were more likely to have a diagnosis of mental illness or substance abuse (MISA). Additionally, women coming into the Bay Area appeared to have higher-risk pregnancies, while the residual of pregnant Bay Area residents treated outside the Bay Area had more injuries or early terminations.

Table 2. Out-of-County (%) Characteristics

| Category | Total | Out-of-County Yes | Out-of-County No | Rel Risk |
|---|---|---|---|---|
| White | 43.0 | 53.0 | 41.6 | 1.93 |
| Black | 7.3 | 10.3 | 7.5 | 1.41 |
| Hispanic | 38.0 | 29.4 | 39.3 | 0.77 |
| Asian | 11.4 | 11.5 | 11.4 | 1.01 |
| 15 to 24 | 27.5 | 23.5 | 28.0 | 0.86 |
| 25 to 34 | 49.8 | 52.1 | 49.5 | 1.05 |
| 35 to 44 | 22.7 | 24.4 | 22.5 | 1.07 |
| Private Pay | 58.1 | 66.2 | 56.8 | 1.49 |
| MISA | 6.1 | 8.34 | 5.73 | 1.49 |
| BA Resident | 19.0 | 30.1 | 17.4 | 2.05 |
| BA Hosp | 19.4 | 33.2 | 17.4 | 2.36 |

Table 2 compares at the person level the characteristics of those who did and did not go OOC. White and Black women were at increased risk, and OOC risk increased linearly with age.

Women with private pay insurance for all admissions had a RR for OOC admissions of 1.49 as did women with MISA diagnoses.

Bay Area residents had elevated risk for OOC admissions (RR = 2.1), and one-third of Bay Area hospital admissions were OOC (RR = 2.36).

Thus women who live in the Bay area almost universally receive all hospital care within the Bay Area but have two times greater risk of admission in a county where their family does not live.

Figure 3. In- and out-migration for hospital services

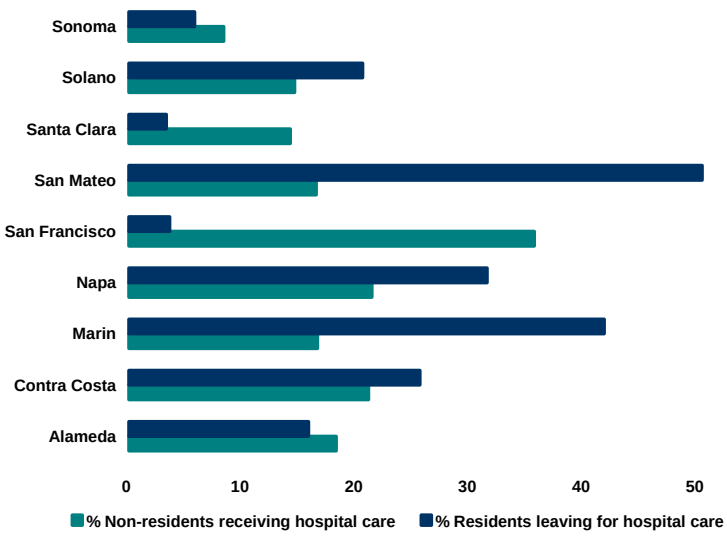



Figure 3 shows the magnitude of the potential time, social and financial burden on pregnant women when they go OOC for care, and the potential for fragmentation of care.

For example, more than 50% of San Mateo County residents receive hospital care in another county. On the other hand, about 20% of pregnancy-related admissions in San Mateo hospitals are women who live elsewhere. Marin County women who go OOC for care go north to Sonoma or south to San Francisco.

Statewide, Sutter Health and Kaiser Permanente accounted for 19% of admissions of ever-pregnant women. In the Bay Area, these systems accounted for 49% of admissions (Sutter, 26%; Kaiser, 23%). Bay Area hospitals (Kaiser, Sutter, others) were more likely to admit OOC patients than hospitals elsewhere in California of all auspices. That is, although two systems dominate the Bay Area, OOC is a regional issue that transcends hospital systems.

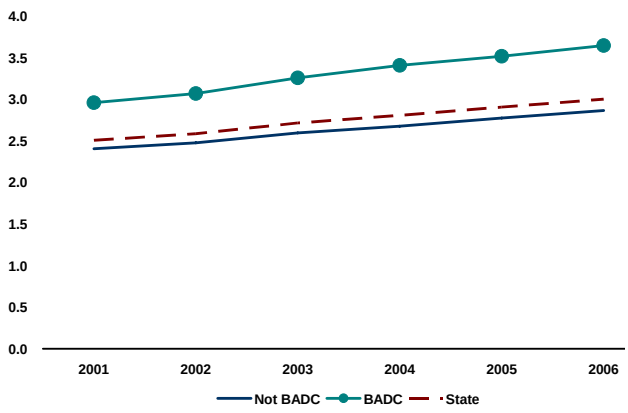
System-wide, 49% of Sutter admissions of ever-pregnant women were in the Bay Area, 19% were OOC, and 69% of their OOC admissions were in the Bay Area. Within Kaiser systemwide, 28% of admissions of ever-pregnant women were in the Bay Area, 20% were OOC, and 51% of their OOC admissions were in the Bay Area. By contrast, in the remaining 81% of admissions to all other hospitals, 10% were in the Bay Area, 8% were OOC, and 20% of OOC admissions were in the Bay Area.

# Comorbid Conditions

## Secondary Diagnoses

OSHPD datasets have fields to record a principal and up to 24 secondary diagnoses, and up to 5 fields to describe injuries. Figure 4 shows trends for number of secondary diagnoses (including injury diagnoses) from 2001 to 2006, comparing the Bay Area to the rest of California and the State average.

Figure 4. Number of Secondary Diagnoses



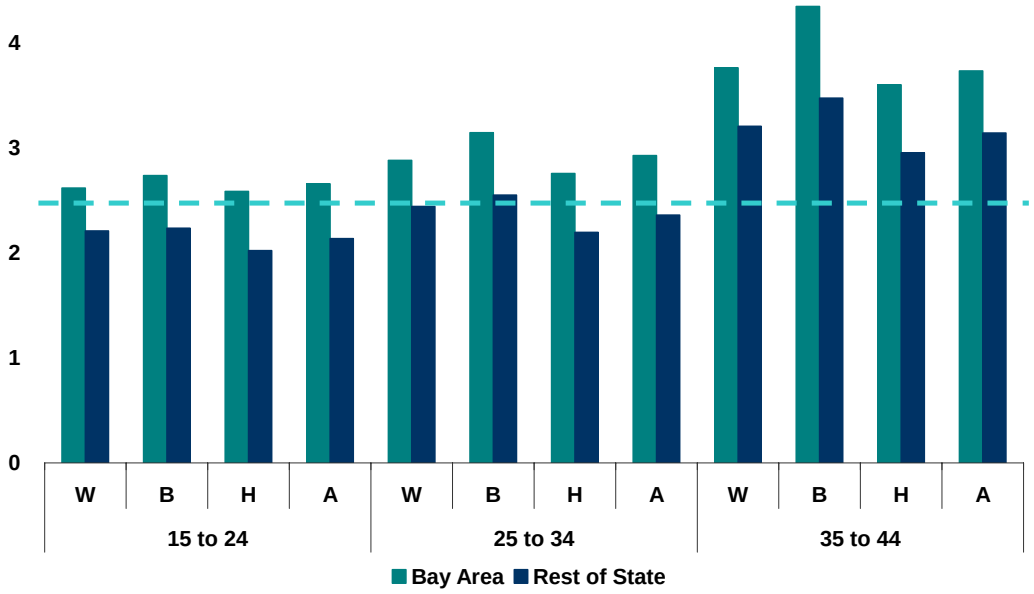

The number of secondary diagnoses rose steadily throughout the period. Bay Area women had more secondary diagnoses than women who live elsewhere. The number of diagnoses may be thought of as a proxy for general health. As one ages, health conditions tend to cumulate. Children and pregnant women typically have fewer diagnoses than do older patients with heart disease or cancer.

This upward trend has been ongoing for many years. In theory, hospitals have an incentive to upcode to increase what they can bill for care. However, Kaiser does not bill for services unless patients are non-subscribers. Another explanation for improved coding is that hospitals that code poorly tend to receive poor rankings in outcome studies, since comorbid conditions that might explain poor outcomes are not available for risk adjustment. Thus, hospitals have incentives from multiple directions to improve coding. Both Sutter and Kaiser have electronic medical records initiatives.

Another possible explanation is that regional differences may reflect true differences in patient mix, a general ethic in the Bay Area to do better coding, or perhaps coding initiatives that are less well developed outside the Bay Area.

We can begin to explore case mix differences in Figure 5, which compares average number of secondary diagnoses regionally, by age and race/ethnicity. The horizontal dashed line represents the state average over the study period for secondary diagnoses.

Figure 5. Number of secondary diagnoses by age and race/ethnicity 2001-2006




Younger women have fewer diagnoses across all race/ethnic groups than older women. Within each age group, Hispanic women have fewer diagnoses than other women. Bay Area have more secondary diagnoses across all age and race/ethnic groups.

## Comorbid Conditions

We used the Clinical Classification Software (CCS) developed by the Agency for Healthcare Research and Quality (AHRQ) to study prevalence of comorbid conditions.[5] The CCS provides a way to compare standardized utilization, outcome, and cost measures at the national, state, and local levels.

