The Perinatal Periods of Risk Approach

Phase 2 Analytic Methods
Phase 1 Narrows the Choices of Action

Maternal Health/Prematurity
- Preconception Health
- Health Behaviors
- Perinatal Care
- etc.

Maternal Care
- Prenatal Care
- High Risk Referral
- Obstetric Care
- etc.

Newborn Care
- Perinatal Management
- Neonatal Care
- Pediatric Surgery
- etc.

Infant Health
- Sleep Position
- Smoking
- Injury Prevention
- etc.
Phase 1 is NOT enough.

Phase 2 analyses are REQUIRED to determine which RISK FACTORS are most important in YOUR COMMUNITY…
Phase 2 Analysis Plan

A separate Phase 2 analysis is completed for each population and period of risk with a large “gap”.
(Urban County vs USA 2000-2002 Reference Group )

EXCESS Fetal-Infant Mortality Rate = 4.4

Excess Mortality

- **IH**: 25%
- **MH/P**: 44%
- **NC**: 18%
- **MC**: 13%

Phase 1 and Exercise
How can we determine the most effective ways to prevent excess deaths?
Phase 2 Analysis Plan Depends On:

- Phase 1 results
- Availability of data
- Community priorities and resources
- Each step depends on the result of the previous step

Protocols were developed for MH/P and IH periods. Possible strategies were outlined for MC.
Steps for Phase 2 Analysis

1. Identify causal pathways or biologic mechanisms for excess mortality

2. Estimate prevalence of risk and preventive factors by type of mechanism

3. Estimate the impact of the risk and preventive factors.
Phase 1
Infant health period gap

Phase 2
Step 1
- Injuries
- Congenital Anomalies
- SIDS

Phase 2
Step 2
- Car seats
- Child abuse/neglect
- Co-sleeping
- Bedding
- Sleep position
Phase 2 Analysis Strategy

- Eliminate consideration of risk and preventive factors that are **UNLIKELY** to be contributing
- Find and target **KNOWN** factors that are likely to be contributing
Phase 2 Analytic Methods
Infant Health Period of Risk
Steps for Phase 2 Analysis

Step 1 “Causal pathway”

What causes of death are contributing the most to excess mortality in this risk period for this population group?
<table>
<thead>
<tr>
<th>Code</th>
<th>Count</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P219</td>
<td>1</td>
<td>Birth asphyxia, unspecified</td>
</tr>
<tr>
<td>Q208</td>
<td>1</td>
<td>Other congenital malformations of cardiac chambers and connections</td>
</tr>
<tr>
<td>Q232</td>
<td>1</td>
<td>Congenital mitral stenosis</td>
</tr>
<tr>
<td>Q249</td>
<td>2</td>
<td>Congenital malformation of the heart, unspecified</td>
</tr>
<tr>
<td>Q909</td>
<td>1</td>
<td>Down's syndrome, unspecified</td>
</tr>
<tr>
<td>Q913</td>
<td>1</td>
<td>Edwards' syndrome, unspecified</td>
</tr>
<tr>
<td>I400</td>
<td>1</td>
<td>Infective myocarditis</td>
</tr>
<tr>
<td>J129</td>
<td>1</td>
<td>Viral pneumonia, unspecified</td>
</tr>
<tr>
<td>J154</td>
<td>2</td>
<td>Pneumonia due to other streptococci</td>
</tr>
<tr>
<td>J180</td>
<td>2</td>
<td>Bronchopneumonia, unspecified</td>
</tr>
<tr>
<td>J189</td>
<td>1</td>
<td>Pneumonia, unspecified</td>
</tr>
<tr>
<td>V486</td>
<td>1</td>
<td>Passenger injured in traffic accident</td>
</tr>
<tr>
<td>V892</td>
<td>1</td>
<td>Person injured in unspecified motor-vehicle accident, traffic</td>
</tr>
<tr>
<td>W08</td>
<td>1</td>
<td>Fall involving other furniture</td>
</tr>
<tr>
<td>W65</td>
<td>1</td>
<td>Drowning and submersion while in bathtub</td>
</tr>
<tr>
<td>W75</td>
<td>2</td>
<td>Accidental suffocation and strangulation in bed</td>
</tr>
<tr>
<td>W84</td>
<td>1</td>
<td>Unspecified threat to breathing</td>
</tr>
<tr>
<td>X00</td>
<td>1</td>
<td>Exposure to uncontrolled fire in building or structure</td>
</tr>
<tr>
<td>X44</td>
<td>1</td>
<td>Accidental poisoning &amp; exposure to other drugs &amp; biological substance</td>
</tr>
<tr>
<td>X91</td>
<td>3</td>
<td>Assault (homicide) by hanging, strangulation, and suffocation</td>
</tr>
<tr>
<td>Y079</td>
<td>2</td>
<td>Other maltreatment syndromes By unspecified person</td>
</tr>
<tr>
<td>Y20</td>
<td>1</td>
<td>Hanging, strangulation, and suffocation, undetermined intent</td>
</tr>
<tr>
<td>R95</td>
<td>15</td>
<td>SIDS</td>
</tr>
<tr>
<td>R99</td>
<td>6</td>
<td>Other ill-defined and unspecified causes of mortality</td>
</tr>
</tbody>
</table>
Phase 2 Analysis--Infant Health Period

