Cardiac Causes of Maternal Morbidity and Mortality
TOP MATERNAL MORTALITY CAUSES IN TEXAS

The Joint Biennial Report of the state’s Maternal Mortality and Morbidity Task Force and the Texas Department of State Health Services examined 189 maternal deaths in Texas during 2011-12. Cardiac events were the most common cause of death among those cases, according to the report, with drug overdoses the second most common.

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac event</td>
<td>20.6</td>
</tr>
<tr>
<td>Drug overdose</td>
<td>11.6</td>
</tr>
<tr>
<td>Hypertension/eclampsia</td>
<td>11.1</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>9.0</td>
</tr>
<tr>
<td>Sepsis</td>
<td>9.0</td>
</tr>
<tr>
<td>Homicide</td>
<td>7.4</td>
</tr>
<tr>
<td>Suicide</td>
<td>5.3</td>
</tr>
</tbody>
</table>
Causes of US Maternal Mortality

Figure 50-4 Cause-specific, pregnancy-related mortality rates (PRMR) for 1987 to 1990, 1991 to 1997, and 1998 to 2005, in the United States. (From Callaghan WM: Overview of maternal mortality in the United States, Semin Perinatol 36:2-6, 2012.)
Improving Health Care Response to Cardiovascular Disease in Pregnancy and Postpartum: A California Quality Improvement Toolkit

The CVD Toolkit was developed by CMQCC at Stanford University under contract with CDPH with funding from federal Title V MCH Block grant

CA-PAMR Findings
Identification and Confirmation of CVD Pregnancy-Related Deaths 2002-2006

<table>
<thead>
<tr>
<th>California Birth Cohort, 2002-2006</th>
<th>N=2,741,220</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnancy-Associated Cohort</td>
<td>N=864</td>
</tr>
<tr>
<td>Pregnancy-Related Deaths</td>
<td>N=257</td>
</tr>
<tr>
<td>Cardiovascular Pregnancy-Related Deaths</td>
<td>N=64</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>N=42</td>
</tr>
<tr>
<td>Other Cardiovascular</td>
<td>N=22</td>
</tr>
</tbody>
</table>


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## CA-PAMR Top 5 Causes of Death
### 2002-2006 (N=257)

<table>
<thead>
<tr>
<th>Grouped Cause of Death, per CA-PAMR Committee</th>
<th>Pregnancy-Related Deaths N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular disease</td>
<td>64 (25)</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>42 (16)</td>
</tr>
<tr>
<td>Other cardiovascular</td>
<td>22 (9)</td>
</tr>
<tr>
<td>Preeclampsia/eclampsia</td>
<td>45 (18)</td>
</tr>
<tr>
<td>Obstetric hemorrhage</td>
<td>25 (10)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>23 (9)</td>
</tr>
<tr>
<td>Venous thromboembolism</td>
<td>22 (9)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>257</strong></td>
</tr>
</tbody>
</table>

**CVD Pregnancy-Related Mortality Rate:** 2.4 deaths /100,000 live births

## CA-PAMR Pregnancy-Related Deaths
### Causes of Death, by Race/Ethnicity
### 2002-2006 (N=257)

<table>
<thead>
<tr>
<th>Clinical Cause of Death</th>
<th>White, Non-Hispanic N (%)</th>
<th>African-American, Non-Hispanic N (%)</th>
<th>Hispanic N (%)</th>
<th>Asian N (%)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular Disease</td>
<td>16 (24)</td>
<td>25 (45)</td>
<td>21 (19)</td>
<td>2 (9)</td>
<td>64 (25)</td>
</tr>
<tr>
<td>Cardiomyopathy*</td>
<td>11 (17)</td>
<td>18 (32)</td>
<td>11 (10)</td>
<td>2 (9)</td>
<td>42 (16)</td>
</tr>
<tr>
<td>Other cardiovascular</td>
<td>5 (8)</td>
<td>7 (13)</td>
<td>10 (9)</td>
<td>0</td>
<td>22 (9)</td>
</tr>
<tr>
<td>Preeclampsia/eclampsia*</td>
<td>11 (17)</td>
<td>5 (9)</td>
<td>27 (24)</td>
<td>2 (9)</td>
<td>45 (18)</td>
</tr>
<tr>
<td>Obstetric hemorrhage</td>
<td>7 (11)</td>
<td>2 (4)</td>
<td>14 (13)</td>
<td>2 (9)</td>
<td>25 (10)</td>
</tr>
<tr>
<td>Venous thromboembolism</td>
<td>6 (9)</td>
<td>7 (13)</td>
<td>9 (8)</td>
<td>0</td>
<td>22 (9)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>5 (8)</td>
<td>2 (4)</td>
<td>11 (9)</td>
<td>5 (22)</td>
<td>23 (9)</td>
</tr>
<tr>
<td>All other causes</td>
<td>21 (32)</td>
<td>15 (27)</td>
<td>30 (27)</td>
<td>12 (52)</td>
<td>78 (30)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>66</strong></td>
<td><strong>56</strong></td>
<td><strong>112</strong></td>
<td><strong>23</strong></td>
<td><strong>257</strong></td>
</tr>
</tbody>
</table>
CA-PAMR Findings
Cardiomyopathy Subtypes
2002-2006

Cardiomyopathy*
N=42

Dilated Cardiomyopathy
N=29 (69%)

Hypertrophic Heart Disease
N=10 (24%)

*The type of cardiomyopathy (dilated or hypertrophic) could not be determined in 3 (7%) cases.