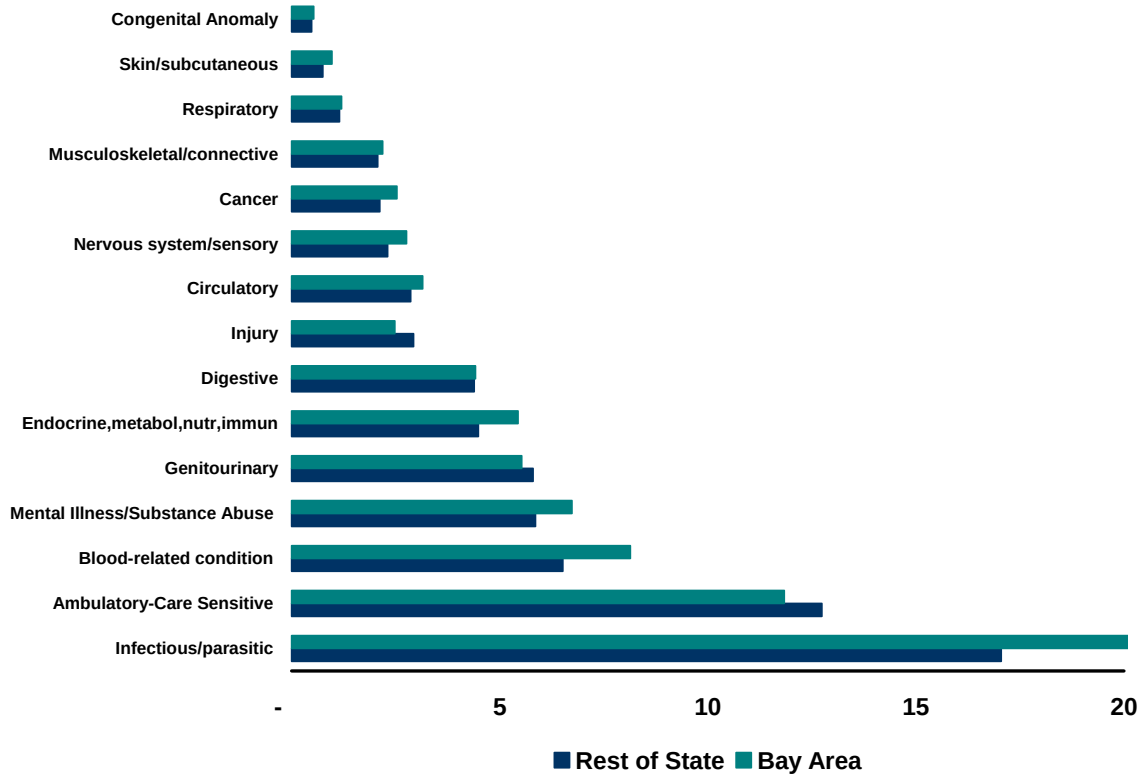
The term "comorbid" currently has two definitions: (1) a medical condition existing simultaneously but independently with another condition in a patient (the older definition) and (2) a medical condition that causes, is caused by, or is otherwise related to another condition in the same patient (a newer definition). In psychiatry, comorbidity does not necessarily imply the presence of multiple diseases, but can reflect our current inability to make a single diagnosis to account for all symptoms.[6]

We summarized records across all diagnoses fields and all records for a given woman because this provides a fuller description of a woman's life course with respect to health conditions that may underlie an adverse delivery outcome or death that might not be recorded on delivery

records. These could include conditions of uncertain clinical significance for pregnancy, conditions that resolve before delivery,[9] or post-partum conditions that may not be reflected in Underlying Cause of Death (UCOD) codes. Examples include mental illness or substance abuse (MISA), or admissions for ambulatory-care-sensitive (ACS) diagnoses. These reflect cumulating evidence that admissions might have been avoided through high-quality outpatient care or conditions that could be less severe, if treated early and appropriately.[10]

Figure 6 compares person-level occurrence of comorbid conditions by region. Infectious/parasitic conditions were found most frequently. These include conditions such as tuberculosis, sexually transmitted diseases, HIV, hepatitis, mycoses, bacterial infections, and septicemia (except labor). Blood disorders include conditions such as red and white cell anemias, sickle cell anemia, and other blood coagulation disorders. ACS diagnoses include a subset of infectious conditions plus other conditions such as asthma, epilepsy, anemia, or respiratory conditions that are thought to represent problems accessing preventive care. ACS is the only classification that crosses multiple CCS categories. An excel spreadsheet summarizing diagnosis classifications is available on request.

Figure 6. Person-level comorbid conditions (%) by California region




Except for digestive disorders, which did not differ proportionately, the comorbidities profile of Bay Area women is significantly different from the rest of California. They were less likely to be

diagnosed with injury and ACS conditions but had high rates of cancer, circulatory, endocrine, MISA, blood-related and infectious/parasitic conditions.

The CCS groups mental illness, substance abuse, and alcohol abuse as mental disorder sub-categories.[14] [15] This recognizes the significant interrelationship between these disorders and is consistent with an extensive literature suggesting they overlap in many cases.[16]

Table 3. Mental disorder subcategories (% MISA)

| Disorders | Total |
|---|---|
| Mood | 20.6 |
| Anxiety | 12.7 |
| Affective | 11.6 |
| Schizophrenia | 1.9 |
| Other Psychoses | 1.2 |
| Other MI | 3.0 |
| Substances | 68.3 |
| Alcohol | 5.3 |

Overall, 6.1% of women with SSNC had one or more MISA diagnoses on one or more discharges. Table 3 summarizes the CCS mental disorder subcategories as a percent of women with any reported MISA diagnosis.

The sum of mental disorders is greater than 100% because the same woman can have multiple diagnoses.[6] Of women with MISA, 42% had mental illness diagnoses, and 70% had substance or alcohol diagnoses. Of mentally ill, 28% had a substance or alcohol diagnosis. Of those with a substance or alcohol diagnosis, 16% had a mental illness. Bay Area women were more likely to have both mental illness (RR = 1.31) and substance abuse (RR = 1.16) diagnoses than women living elsewhere in California.

Table 4. Demographic distribution with and without MISA diagnosis

| | Total | MISA Dx | | Rel Risk |
|---|---|---|---|---|
| | | Yes | No | |
| White | 43.0 | 55.4 | 42.2 | 1.29 |
| Black | 7.3 | 12.8 | 6.9 | 1.76 |
| Hispanic | 38.0 | 27.2 | 38.7 | 0.72 |
| Asian | 11.4 | 4.2 | 11.9 | 0.36 |
| 15 to 24 | 27.5 | 32.5 | 27.1 | 1.18 |
| 25 to 34 | 49.8 | 44.6 | 50.2 | 0.90 |
| 35 to 44 | 22.7 | 22.9 | 22.7 | 1.01 |

Table 4 compares total race/ethnic and age percents for women with and without MISA diagnoses on one or more discharges. The last column shows the RR for having a MISA diagnosis. Given their percent in the population, White and Black women, and young women were more likely to have a MISA diagnosis.

Figure 7. Mental Disorder (%) by Race/ Ethnicity and Age

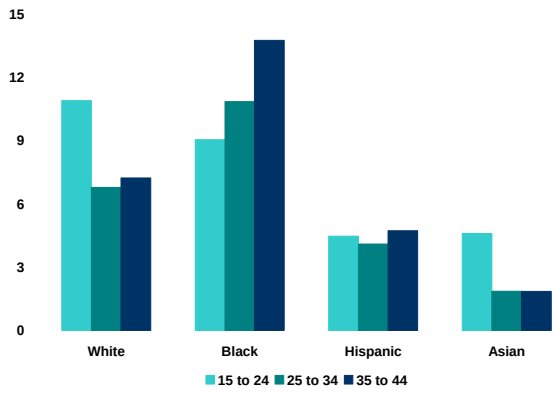



Figure 7 shows that the percent of women with mental disorders varied by race/ethnicity and age. White and Black women had the highest percentages across all age groups. Among Hispanic women, the percent with MISA diagnoses varied little by age. White and Asian women were less likely to have MISA diagnoses after age 15 to 24. Among Black women, the percent with MISA diagnoses rose about 3% for each 10-year age increment. These relationships did not vary importantly based on region.

Bay Area residents had an RR of 1.15 for a MISA diagnosis compared to women living elsewhere in California. The small group of women coming into and going out of the Bay Area for care had RR of 1.9 for a MISA diagnosis compared with women living outside the Bay Area. By definition, these latter groups of women were receiving OOC care. Statewide, women with a MISA diagnosis had a RR of 1.5 for OOC care compared to women without this diagnosis, and a RR of 1.6 for having at least one admission where the insurer was a public entity.

In the general population, individuals with severe MISA have about 1.5 to 2 times the general population prevalence of cardiovascular disease, diabetes, dyslipidemia, hypertension, and obesity.[17 18 19] In this population, the RR for having a comorbid condition given a MISA diagnosis was: respiratory, 5.0; injury, 4.7; circulatory, 3.4; ACS, 3.1. In fact, women with a MISA diagnosis had elevated risk of all major CCS categories except congenital anomaly.

## Obstetric Diagnoses and Procedures

Table 5 summarizes major CCS obstetric diagnoses and procedures. Following the method from the Healthcare Cost and Utilization Project (HCUP) website for national data, CCS obestetric measures were found by searching over all available diagnosis or procedure fields. The column labeled "Percent" is the percent of discharges with a condition. Table 5 also includes summary results of statistical tests to assess (1) if women with MISA diagnoses had the same risk for these obstetric factors as other women, (2) the association between the obstetric factor and death, and (3) whether the Bay Area or the rest of the State was more or less likely to report these obstetric factors in their patient populations as compared with national data. Comparisons are in words (High, Low, Same) to simplify the presentation. Excel files with detailed tables, statistics, and trend graphics are available on request.

Table 5. Pregnancy diagnoses, procedures and risk for MISA, death, and regional differences

| | | | | Risk | | Local to Federal | |
|---|---|---|---|---|---|---|---|
| Measure | Type | CCS category | Percent | MISA | Death | Bay Area | Rest of CA |
| Diagnoses | Risk | Other complications of pregnancy | 40.0 | High | High | High | Same |
| | | Early or threatened labor | 6.4 | High | High | Low | Low |
| | | Diabetes, abnormal glucose complic. pregnancy, childbirth, puerperium | 5.9 | High | High | High | High |
| | | Hypertension complic. pregnancy, childbirth, puerperium | 5.9 | High | High | Low | Low |
| | | Hemorrhage during pregnancy, abruptio placenta, placenta previa | 1.9 | High | High | Same | Same |
| | | Previous cesarean | 13.8 | High | Same | Low | Same |
| | | Fetal distress and abnormal forces of labor | 10.5 | High | Same | High | Same |
| | | Polyhydramnios and other problems of amniotic cavity | 9.6 | High | Same | High | Low |
| | | Malposition, malpresentation | 6.7 | High | Same | High | Low |
| | | Ectopic pregnancy | 0.7 | High | Same | Same | Same |
| | | Fetopelvic disproportion, obstruction | 5.3 | Low | Same | High | Same |
| | | Other complications of birth, puerperium affecting management | 25.6 | High | Low | Low | Low |
| | | Prolonged pregnancy | 11.4 | Same | Low | High | High |
| | | Umbilical cord complication | 19.1 | Low | Low | High | Low |
| | Quality | Abortion complications | 0.2 | High | High | High | Same |
| | | Trauma to perineum and vulva | 31.2 | Low | Low | High | Same |
| Procedures | Risk | Removal ectopic pregnancy | 0.4 | High | Same | Same | Same |
| | | Artificial rupture of membranes to assist delivery | 20.3 | High | Low | High | Low |
| Procedures | Quality | Cesarean deliveries | 27.6 | High | High | Low | Same |
| | | Other therapeutic obstetrical procedures | 2.9 | High | Same | High | Low |
| | | Other procedures to assist delivery | 52.1 | Same | Low | High | High |
| | | Repair of current obstetric laceration | 31.0 | Low | Low | High | Same |
| | | Episiotomy | 12.5 | Low | Low | Low | Same |
| | | Forceps, vacuum, and breech delivery | 7.7 | Low | Low | High | Same |

The highest pregnancy risk CCS categories were "Other complications of pregnancy" and "Other complications of birth and puerperium." The most frequent sub-groups of "Other complications of pregnancy" were largely preventable or controllable antepartum conditions: anemia, genito-urinary infections, metabolic disorders. "Other complications of birth and puerperium" combines maternal, infant, and delivery risk factors. The most frequent maternal sub-groups were older age and inadequate prenatal care. Most frequent infant sub-groups were RH reactions, multiple fetus, preterm delivery. Variations on a theme of adverse outcomes (puerperal infections, hemhorrhages, lacerations, etc.) were the third most frequent sub-group for "Other complication of birth and puerperium".