The many causes of death must be grouped.

Several proposed grouping systems, such as:

- Birth defects
- Infections
- Injuries (intentional and unintentional)
- Perinatal conditions
- SIDS/SUID (possibly suffocation)
## Modified Dolfus from State Infant Mortality Committee

<table>
<thead>
<tr>
<th>Modified Dolfus 7/2005</th>
<th>ICD-9</th>
<th>ICD-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prematurity and related conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immaturity and preterm</td>
<td>765.0, 765.1</td>
<td>P07.0, P07.1, P07.2, P07.3</td>
</tr>
<tr>
<td>Intracranial hemorrhage (mostly IVH)</td>
<td>431</td>
<td>I61</td>
</tr>
<tr>
<td>Respiratory problems</td>
<td>767.0, 772.1</td>
<td>P10.0, P10.1, P10.2, P10.4, P10.9, P29.0, P29.1, P52.0-P52.3, P52.9</td>
</tr>
<tr>
<td>RDS (excludes transient tachypnea)</td>
<td>769</td>
<td>P22.0, P22.8, P22.9</td>
</tr>
<tr>
<td>Interstitial emphysema</td>
<td>770.2</td>
<td>P25</td>
</tr>
<tr>
<td>Pulmonary hemorrhage</td>
<td>770.3</td>
<td>P26</td>
</tr>
<tr>
<td>Chronic respiratory disease</td>
<td>770.7</td>
<td>P27</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>770.4, 770.5</td>
<td>P28.0, P28.1</td>
</tr>
<tr>
<td>Other respiratory conditions</td>
<td>770.8</td>
<td>P28.2-P28.9</td>
</tr>
<tr>
<td>NEC</td>
<td>777.5</td>
<td>P77</td>
</tr>
<tr>
<td>Other specified perinatal conditions</td>
<td>779.8</td>
<td>P96.8</td>
</tr>
</tbody>
</table>
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<th>Modified Dolfus 7/2005</th>
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<th>ICD-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Congenital anomaly</td>
<td>740-759</td>
<td>Q00-Q99</td>
</tr>
<tr>
<td>3. SIDS and SUID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIDS</td>
<td>798</td>
<td>R95</td>
</tr>
<tr>
<td>Unknown</td>
<td>799</td>
<td>R99</td>
</tr>
<tr>
<td>(Decided to combine this category because of changes in reporting in recent years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Obstetric Conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROM and incompetent cervix</td>
<td>761.0, 761.1</td>
<td>P01.0, P01.1</td>
</tr>
<tr>
<td>Multiple pregnancies</td>
<td>761.5</td>
<td>P01.5</td>
</tr>
<tr>
<td>Placental abnormalities</td>
<td>762.0- 762.2</td>
<td>P02.0, P02.1, P02.2</td>
</tr>
</tbody>
</table>
## Modified Dolfus from State Infant Mortality Committee