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CA-PAMR Findings
Cardiomyopathy Subtypes, 2002-2006

Hypertrophic Heart Disease
N=10 (24%)

- Primary, potential (n=2)
- 2nd to hypertension (n=3)
- 2nd to drug use (n=1)
- 2nd to valvular disease (n=1)
- HHD etiology could not be determined (n=3)

*The type of cardiomyopathy (dilated or hypertrophic) could not be determined in 3 cases.


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CA-PAMR Findings
Other Cardiovascular Disease Subtypes
2002-2006

Other Cardiovascular
N=22

- Pulmonary Hypertension (N=7)
- Aortic Dissection (N=5)
- Unexplained Sudden Death, probable arrhythmia (N=3)
- Non-Valvular, congenital (N=3)
- Coronary Artery Disease (N=2)
- Valvular Disease (N=2)


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CA-PAMR Findings
Presentation of Women with CVD
2002 - 2006

- Only 2 women entered pregnancy with known CVD
- Prevalence of CVD symptoms (SOB, wheezing, palpitations, edema, chest pain, dizziness, or extreme fatigue)
  - Prenatal period: 43%
  - Labor and delivery: 51%
  - Postpartum: 80%

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CA-PAMR Findings
Presentation of Women with CVD
2002 - 2006

- Abnormal physical exam findings
  - HTN >140/90 (64%)
  - HR >120 (59%)
  - Crackles, S3 or gallop rhythm etc. (44%)
  - O2 <90% (39%)

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CA-PAMR Findings
Timing of Diagnosis and Death
2002-2006

- Timing of CVD Diagnosis (n=64)
  - 34% 48%
  - 3% 8% 8%
  - Preexisting (prior to pregnancy)
  - Prenatal period
  - At labor and delivery
  - Postpartum period
  - Postmortem

- Timing of Death
  - 30% of all CVD deaths were >42 days from birth/fetal demise vs. 7.3% of non CVD pregnancy-related deaths
  - Driven by Cardiomyopathy deaths, with 42.9% deaths >42 days

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CA-PAMR Findings
Contributing Factors & Quality Improvement Opportunities (2002-2006) for CVD

Health Care Provider Related

- Contributing Factors: (69% of all cases)
  - Delayed or inadequate response to clinical warning signs (61%)
  - Ineffective or inappropriate treatment (39%)
  - Misdiagnosis (37.5%)
  - Failure to refer or consult (30%)

- Quality Improvement Opportunities
  - Better recognition of signs and symptoms of CVD in pregnancy
    - Shortness of breath, fatigue
    - Tachycardia, blood pressure change, or low oxygen saturation
    - Improved management of hypertension

Patient Related

- Contributing factors: (70% of all cases)
  - Presence of underlying medical conditions (64%)
  - Obesity (31%)
  - Delays in seeking care (31%)
  - Lack of recognition of CVD symptoms (22%)

- Quality improvement opportunities
  - Education around when to seek care for worrisome symptoms
  - Support for improving modifiable risk factors, such as attaining healthier weight and discontinuing drug use
24% of ALL CVD pregnancy-related deaths (and 31% of cardiomyopathy deaths) were determined to be potentially preventable

CVD Assessment Algorithm
For Pregnant and Postpartum Women

Red Flags
- Shortness of breath at rest
- Severe orthopnea ≥ 4 pillows
- Resting HR ≥ 120 bpm
- Resting systolic BP ≥ 160 mm Hg
- Resting RR ≥ 30
- Oxygen saturations ≤ 94% with or without personal history of CVD

PROMPT EVALUATION and/or hospitalization for acute symptoms

CONSULTATIONS with MFM and Primary Care/Cardiology

Personal History of CVD
Without Red Flags

CONSULTATIONS with MFM and Primary Care/Cardiology

CARDIOVASCULAR DISEASE ASSESSMENT IN PREGNANT and POSTPARTUM WOMEN

SYMPTOMS
- NYHA class > II
- Syncope
- MI/orthopnea
- Tachypnea
- Asthma unresponsive to therapy

VITAL SIGNS
- Resting HR ≥ 110 bpm
- Systolic BP ≥ 140 mm Hg
- RR ≥ 24
- Oxygen sat ≤ 90%

RISK FACTORS
- Age ≥ 40 years
- African American
- Pre-pregnancy obesity (BMI ≥ 35)
- Pre-existing diabetes
- Hypertension
- Substance use (nicotine, alcohol, methamphetamine)
- History of chemotherapy

ANOMALOUS FINDINGS
- Heart: Loud murmur or
- Lung: Basilar cracks

NO YES

Consultation indicated:
MFM and Primary Care/Cardiology

Results abnormal
CVD highly suspected

Obtain: EKG and BNP
- Echocardiogram +/- CXR if HF or valve disease is suspected, or if the BNP levels are elevated
- 24-hour Holter monitor, if arrhythmia suspected
- Referral to cardiologist for possible treadmill echo vs. CTA vs. alternative testing if postpartum
Consider: CXR, CBC, Comprehensive metabolic profile, Arterial blood gas, Drug screen, TSH, etc.
Follow-up within one week

Results negative
Signs and symptoms resolved
Reassurance and routine follow-up

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CVD Algorithm Validation

- We applied the algorithm to 64 CVD deaths from 2002-2006 CA-PAMR.
- 56 out of 64 (88%) cases of maternal mortality would have been identified.
- Detection increased to 93% when comparison was restricted to 60 cases that were symptomatic.