These CCS classifications were followed in prevalence by umbilical cord complication, previous cesarean delivery, prolonged pregnancy, fetal distress, and abnormal forces of labor. Bay Area rates for eight of these conditions were higher than national rates, compared to the rest of the state which was higher in only two categories. Eleven of the 14 diagnosis risk categories were associated with higher rates for women with a MISA diagnosis. Of these, five conditions -- other complications of pregnancy, early or threatened abortion, hypertension, diabetes and hemorrhage -- were associated with both a MISA diagnosis and higher risk of death. Two of these -- other complications of pregnancy and diabetes -- were higher in the Bay Area than the nation. Rates for the two adverse quality indicators were higher in the Bay area compared to the rest of the state and nation. Increased abortion complication rates were associated with both a higher rate for MISA diagnosis and a higher death rate.

Of the eight procedure groups, cesarean deliveries were associated with high MISA rates and "other therapeutic obstetric procedures" were associated with high MISA rates and high death rates. Compared to the nation, the Bay Area had lower cesarean and episiotomy rates but higher rates for all remaining five procedure groups except "removal of ectopic pregnancy." The rest of the state was high compared to the nation on only "Other procedures to assist delivery".

Table 6. Endocrine disorders and MISA

| Condition | Total | MISA Yes | MISA No | Rel Risk |
|---|---|---|---|---|
| Endocrine disorder | 4.7 | 13.8 | 4.1 | 3.7 |
| Diabetes Mellitis | 1.3 | 3.0 | 1.2 | 2.7 |
| Pregnancy DM | 6.7 | 7.4 | 6.7 | 1.1 |
| Died | | | | |
| Endocrine disorder | 33.0 | 51.1 | 23.9 | 3.3 |
| Diabetes Mellitis | 9.0 | 14.9 | 6.0 | 2.8 |
| Pregnancy DM | 7.9 | 9.2 | 7.2 | 1.3 |

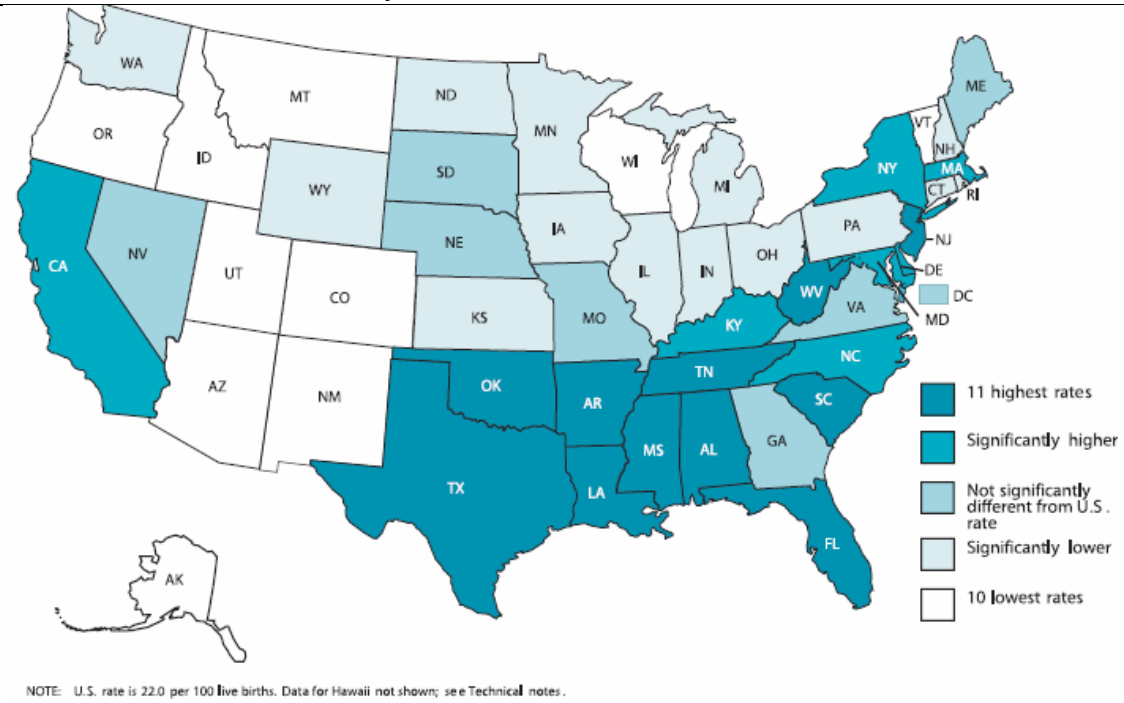
Table 6 examines elevated risk for women with MISA diagnoses. They were more likely overall to have endocrine disorders, diabetes mellitis, and diabetes mellitus during pregnancy, childbirth, or peurperium. Of women who died, risk again was high for MISA women with chronic endocrine and diabetes disorders compared with women who had pregnancy-related diabetes.

## Mode of Delivery or Pregnancy Termination

By focusing on ever-pregnant woman, we obtained limited information about hospital-based pregnancies that did not end in delivery. Spontaneous abortions (1.63%), induced abortions (0.8%) and ectopic pregnancies (0.73%) were rare. Whether induced or spontaneous, most abortions occur outside of hospitals and women rarely enter a hospital for these except in a high risk situation. Most women deliver vaginally with or without instrumentation. Other delivery modes include cesarean section and vaginal birth after a previous cesarean (VBAC).

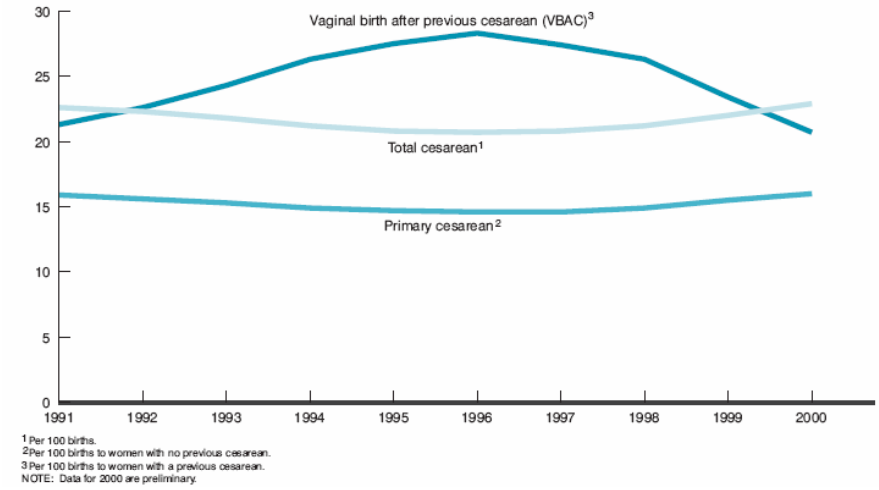
Lowering the cesarean rate has been a national goal for more than two decades.[20] Although the appropriate target for the rate as well as best methods to safely lower it have been debated, the federal government set a goal in the 1990s to achieve no more than 15 cesareans per 100 births by the year 2000. When objectives were evaluated for Healthy People 2010, the focus of the objective changed from all women giving birth to low-risk women - those having singleton babies at 37 weeks gestation or more. Coming into the new century, Figure 8 shows that California's total cesarean rate was in the nation's highest quintile in 1999.

Figure 8. Total cesarean rates by State: United States 1999




NOTE: U.S. rate is 22.0 per 100 live births. Data for Hawaii not shown; see Technical notes.

Figure 9. Total primary and cesarean rates and vaginal birth after previous cesarean rate: United States, 1991-2000.




1 Per 100 births.
2 Per 100 births to women with no previous cesarean.
3 Per 100 births to women with a previous cesarean.
NOTE: Data for 2000 are preliminary.

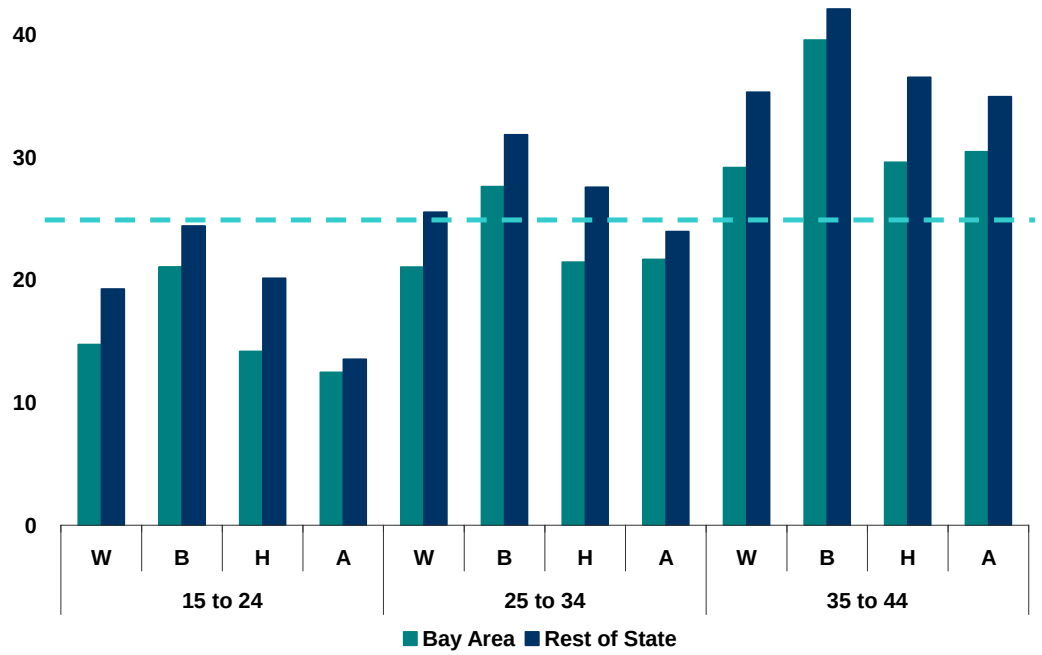
Figure 9 shows that cesarean rates dropped through mid-1990s and rose steadily thereafter.