<table>
<thead>
<tr>
<th>Modified Dolfus 7/2005</th>
<th>ICD-9</th>
<th>ICD-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Birth Asphyxia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unspecified fetal distress</td>
<td>768.4</td>
<td>P20.9</td>
</tr>
<tr>
<td>Severe &amp; unspecified birth asphyxia</td>
<td>768.5, 768.9</td>
<td>P21.0, P21.9</td>
</tr>
<tr>
<td>6. Perinatal Infections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptococcous meningitis</td>
<td>320.2</td>
<td>G00.2</td>
</tr>
<tr>
<td>Maternal infection</td>
<td>760.1, 760.2, 760.8</td>
<td>P00.1, P00.2, P00.8</td>
</tr>
<tr>
<td>Chorioamnionitis</td>
<td>762.7</td>
<td>P02.7</td>
</tr>
<tr>
<td>Other perinatal infections</td>
<td>771.8</td>
<td>P36, P39.9</td>
</tr>
</tbody>
</table>
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<th>Modified Dolfus 7/2005</th>
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<th>ICD-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Other infections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infectious and parasitic diseases (we also included neonatal tetanus A33 or 771.3 in this category unlike Dolfus)</td>
<td>001-139</td>
<td>A00-B99</td>
</tr>
<tr>
<td>Meningitis</td>
<td>320.0, 320.1, 320.8, 320.9, 322.9</td>
<td>G00.0, G00.1, G00.8, G00.9, G03.9</td>
</tr>
<tr>
<td>Respiratory infections</td>
<td>460-466, 480-487, 490</td>
<td>J00-J06, J10-J21, J40</td>
</tr>
<tr>
<td>8. External Causes/Injuries</td>
<td>E800-E999</td>
<td>V01-Y89</td>
</tr>
</tbody>
</table>

WE decided to include all external causes. Dolfus excluded MVAs due to railroad accidents and other than typical modes of transportation, as well as by firearms.
Death Certificate recording is not always correct. Check local practices.

Example:
Child Death Review Teams frequently reclassified

- Death Cert R99 Ill-defined → as R95 SIDS
- Death Cert R95 SIDS → as W75 suffocation

FIMR, medical examiners, and others may also be good sources
1. Decide how to categorize causes of death
2. Categorize the same way for study and reference groups
3. Count number of deaths in each category
4. Calculate “cause-specific mortality rates”
5. Compare study and reference groups rates
Example, Cause of Death
Identify causal pathways or biologic mechanisms for excess mortality

<table>
<thead>
<tr>
<th>Postneonatal Deaths &gt;1500 g</th>
<th>State Ref</th>
<th>Study Pop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perinatal conditions</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Congenital anomalies</td>
<td>55</td>
<td>6</td>
</tr>
<tr>
<td>Infections</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Injury</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>SIDS</td>
<td>61</td>
<td>15</td>
</tr>
<tr>
<td>Ill-defined</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>29</td>
<td>4</td>
</tr>
<tr>
<td>Total Deaths</td>
<td>183</td>
<td>54</td>
</tr>
</tbody>
</table>

Ideal denominator is the population at risk
Live Births >1500 grams, surviving 28 days
Phase 2 Analysis-Infant health period
Identify causal pathways or biologic mechanisms for excess mortality

In each Study and Reference Population:

**CSMR** = Cause-specific mortality rate

\[
\text{CSMR} = \frac{\text{the number of IH deaths due to a specific cause}}{\text{number of all IH live births}}
\]

**Excess CSMR** = Excess cause-specific mortality rate

\[
\text{Excess CSMR} = \text{Study Pop. CSMR} - \text{Reference Pop. CSMR}
\]

*Denominator is Infant Health live births weighing >1500 grams at birth, and surviving 28 or more days*
Phase 2 Analysis - Infant Health Period
Identify causal pathways or biologic mechanisms for excess mortality

<table>
<thead>
<tr>
<th>Postneonatal Deaths</th>
<th>State Ref Rate</th>
<th>Study Pop Rate</th>
<th>Excess Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1500 g</td>
<td>0.05</td>
<td>0.12</td>
<td>0.07</td>
</tr>
<tr>
<td>Perinatal conditions</td>
<td>0.35</td>
<td>0.70</td>
<td>0.35</td>
</tr>
<tr>
<td>Congenital anomalies</td>
<td>0.03</td>
<td>0.82</td>
<td>0.79</td>
</tr>
<tr>
<td>Infections</td>
<td>0.10</td>
<td>1.75</td>
<td>1.65</td>
</tr>
<tr>
<td>Injury</td>
<td>0.38</td>
<td>1.75</td>
<td>1.37</td>
</tr>
<tr>
<td>SIDS</td>
<td>0.06</td>
<td>0.70</td>
<td>0.64</td>
</tr>
<tr>
<td>Ill-defined</td>
<td>0.18</td>
<td>0.47</td>
<td>0.28</td>
</tr>
<tr>
<td>Total Deaths</td>
<td>1.15</td>
<td>6.32</td>
<td>5.16</td>
</tr>
<tr>
<td>Denominator</td>
<td>158,577</td>
<td>8,550</td>
<td></td>
</tr>
</tbody>
</table>
Phase 2 Analysis - Infant Health Period
Identify causal pathways or biologic mechanisms for excess mortality
Phase 2 Analysis - Infant Health Period
Identify causal pathways or biologic mechanisms for excess mortality