The VBAC denominator is women who had a previous cesarean. Only about 2% of deliveries are VBACs. This delivery mode declined steadily since the mid 1990s after studies found it incurred significant maternal morbidity and mortality.[21] [22] [23] In 1999 only 97,680 births nationally were delivered by VBAC.[24] Between 2001 and 2006, the percent of VBAC deliveries in California dropped from 2.84% to 1.24%.

Figure 10 shows total cesarean rates by age, race/ethnicity, and region. The dashed horizontal line is the state average over the study period. Rates tend to rise with age, Black women of each age group had more cesareans, and Bay Area women had fewer across all age and race

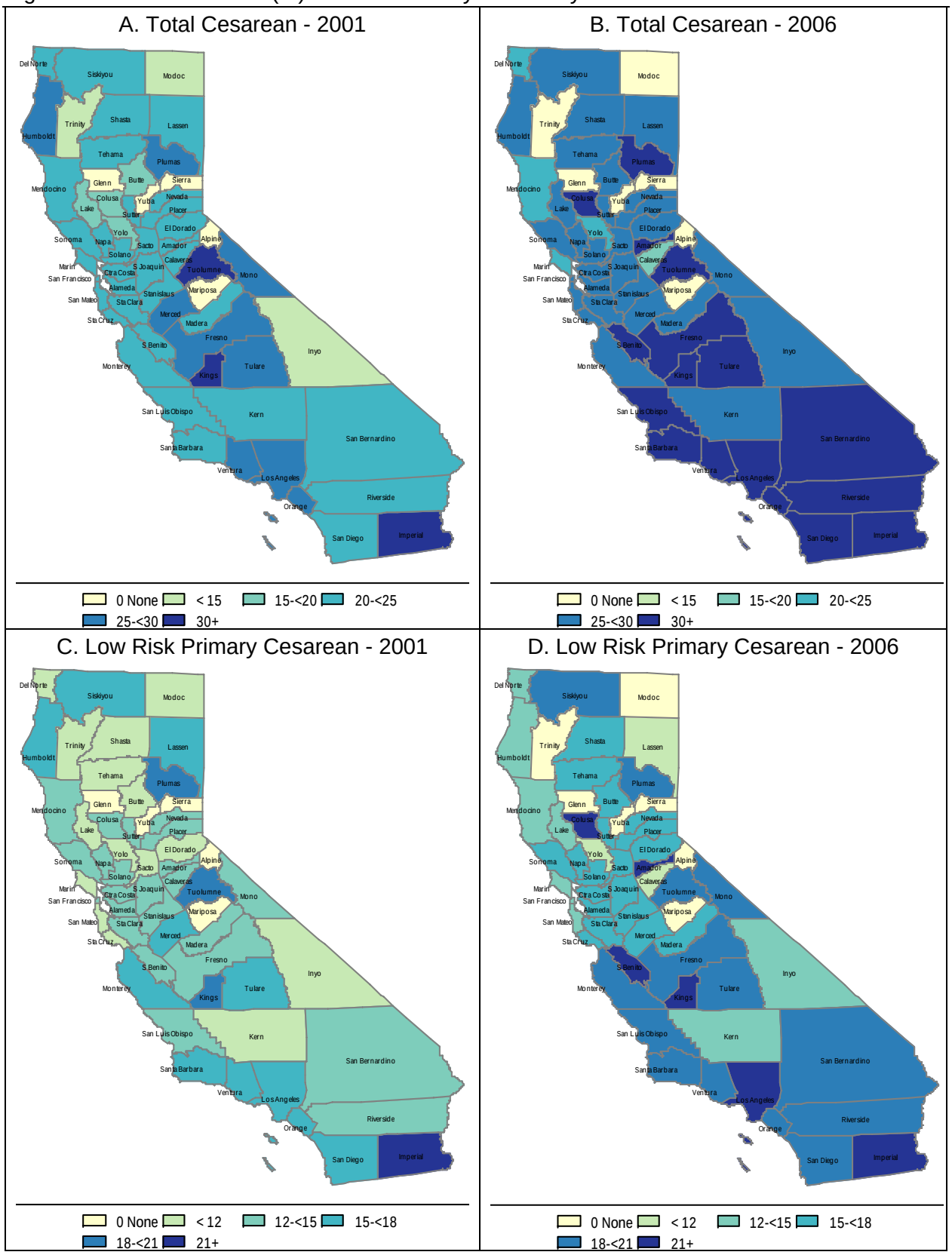
combinations. Women with MISA diagnoses were 19% more likely to have a cesarean delivery than women without such a diagnosis.

Figure 10. Total cesarean rates (%) by age, race/ethnicity, and region 1991-2006




Although the Bay Area had lower total cesarean rates averaged across the period, this does not mean rates were steady. Figure 11 compares percent of total cesarean and low-risk primary cesarean deliveries in 2001 and 2006 based on county of delivery. In 2001, five counties had no hospitals. By 2006, seven counties had no hospitals. In 2001, 12 counties had total cesarean delivery rates exceeding 25%. By 2006, only 5 counties had total cesarean rates below 25%. In 2001, all Bay Area counties had a total cesarean rate of 20-25%. By 2006, all but one Bay Area county had total cesarean rates of 25-30%. Low-risk primary cesarean rates also rose, with much variation across counties. In 2001, 15 counties exceeded the national goal of 15% for low-risk cesarean deliveries. By 2006, 39 counties exceeded the national goal.

Figure 11. Cesarean rates (%) based on county of delivery - 2001 and 2006



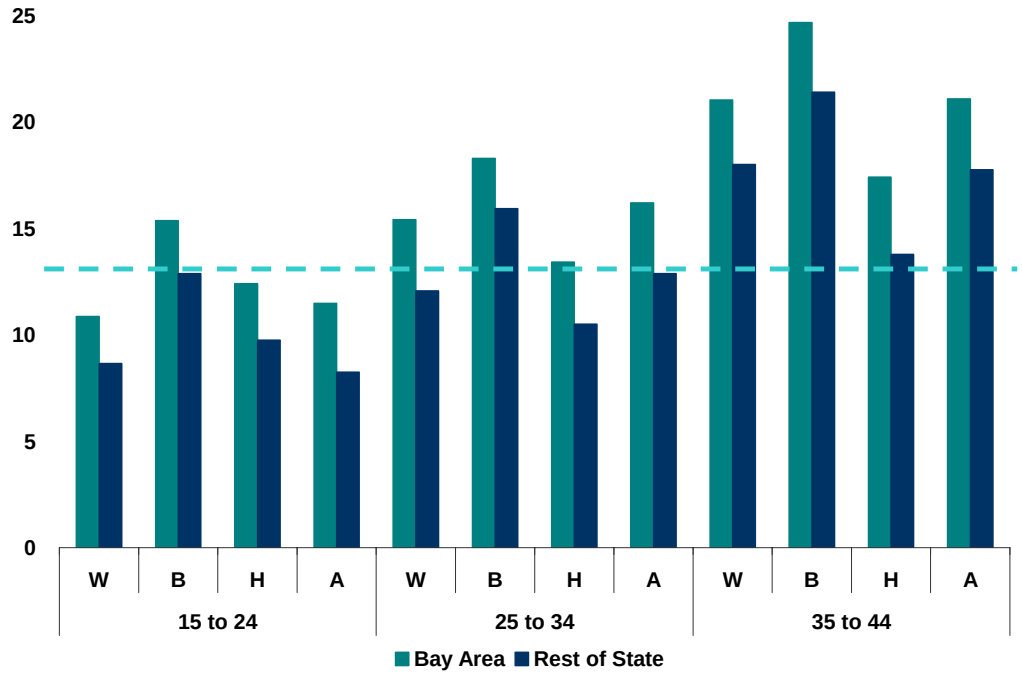
# Outcomes

## Extended Length of Stay

AHRQ recommends examining length of stay to account for differing discharge practices among hospitals when evaluating inpatient care quality indicators.[25] In the maternal population, studies have tended to focus on very short stays, sometimes called "drive-thru deliveries." DeMoro found that California's registered nurses were working more quickly and intensely, with fewer beds and the same number of patients who had shorter stays.[26] At a hospital with almost 100% occupancy most of the year, a 0.1% increase in the patient-to-nurse ratio led to a 28% increase in the adverse event rate.[27] In such environments, outcomes potentially sensitive to nursing have been shown to extend LOS.[13] While staffing in California labor and delivery units generally is protected, high occupancy rates may affect outcomes.

Only 15% of admissions lasted 4 days or longer (ELOS). Figure 12 compares ELOS by age and race/ethnicity, in the Bay area and the rest of California. At every age, Black women and women age 35 or older had longer stays. Bay Area women had disproportionately longer stays than women elsewhere in the State.

Figure 12. Stays 4 days or longer by age, race/ethnicity, and region




In the Bay Area, ELOS varied widely by system and Kaiser had a higher ELOS than Sutter. In the rest of California, stays were more closely aligned, and Kaiser had a lower ELOS than

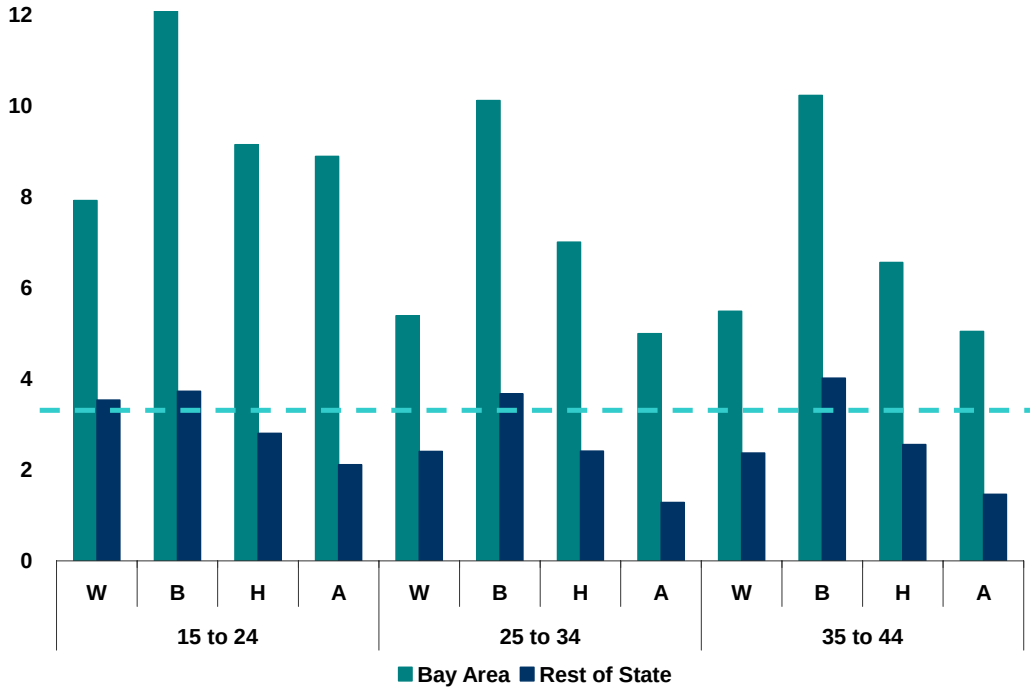
Sutter. By 2006, less than 5% of Bay Area women treated in Sutter hospitals had stays 4 days or longer.

## Non-Routine Dispositions

Rather than measure patient outcomes in terms of specific procedures relative to specific medical conditions, DeMoro suggested it may be fruitful to measure outcomes in terms of aggregated patient discharge classifications where possible.[26] He specifically proposed the percent of non-routine (NRD) dispositions as a patient discharge quality index. The NRD is anything other than returning home, e.g., transfer to another facility, leaving against medical advice, home health care, death. DeMoro showed that the NRD ratio increased over time in California hospitals. A study of pediatric outcomes found increased NRD was associated with other markers of adverse outcomes, including ELOS and patient safety indicators.[13] AHRQ recommends examining transfer rates to account for differing discharge practices among hospitals when evaluating inpatient care quality indicators.[29]

Figure 13 compares NRD by age, race/ethnicity, and region. While the rest of California had some variation in this outcome measure, all Bay Area age and race/ethnic groups were much higher risk. Blacks had the most NRD across all age groups and particularly in the Bay Area. Although not shown here, trends for Bay Area women were markedly different and decreasing in different ways based on system of care. The rest of the state was closer to national and state averages over the trend.

Figure 13. Non-routine disposition (%) by age, race/ethnicity and region



## Patient Safety Indicators

Patient Safety Indicators (PSI) are a set of measures developed by the Agency for Healthcare Research and Quality (AHRQ) that screen for adverse events patients experience as a result of exposure to the health care system. The PSI relate to inpatient care and are not measured in outpatient settings such as emergency departments. PSI rates have been shown to vary substantially and significantly across hospitals, and have acceptable validity and reliability.[30] [31] These events are likely amenable to prevention by changes at the system or provider level.[32]

PSIs do not capture "near misses" or other undocumented adverse events. They also do not include adverse events related to a number of important patient safety concerns that are not reliably specified using ICD-9-CM. Adverse outcomes identified after discharge are common and often preventable.[33] [34] [35] [36] In one followup study, an adverse event manifested in about 25% of patients after discharge; most caused symptoms but did not result in an emergency department visit, hospitalization, or death.[35] Another study found the prevalence of medical errors following hospitalization was high because of discontinuity between the inpatient and outpatient setting, which resulted in an increased rate of rehospitalization.[35]

Because of variation in definitional criteria, a patient can be included in or excluded from more than one PSI. Mentally ill and pregnant women are excluded from most PSI, for example, post-operative hemorrhage or anesthesia problems. The only PSI indicator specific to delivery is third and fourth degree perineal trauma, which is coded with high specificity.[31] Finally, to get rates in the same general scale, different denominators (per 100, 1,000, etc) can be used. Table 7 summarizes variations in numbers of eligible cases and rate trends for PSI that could be calculated for this study.

Table 7. Patient safety indicators, eligible cases and rates by geographic area, 2001-2006

| Patient Safety Indicator | Eligible Cases Number | Eligible Cases Rate Per | Geographic Area | Year 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|
| Anesthesia complications | 835,238 | 10,000 | Rest of State | 2.38 | 3.81 | 3.81 | 4.26 | 4.15 | 4.05 |
| | 158,521 | 10,000 | Bay Area | 3.34 | 5.48 | 6.06 | 5.99 | 5.80 | 6.01 |
| Death low mortality DRG | 2,573,089 | 100,000 | Rest of State | 7.96 | 8.90 | 7.50 | 7.87 | 7.11 | 10.71 |
| | 565,520 | 100,000 | Bay Area | 7.41 | 2.11 | 5.26 | 4.27 | 5.37 | 3.18 |
| Foreign body left during procedure | 2,577,562 | 100,000 | Rest of State | 3.13 | 2.88 | 3.74 | 3.00 | 3.20 | 5.12 |
| | 566,916 | 100,000 | Bay Area | 5.28 | 1.05 | 3.15 | 4.25 | 5.35 | 5.28 |
| Infection due to medical care | 2,067,099 | 100,000 | Rest of State | 5.30 | 4.26 | 5.55 | 5.98 | 4.77 | 4.62 |
| | 481,790 | 100,000 | Bay Area | 6.38 | 8.82 | 8.64 | 3.74 | 9.95 | 2.43 |
| OB trauma-vaginal w instrument | 190,941 | 100 | Rest of State | 15.35 | 14.85 | 14.46 | 14.09 | 13.73 | 12.44 |
| | 48,650 | 100 | Bay Area | 22.93 | 21.40 | 22.32 | 20.91 | 19.86 | 18.30 |
| OB trauma-vaginal w/o instrument | 1,634,072 | 100 | Rest of State | 4.15 | 3.93 | 3.73 | 3.57 | 3.49 | 3.28 |
| | 372,880 | 100 | Bay Area | 5.00 | 4.54 | 4.35 | 4.19 | 4.14 | 3.83 |
| OB trauma-C-section | 752,549 | 1,000 | Rest of State | 3.13 | 2.65 | 2.66 | 2.61 | 2.56 | 2.71 |
| | 145,386 | 1,000 | Bay Area | 5.62 | 4.70 | 6.08 | 5.99 | 6.71 | 5.74 |
| Any Patient Safety Indicator | 2,577,562 | 100 | Rest of State | 4.14 | 3.83 | 3.60 | 3.37 | 3.18 | 2.94 |
| | 566,916 | 100 | Bay Area | 5.74 | 5.14 | 5.06 | 4.73 | 4.44 | 3.98 |
| Defined Adverse Event | 2,577,562 | 1,000 | Rest of State | 6.36 | 6.54 | 6.76 | 7.08 | 6.85 | 6.80 |
| | 566,916 | 1,000 | Bay Area | 7.14 | 7.44 | 8.91 | 7.94 | 8.62 | 9.29 |
| Any PSI or Defined Adverse Event | 2,577,562 | 100 | Rest of State | 4.74 | 4.44 | 4.24 | 4.03 | 3.83 | 3.58 |
| | 566,916 | 100 | Bay Area | 6.40 | 5.81 | 5.86 | 5.46 | 5.23 | 4.84 |

For indicators specific to delivery, OB trauma-vaginal instrument and OB trauma-C-section are significantly higher in the Bay Area for all 6 years. Using data from 1999-2001, a study of PSI in New York, Massachusetts, and North Carolina found an average rate of about 24/100 OB trauma-vaginal with instrument, 7/100 for OB trauma-vaginal without instrument, and 6/1,000 for OB trauma-C-section.[37] In 2003, the national rate for OB trauma-vaginal with instrument was about 23/100, and for OB trauma-vaginal without instrument, the national rate was about 9/100.[38] One possibility for California's apparently lower rates may be that obstetric trauma is underreported, thus affecting rates, because an episiotomy extending into a third- or fourth-degree laceration need not be reported on discharge abstracts.[9] Another possibility is that these data acurately reflect care. Without a reabstraction study, we have no way to evaluate this.

For this analysis, we created a single summary variable flagging any PSI or any discharge with an adverse event ICD-9 code by definition. Adverse events declined over the study period, and trends are somewhat consistent with trends in "harder" outcomes such as ELOS and NRD. The Bay Area had higher rates throughout.