Excess Cause-Specific Mortality Rate

- Injury: 32%
- SIDS: 27%
- Perinatal conditions: 1%
- Congenital anomalies: 7%
- Ill-defined: 12%
- Infections: 15%
- Other: 6%
From CDC Wonder accessed 4/21/2011

**Post-neonatal deaths among infants born at 1,500 grams or larger**
Black (non-Hispanic) in Philadelphia County and a Reference Group of White (non-Hispanic) mothers age 20-39, in Bucks, Chester, Delaware, and Montgomery Counties in Pennsylvania

<table>
<thead>
<tr>
<th>Cause of Death Categories</th>
<th>Black Philadelphia County</th>
<th>Ref Group: White age 20-39 4 adjoining counties</th>
</tr>
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<tbody>
<tr>
<td>Congenital Anomaly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Perinatal Conditions</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>R95-SIDS</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>R99-Ill-defined</td>
<td>29</td>
<td>2</td>
</tr>
<tr>
<td>W75-Accidental suffocation/Strangulation in bed</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>97</strong></td>
<td><strong>64</strong></td>
</tr>
<tr>
<td><strong>Denominator (births &gt; 1,500 grams minus neonatal deaths)</strong></td>
<td><strong>30,187</strong></td>
<td><strong>61,823</strong></td>
</tr>
</tbody>
</table>

Why so many Ill-defined for Blacks?
From CDC Wonder accessed 4/21/2011

**Post-neonatal deaths among infants born at 1,500 grams or larger**

Black (non-Hispanic) in Philadelphia County and a Reference Group of White (non-Hispanic) mothers age 20-39, in Bucks, Chester, Delaware, and Montgomery Counties in Pennsylvania

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<td>15</td>
</tr>
<tr>
<td>Infection</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Injury</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
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<td>21</td>
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</table>
From CDC Wonder accessed 4/21/2011

Post-neonatal deaths among infants born at 1,500 grams or larger
Black (non-Hispanic) in Large Urban County and a Reference Group of White (non-Hispanic) mothers age 20-39, in 4 neighboring counties

<table>
<thead>
<tr>
<th>Cause of Death Categories</th>
<th>Black Philadelphia County</th>
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Are birth defects less common for Blacks, or are they less diagnosed?
CDC, NCHS, Linked Birth / Infant Death Records 2003-2006

State

**R95** (Sudden infant death syndrom - SIDS) 132
**Other Q00-Q99** (Congenital malformations, deformations and chromosomal abnormalities) 55
**Other V01-Y89** (External causes of morbidity and mortality) 51
**R99** (Other ill-defined and unspecified causes of mortality) 24
**Other & Suppressed** 21

**W75** (Accidental suffocation and strangulation in bed) 20
**J00-J98** (Diseases of the respiratory system) 19
**I00-I99** (Diseases of the circulatory system) 18

**Q24.9** (Congenital malformation of heart, unspecified) 18
**A00-B99** (Certain infectious and parasitic diseases) 16
**G00-G98** (Diseases of the nervous system) 16
**Other R00-R99** (Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified) 3

**Denominator 273,899 (>1500 grams all Colorado residents)**
Neighboring States Reference Group

CDC, NCHS, Linked Birth / Infant Death Records 2003-2006

Mountain States Reference Group

A00-B99 (Certain infectious and parasitic diseases) 13
G00-G98 (Diseases of the nervous system) 20
I00-I99 (Diseases of the circulatory system) 12
J00-J98 (Diseases of the respiratory system) 23
P00-P96 (Certain conditions originating in the perinatal period) 13
Other Q00-Q99 (Congenital malformations, deformations and chromosomal abnormalities) 59
   Q24.9 (Congenital malformation of heart, unspecified) 20
Other R00-R99 (Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified) 7
   R95 (Sudden infant death syndrome - SIDS) 112
   R99 (Other ill-defined and unspecified causes of mortality) 25
Other V01-Y89 (External causes of morbidity and mortality) 44
   W75 (Accidental suffocation and strangulation in bed) 12
All Other & suppressed 24