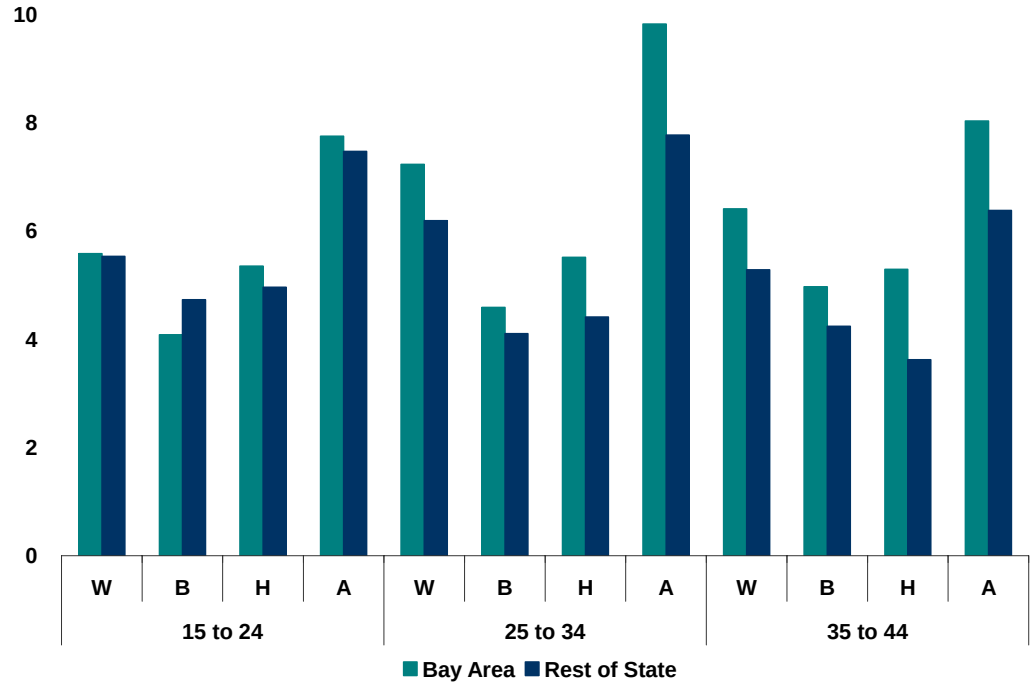
Table 8. Any patient safety event (%)

| Category | Total | PSI Yes | PSI No | Rel Risk |
|---|---|---|---|---|
| White | 43.0 | 46.3 | 42.8 | 1.08 |
| Black | 7.3 | 5.7 | 7.4 | 0.79 |
| Hispanic | 38.0 | 31.3 | 38.4 | 0.82 |
| Asian | 11.4 | 16.4 | 11.1 | 1.44 |
| 15 to 24 | 27.5 | 26.0 | 27.5 | 0.95 |
| 25 to 34 | 49.8 | 52.7 | 49.7 | 1.06 |
| 35 to 44 | 22.7 | 21.4 | 22.8 | 0.94 |
| Private Pay | 58.1 | 57.7 | 64.8 | 1.35 |
| MISA | 6.1 | 6.82 | 6.02 | 1.14 |
| BA Resident | 19.0 | 23.1 | 18.7 | 1.30 |
| BA Hosp | 19.4 | 23.6 | 19.1 | 1.31 |

At the person level, 5.6% of women experienced one or more PSI or other adverse event by definition (Any PSI) on one or more admissions. Bay Area women (6.8%) were at increased risk compared with women living elsewhere in the state (5.3%). Table 8 compares women who did and did not have any PSI. White and Asian women were at increased risk compared with Black and Hispanic women, and women age 25 to 34 were at greater risk compared with women of other ages. Women with private insurance for all admissions were at increased risk, as were those with a MISA diagnosis. Women who lived in the Bay Area or were admitted to a Bay Area hospital had a RR of 1.30 and 1.31 respectively.

Figure 14 compares PSI by age group, race/ethnicity, and region. At every age, White and Asian women have higher PSI rates, and Bay Area rates are higher for all groups except White and Black women age 15 to 24. PSI vary most by race/ethnicity and region.

Figure 14. Any patient safety indicator (%) by age, race/ethnicity, and region



# Maternal Mortality

## Incidence

An important goal of this study was to answer question 113A in the death certificate: How many women between the ages of 10 and 60 died in the last year for any reason after birth of a child. This entailed knowing how many women age 10 to 60 died in California, identifying women who had been pregnant, then those who had died within one year of pregnancy. We were unable to obtain 2006 death data in time for this study. Thus our death analysis combines information from the 2001 to 2005 death certificates and the 2001 to 2006 OSHPD data.

Table 9 compares deaths in 2005 by region. Women age 10 to 60 were 7.7% of deaths statewide. In the Bay Area, female deaths age 10 to 60 ranged from a low of 5.0% in Napa County based on place of residence to a high of 9.3% in Solano County based on place of occurrence.

Table 9. Deaths and female deaths by region of residence and occurrence - 2005

| | All Deaths | | Female Age 10-60 | | % Fem Dth | |
|---|---|---|---|---|---|---|
| Region | Residence | Occurrence | Residence | Occurrence | Residence | Occurrence |
| Alameda | 9,232 | 9,283 | 763 | 752 | 8.3 | 8.1 |
| Contra Costa | 6,716 | 6,625 | 515 | 509 | 7.7 | 7.7 |
| Marin | 1,776 | 1,792 | 114 | 111 | 6.4 | 6.2 |
| Napa | 1,198 | 1,161 | 60 | 59 | 5.0 | 5.1 |
| San Francisco | 5,935 | 6,290 | 391 | 388 | 6.6 | 6.2 |
| San Mateo | 4,622 | 4,629 | 269 | 266 | 5.8 | 5.7 |
| Santa Clara | 8,639 | 9,345 | 610 | 605 | 7.1 | 6.5 |
| Solano | 2,739 | 2,576 | 242 | 240 | 8.8 | 9.3 |
| Sonoma | 3,673 | 3,689 | 239 | 237 | 6.5 | 6.4 |
| Bay Area | 44,530 | 45,390 | 3,203 | 3,167 | 7.2 | 7.0 |
| Rest of State | 192,640 | 191,780 | 15,018 | 15,054 | 7.8 | 7.8 |
| California | 237,170 | 237,170 | 18,221 | 18,221 | 7.7 | 7.7 |

Table 10 shows by region the total number of women we identified who died between 2001 and 2006, and of those, the pregnancy-associated deaths, defined as the death of a woman while pregnant or within 1 year of termination of pregnancy, irrespective of cause.[41] The methodology we used identified 2,856 deaths including 1,292 that were pregnancy-associated. The number of pregnancy-associated deaths is less than what would be found if we had 2007 and 2008 discharges, and death certificates for the same period, so we could find out-of-hospital deaths and one-year deaths for women who were pregnant in 2005 and 2006. Despite this limitation, the result is about two times higher than previously reported for maternal mortality in California.

Table 10. Deaths of ever-pregnant women by region of residence and occurrence -- 2001-2006

| | Ever-Pregnant | | Pregnancy Associated | |
|---|---|---|---|---|
| Region | Residence | Occurrence | Residence | Occurrence |
| Alameda | 122 | 108 | 73 | 63 |
| Contra Costa | 99 | 100 | 59 | 61 |
| Marin | 10 | 8 | 10 | 6 |
| Napa | 10 | 11 | 5 | 7 |
| San Francisco | 40 | 63 | 17 | 31 |
| San Mateo | 27 | 25 | 16 | 15 |
| Santa Clara | 87 | 114 | 45 | 64 |
| Solano | 35 | 30 | 19 | 16 |
| Sonoma | 30 | 33 | 16 | 18 |
| Bay Area | 460 | 492 | 260 | 281 |
| Rest of State | 2,396 | 2,364 | 1,292 | 1,271 |
| California | 2,856 | 2,856 | 1,552 | 1,552 |

For women age 10 to 60, San Francisco and Santa Clara Counties had the largest migration disparity for admissions (Figure 3), no disparity for total deaths (Table 9), and the largest disparity between place of residence and occurrence for deaths (Table 10).

We multiplied the number of female deaths age 10 to 60 in 2005 (Table 9) by six to estimate a population of female deaths between 2001-2006. We divided the number of deaths of ever-pregnant hospitalized women between 2001 and 2006 (Table 10) by the result, then multiplied by 10,000 to estimate the proportion of female deaths that had been pregnant.

Table 11 shows estimated death rates based on the number of study subjects who died between 2001 and 2006, given the estimated number of deaths of women in the same age range who died during the same interval. Because numbers of cases in the numerator were small, we used the Poisson distribution to calculate significance. To simplify the display, rates that were high are shown in yellow, low rates in green.

Table 11. Deaths of ever-pregnant hospitalized women and pregnancy-associated deaths per 10,000 deaths of women age 10 and 60 between 2001 and 2006

| | Ever-Pregnant | | Pregnancy Associated | |
|---|---|---|---|---|
| Region | Residence | Occurrence | Residence | Occurrence |
| Alameda | 22 | 19 | 13 | 11 |
| Contra Costa | 25 | 25 | 15 | 15 |
| Marin | 9 | 7 | 9 | 6 |
| Napa | 14 | 16 | 7 | 10 |
| San Francisco | 11 | 17 | 5 | 8 |
| San Mateo | 10 | 9 | 6 | 5 |
| Santa Clara | 17 | 20 | 9 | 11 |
| Solano | 21 | 19 | 12 | 10 |
| Sonoma | 14 | 15 | 7 | 8 |
| Bay Area | 17 | 18 | 10 | 10 |
| Rest of State | 21 | 21 | 11 | 11 |
| California | 20 | 20 | 11 | 11 |

| Legend | High | Low |
|---|---|---|

Contra Costa County had rates higher than the state average across all four measures, and San Mateo was low on all four. San Francisco was low based on place of residence for both mortality measures. Marin and the Bay Area had low rates , and Sonoma was below the state average based on residence.

## When Did Women Die?

**113A If female, pregnant in last year?**

**Enter the information as appropriate *Yes, No, Unk,* indicating if the decedent was pregnant at the time of death or within the year prior to death. The information may be obtained by the following:**

**1 observation**
**2 autopsy, or**
**3 review of the medical record**

**A pregnancy test, autopsy, and/or review of the medical records are not required to complete the death certificate.**

Instructions to the physician on how to record Question 113A in the California Death Certificate is shown on the left.[42] It was added to the death certificate effective 2003. The CDC uses this question to calculate the pregnancy-associated death rate.

Table 12 compares the answer to Question 113A for 2003 through 2005 by region. The first row shows the total number of pregnancy-associated deaths. The second row shows the number of pregnancy-associated deaths identified as such in the death certificates. Finally, the table shows the additional deaths, compared by answers in the death certificate. For example, in 2003, the physician certifier said 73 women had not been pregnant when we found they had been, and recorded 75 deaths we identified as pregnant as unknown pregnancy status. Comparing numbers in the death file and additional cases, data quality seemed to decline with time. The Bay Area appears to be achieving marginally better data quality than the rest of the State. About half of pregnancy-associated deaths were not identified in the death certificates. Similar findings have been reported in other states.[43 44 45 46 47]

Table 12. Pregnancy-associated deaths by region 2003-2005

| Pregnancy Associated | California | | | | Bay Area | | | | Rest of State | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2004 | 2005 | Total | 2003 | 2004 | 2005 | Total | 2003 | 2004 | 2005 | Total |
| Total | 324 | 279 | 324 | 927 | 68 | 59 | 63 | 190 | 265 | 216 | 134 | 615 |
| Death File | 176 | 122 | 148 | 446 | 33 | 26 | 36 | 95 | 150 | 86 | 53 | 296 |
| Additional | 148 | 157 | 176 | 481 | 35 | 33 | 27 | 95 | 115 | 130 | 81 | 366 |
| No | 73 | 73 | 110 | 256 | 21 | 24 | 17 | 62 | 49 | 56 | 48 | 207 |
| Unknown | 75 | 84 | 66 | 225 | 14 | 9 | 10 | 33 | 66 | 74 | 33 | 159 |

Table 13 compares deaths and death rates per 100,000 women by time to death. Rate denominators are based on the number of women over the entire period, including records with no SSNC. With respect to mortality rates, the Bay Area was similar to the rest of the state. Women coming into the Bay Area from other counties had extremely high death rates. Unlike women leaving the Bay Area for care, women coming into the Bay Area had high risk pregnancies and this group had a MISA rate more than two times higher.

Table 13. Deaths and deaths per 100,000 women by time from last pregnancy and region

| Variable | Region | Women | Deaths by time from last pregnancy | | | | |
|---|---|---|---|---|---|---|---|
| | | | Delivery | 42 days | 1 year | 2 year | 3+ year |
| Number | State | 3,014,049 | 764 | 155 | 633 | 559 | 745 |
| | Rest of State | 2,459,682 | 615 | 125 | 520 | 445 | 624 |
| | Bay Area | 537,803 | 133 | 27 | 100 | 101 | 104 |
| | Into Bay Area | 12,466 | 15 | 3 | 13 | 13 | 14 |
| | Out of Bay Area | 4,098 | 1 | | | | 3 |
| Rate/100,000 | Total | 95 | 25 | 5 | 21 | 19 | 25 |
| Within Period | Rest of State | 95 | 25 | 5 | 21 | 18 | 25 |
| | Bay Area | 86 | 25 | 5 | 19 | 19 | 19 |
| | Into Bay Area | 465 | 120 | 24 | 104 | 104 | 112 |
| | Out of Bay Area | 98 | 24 | 0 | 0 | 0 | 73 |

Figure 15. Death rate trends

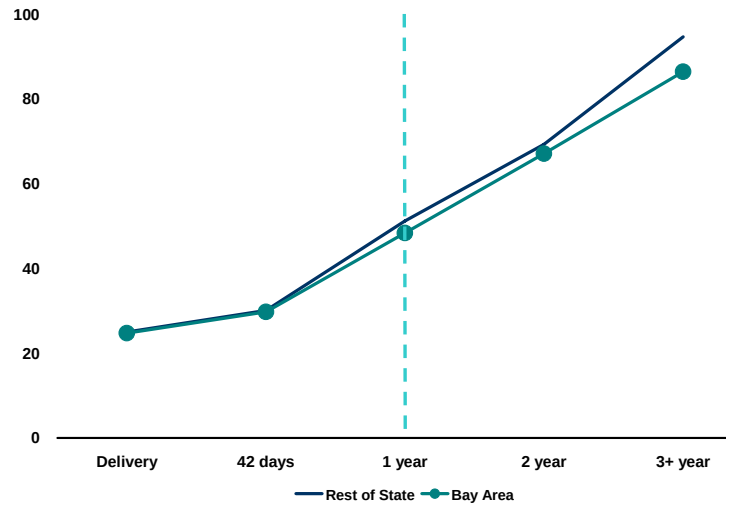



Figure 15 compares death rate trends for Bay Area residents receiving all their care in the Bay Area to the rest of the state. Although the Bay Area had a slightly lower death rate overall, differences do not emerge until after the one-year period for pregnancy-associated death rates, shown by the vertical dashed line.

## Why Did Women Die?

We reviewed all deaths for women we found who died in the hospital at delivery. Table 14 gives examples of cases from 2003 to 2005 where Question 113A was answered "no" or "unknown" as to whether these women -- *who died in a hospital during a delivery admission* -- had been pregnant in the last year. For these examples, we show the recorded DRG, the presence or absence of any PSI or MISA, and the underlying cause of death (UCOD) in the death certificate.

Table 14. Death at delivery, patient safety, MISA, and recorded underlying cause of death

| Delivery Mode | DRG | PSI | MISA | UCOD |
|---|---|---|---|---|
| Cesarean | 371 Cesarean section w/o complicating conditions | Yes | No | Missing |
| | 370 Cesarean section w complicating conditions | No | Yes | Missing |
| | 370 Cesarean section w complicating conditions | Yes | No | Circulatory |
| Vaginal | 373 Vaginal delivery w/o complicating diagnoses | No | Yes | Missing |
| | 374 Vaginal delivery w sterilization &/or d&c | No | No | Missing |
| | 372 Vaginal delivery w complicating diagnoses | Yes | Yes | Missing |

In 2003 through 2005, after Question 113A was added to the death certificate, 435 women died during the admission concluding the pregnancy by either delivery or early termination. In only 175 deaths (40.2%) did the UCOD indicate the death was related to pregnancy, childbirth, and puerperium. The next most common UCOD was "circulatory disorders" (11.7%) and unknown (10.3%). Only 2 deaths had a UCOD indicating complications of medical or surgical care, even though 212 (48.7%) showed an adverse event on the hospital record.

The CDC uses the UCOD to calculate direct obstetric death rates: "those resulting from obstetric complications of the pregnant state (pregnancy, labour and puerperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above."[41] Based on our findings, California's direct obstetric death rate is much higher than what would be calculated from the single cause of death file we used.

The two primary reasons identified by this study for maternal mortality in California are the occurrence of any AHRQ-defined PSI or adverse event by definition, and the presence of a mental disorder. Table 15 summarizes the major findings addressing these.

Table 15. Summary of findings regarding PSI and MISA at discharge and person levels

| | | |
|---|---|---|
| Discharge Level | Patient Safety | 4% had a PSI<br>60% of in-hospital deaths had a PSI<br>90% of delivery deaths had a PSI |
| | Of deliveries or other pregnancy terminations that the woman survived | 1.0% of terminations had a PSI<br>1.9% of cesarean deliveries had a PSI<br>5.2% of vaginal deliveries had a PSI<br>6.6% of VBACs had a PSI |
| | MISA diagnoses | 4.9% of discharges<br>27% of inpatient deaths<br>66% of MISA inpatient deaths had a PSI |
| Person Level | Patient Safety | 5.6% had a PSI<br>37% of deaths had a PSI |
| | MISA diagnoses | 6.1% women<br>34% of deaths<br>36% of deaths with PSI<br>46% of pregnancy-associated death |

Figure 16 compares death rates per 10,000 women who died by race/ethnicity, age, and the presence or absence of a MISA diagnosis. Absent a MISA diagnosis, deaths increase modestly with age. A MISA diagnosis is associated with much higher death rates, magnifying the effects of age and race/ethnicity. Blacks have the highest mortality rate.