Denominator 397,082 (>1500 grams >12 yrs ed, >19 age, non-Hispanic White)
## Compare States Reference Group
### Cause-Specific Mortality Rates (IH deaths per thousand live births)

<table>
<thead>
<tr>
<th>Category</th>
<th>State</th>
<th>Neighbor States Reference Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suppressed, P00-P96, R00-R94</td>
<td>0.088</td>
<td>0.111</td>
</tr>
<tr>
<td>Infectious diseases</td>
<td>0.058</td>
<td>0.033</td>
</tr>
<tr>
<td>Nervous system diseases</td>
<td>0.058</td>
<td>0.050</td>
</tr>
<tr>
<td>Circulatory System diseases</td>
<td>0.066</td>
<td>0.030</td>
</tr>
<tr>
<td>Congenital malformations of the heart</td>
<td>0.066</td>
<td>0.050</td>
</tr>
<tr>
<td>Respiratory diseases</td>
<td>0.069</td>
<td>0.058</td>
</tr>
<tr>
<td>W75 Suffocation/Strangulation</td>
<td>0.073</td>
<td>0.030</td>
</tr>
<tr>
<td>R99 Other Ill-defined</td>
<td>0.088</td>
<td>0.063</td>
</tr>
<tr>
<td>V01-Y External causes</td>
<td>0.186</td>
<td>0.111</td>
</tr>
<tr>
<td>Q00-99 Other Birth Defects</td>
<td>0.201</td>
<td>0.149</td>
</tr>
<tr>
<td>R95 SIDS</td>
<td>0.482</td>
<td>0.282</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1.435</strong></td>
<td><strong>0.856</strong></td>
</tr>
</tbody>
</table>

CDC, NCHS, Linked Birth / Infant Death Records 2003-2006
Infant Health Period of Risk, Phase 2 analysis, Comparison of Colorado with Mountain State Reference Group (2003-2006, from CDC Wonder)

- Suppressed, P00-P96, R00-R94
- Infectious diseases
- Nervous system diseases
- Circulatory System diseases
- Congenital malformations of the heart
- Respiratory diseases
- W75 Suffocation/Strangulation
- R99 Other ill-defined
- V01-Y External Causes
- Q00-99 Other Birth Defects
- R95 SIDS

CO | Mountain States Ref Gp
---|-------------------------
0.1 | 0.1
0.1 | 0.0
0.1 | 0.1
0.0 | 0.1
0.1 | 0.1
0.1 | 0.0
0.1 | 0.1
0.2 | 0.1
0.1 | 0.2
0.1 | 0.3
0.5 | 0.5
Steps for Phase 2 Analysis

2. “Risk and Preventive Factors”

- What are the primary risk and preventive factors **KNOWN** to be associated with the identified causal pathways or biological mechanisms?

- Which factors exhibit **DISPARITIES** in prevalence that reflect the observed outcome disparities?
Phase 2 Analysis - Infant Health period

Step 2: Estimate prevalence of risk and preventive factors by type of mechanism

Infant Health

- SIDS
- Injury
- Infection
- Anomalies
- Perinatal

Each cause category has its own set of risk and preventive factors
### Phase 2 Analysis-Infant health period

Partial list of risk factors by major cause of death

<table>
<thead>
<tr>
<th>Anomalies</th>
<th>SUID (&amp; Sleep Injury?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folic acid intake</td>
<td>Passive smoke</td>
</tr>
<tr>
<td>Alpha-feto protein</td>
<td>Prematurity</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Sleep position</td>
</tr>
<tr>
<td>Drug abuse</td>
<td>Breast-feeding</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Bedding</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>Co-sleep</td>
</tr>
<tr>
<td>Delivery site</td>
<td>Maternal age</td>
</tr>
<tr>
<td></td>
<td>Death scene investigation</td>
</tr>
</tbody>
</table>
Phase 2 Analysis-Infant health period
Partial list of risk factors by major cause of death