Figure 16. Deaths per 10,000 women by race/ethnicity, age, and MISA diagnosis

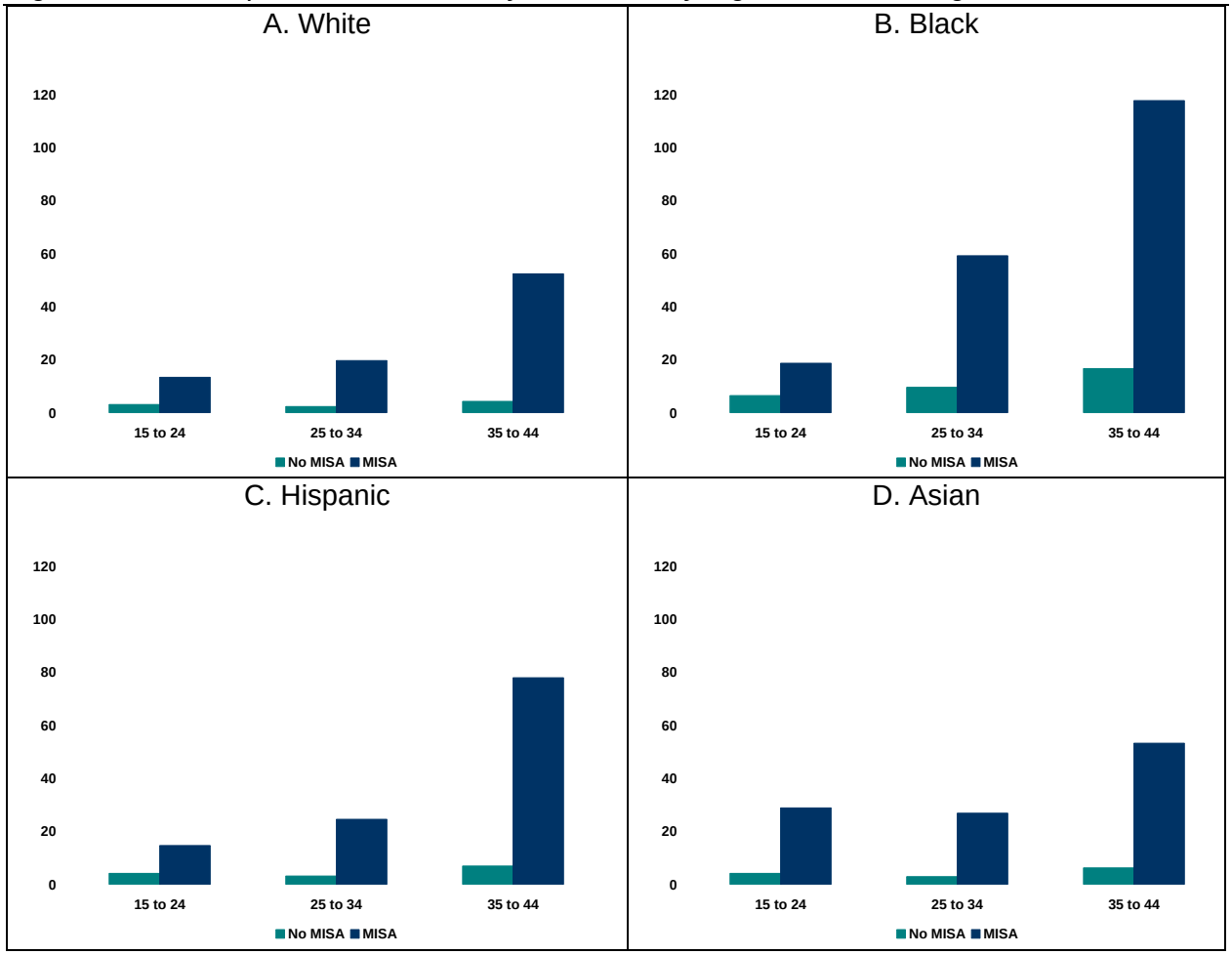


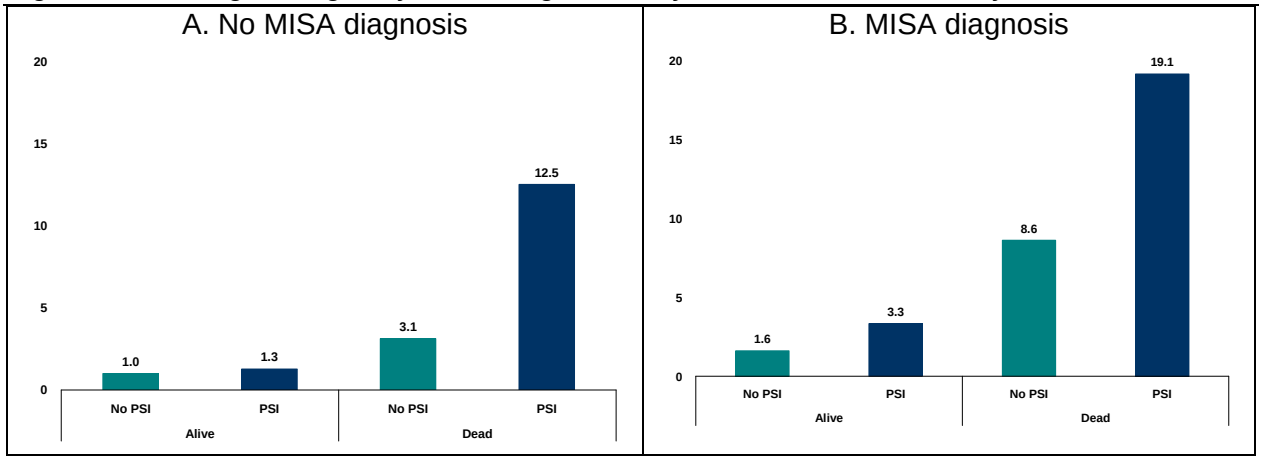

Table 16. Time to death by MISA and PSI diagnoses (%)

| Indicator | 1 Year | > 1 Year |
|---|---|---|
| MISA | 34 | 37 |
| Patient Safety | 51 | 27 |
| No MISA | 48 | 22 |
| MISA | 51 | 37 |

Table 16 compares time to death by the presence of MISA or PSI diagnoses. Of women who died within 1 year of their last pregnancy discharge, 34% had a MISA diagnosis, compared with 37% of those dying after one year. Thus, MISA is a steady influence on risk of dying up to several years after the last pregnancy. Of women who died within one year of the last pregnancy discharge, 51% had a PSI, and PSI was equally powerful in the first year whether they had a MISA diagnosis (51%) or did not (48%). After the first year, 22% of women dying who had no MISA diagnosis had a PSI associated either with their last pregnancy or a later admission for another condition where they died. However, 37% of women with a MISA diagnosis who died after one-year had a PSI either during their last pregnancy discharge or a later admission for another condition where they died.

Figure 17 compares the increase in average charges for patients without and with MISA diagnoses, with and without PSI, who were alive or dead by study end. Average charges for patients without MISA, no PSI, and alive were $15,324 (reference group = 1). Average charges for non-MISA patients who had a PSI and survived increased 1.3 fold. For the MISA group without PSI and alive at study end, average charges increased 1.6 fold. For MISA patients who survived a PSI, average charges increased 3.3 fold. Charges for patients without a MISA diagnosis, who had a PSI and died increased 12.5 fold. For a similar patient with a MISA diagnosis, charges averaged $293,738, a 19.1 fold increase over the reference group. Clearly, the economic consequences of the interaction between MISA and PSI are staggering, with MISA greatly compounding PSI.

Figure 17. Average charges by MISA diagnosis, any PSI event, and mortality




# Discussion

## Mental Illness and Substance Abuse

The longitudinal design of this study identified more women with MISA problems than otherwise would have been found. Although about 6% of women had MISA diagnoses, more than one-third of women who died had at least one hospital record with a MISA diagnosis. The two major causes found to underlie maternal mortality in California -- PSI and MISA -- accounted for 57% of all deaths and 60% of pregnancy-associated deaths. Women with MISA diagnoses were more likely to go OOC for care, had proportionately more comorbid conditions, pregnancy complications, cesarean deliveries, and PSI. Echoing another study of MISA in California's reproductive age population,[62] costs of providing care to MISA women were staggeringly disproportionate, and more so when they had a PSI and/or died.

The role of mental disorders in maternal morbidity and mortality historically is underreported and underestimated. In one of the most comprehensive examinations of maternal deaths using data linkage and improved case ascertainment, the United Kingdom's Confidential Enquiries into

Maternal Deaths found that mental disorders emerged as the leading cause of maternal morbidity and mortality.[57] Psychiatric causes included suicide, substance abuse, and physical illness and accidents that would not have occurred without a psychiatric disorder. Results of this study are consistent with the United Kingdom's. Findings also are consistent with a study on mental health hospitalizations for California residents of reproductive age.[58]

With adoption of the ICD-10 for death certificates, the definition of maternal death changed. The inclusion of deaths occurring after 42 days post-delivery identified suicides and homicides as significant causes of maternal death in the United States.[59] MISA underlies a substantial proportion of domestic violence for women and their partners.[60] [61]

Mental illness and substance abuse are under-reported in hospital data, due to the reluctance of pregnant women to self-report and physician reluctance to ask. For major depression alone, a large Federal study found prevalence estimates ranged from 3% to 5% at different times during pregnancy and 1% to 6% at different times during the first postpartum year.[64] For major and minor depression, estimates ranged from 9% to 11% during pregnancy and 7% to 13% during the first year postpartum. Importantly, prevalence estimates are not significantly different for similarly aged women who are not pregnant and have not recently given birth.

Providers are failing to recognize mental health problems. When relying solely on clinical indicators, pediatricians recognized only 29% of mothers with high levels of depressive symptoms, suggesting that a screening tool may be useful.[65] In a study of 3,000 OB/GYN patients, 20% met criteria for a psychiatric diagnosis, but their provider did not recognize 77% of these patients as having a disorder.[66] Providers recognized only 26% of pregnant patients in an obstetric setting who screened positive for a psychiatric disorder. Rates for detecting depressive disorders were lower than for panic disorders, and obstetric settings identified fewer cases than primary care settings, which means many depressed pregnant women are undetected.[67]

Although most physicians agree that perinatal screening would improve MISA detection, early diagnosis and treatment, most are reluctant to screen because they feel they lack resources to screen all patients, have not been adequately trained to screen or treat women with mental problems, and lack information about referral resources.[68] Yet failing to screen all women increases risk of adverse infant and pregnancy outcomes including death, greatly increases healthcare costs, and reduces profits that physicians and hospitals often share.

Another issue identified in this study is that mood disorders (including depression) accounted for only about 1 in 5 women with MISA diagnoses. The frequency distribution of MISA diagnoses among women who died closely mirrored the distribution of all MISA diagnoses. For example, anxiety disorders were found in 13% of MISA women and in 14% of MISA women who died. Substance abuse disorders were found in 68.3% of MISA cases and 67.7% of MISA women who died. As in previous studies of high-risk populations, we documented a sizeable overlap between psychiatric and substance abuse disorders.[62] [69]

MISA significantly complicates health, healthcare delivery, and survival. Since almost all women who died had a hospital record of MISA severe enough to be recorded, the findings suggest that it would be most fruitful to screen all women and aggressively treat the most severely impaired regardless of diagnostic sub-category. At least in California hospital records, a MISA diagnosis *per se*, rather than a particular diagnosis (e.g., mood disorders such as maternal depression), signaled a pregnant woman at increased risk of morbidity and mortality. With mood disorders including depression accounting for only 1 in 5 MISA diagnoses, trying to reduce maternal mortality by focusing on that population would miss most women at significant risk of death.

Like others with chronic illnesses, the treatment goal for the MISA population is to shorten the time it takes to control the illness and lengthen the time between acute episodes. The MISA population requires careful follow-up for medication side effects and monitoring for compliance, and has great difficulty complying with treatment plans. These problems magnify when the woman is pregnant and/or caring for infants and young children.

Insurers need to ensure that women with MISA diagnoses have mental health parity and priority in receiving services. Numerous studies have shown that medications plus counseling is more effective than medication alone. A growing body of evidence-based practices suggest that mental health is a treatable condition but the lag from research to practice to insurance coverage has been painfully slow.[70]

Treatment priority is urgent because onset is often rapid and these women are caretakers for young children who at increased risk for harm. Whether public or private, insurers are the primary gatekeepers to prevent escalating consequences of untreated MISA. Although two-thirds of Bay Area women had private coverage, over time MISA patients across the state increasingly had public coverage. Thus this is a perfect arena for public and private managed care plans to coalesce to address a problem with huge economic impact.

Addressing PSI is the responsibility of the hospitals. Addressing health problems of MISA women that are associated with maternal morbidity and mortality is within the purview of MCAH jurisdictions. Results of this research indicate that preventing the death each year of one MISA patient who had a PSI could free almost $300,000 in healthcare costs. Shared across 10 health jurisdictions, costs for an effective Bay Area program to increase case identification and direct mothers to treatment programs would be negligible.

## Improving Death Certificate Data Quality

Our findings mirrored those of others as to the quality of death certificate data elements addressing maternal mortality. California's maternal mortality indicators likely are under-reported by perhaps as much as half.

Improving death certificates data quality for maternal mortality indicators is under the control of local public health departments. Women in the age range 10 to 60 account for about 8% of California deaths. It would not create an undue burden for counties to implement a policy that, when any woman in this age range dies, vital statistics staff are to check electronic birth and fetal death records to see if she was pregnant in the last year. For women found to have been pregnant, the jurisdiction could return the certificate and ask the physician to review the case.

This would not require a special project or additional funding. It would require only a simple policy directive from the local health officer to the person responsible for death certificates. Inaugurating this policy would greatly improve the accuracy of California's underlying cause of death reporting.

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