Infection
- Medical home
- Prematurity
- Immunizations
- Breast-feeding
- Passive smoke
- Prenatal care
- Maternal age
- Infection type

Injury
- Bedding
- Carseats
- Supervision
- Environment
- Parent mental health/substance use
Phase 2: Analysis---Ficticiosia - Infant health period

- Step 2 examines risk and preventive factors for SUID and Injury
- Compares Study Population to Reference Population
- Population at risk is infants >1500 grams surviving 28 or more days
Disparities in prevalence of some risk factors for SIDS from BRFSS (Urban County)

- Inadequate social and emotional support
- Smoking
- Alcohol use (binge drinking) BRFSS
- Low birthweight

Bar chart showing differences between Black and Reference Group for each risk factor.
Steps for Phase 2 Analysis

- Tempting to pick the risk and preventive factors with the biggest disparity in prevalence

- Ideally should address factors with the biggest potential impact

- Estimating preventive impact of each factor on excess mortality helps prioritize the factors likely contributing to excess mortality
Infant Health Period

Step 3: Estimate the impact of the risk and preventive factors

How much will the infant mortality rate in the study population decrease if we decrease a risk factor?

Population Attributable Risk

Depends predominantly on:

- How “risky” the risk factor is?

Relative Risk

- How many in the population are “exposed” to it?
Population Attributable Risk Percent

- Compares rate for the whole population to the rate for those WITHOUT the risk factor.
- Based on rate difference or (equivalently) on relative risk and prevalence of the exposure for the whole population.
- Interpretation: "Percent of the population that would be prevented from the poor outcome if the risk factor were eliminated from the entire population."
- Relevant to estimating overall impact and cost.
Infant Health Period

Step 3: Estimate the impact of the risk and preventive factors

- Crude Estimate of Population Attributable Risk
- Population Attributable Risk Based on published adjusted relative risk
- Adjusted Population Attributable Risk using regression
- Which factors are modifiable? By how much?
Step 3: Estimate the impact of the risk and preventive factors

Population Attributable Risk Percent

<table>
<thead>
<tr>
<th></th>
<th>“Disease”</th>
<th>Not</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed</td>
<td>a</td>
<td>b</td>
<td>n₁</td>
</tr>
<tr>
<td>Unexposed</td>
<td>c</td>
<td>d</td>
<td>n₂</td>
</tr>
<tr>
<td>All</td>
<td>a+c</td>
<td>b+d</td>
<td>n₀</td>
</tr>
</tbody>
</table>

\[p₂ = \frac{c}{n₂}\] (rate of disease in low risk group)

\[p₀ = \frac{(a+c)}{n₀}\] (rate of disease in whole population)

Levin’s PAF = \(\frac{(p₀ - p₂)}{p₀}\)
15 sleep related deaths in a population of 8,550 were cross-tabulated by sleep safety and cause of death.

<table>
<thead>
<tr>
<th></th>
<th>Sleep related death</th>
<th>Not sleep related death</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed to risk (e.g.</td>
<td>12</td>
<td>3408</td>
<td>5130</td>
</tr>
<tr>
<td>tummy-sleeping)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unexposed (e.g. back</td>
<td>3</td>
<td>5127</td>
<td>3420</td>
</tr>
<tr>
<td>sleeping)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>8535</td>
<td>8550</td>
</tr>
</tbody>
</table>
**Infant Health Period--PAF example, continued**

PAF answers the question: What if the whole population had the lower, “safe sleep” rate of SUIDS deaths?

<table>
<thead>
<tr>
<th>Mortality rate due to SIDS and unsafe sleep among those who slept safely</th>
<th>[ \frac{3}{3420} \times 1,000 ]</th>
<th>= .58 deaths per thousand</th>
</tr>
</thead>
<tbody>
<tr>
<td>If all 8550 babies had slept safely, the estimated number of deaths is</td>
<td>[ .58 \times 8,550 ]</td>
<td>= 5 deaths</td>
</tr>
</tbody>
</table>

Compared to the actual 15 deaths, we would save 10, or 67% if we could make all babies sleep safely.
Step 3: Infant Health Period
Estimate impact of the risk and preventive factors

<table>
<thead>
<tr>
<th>Population Attributable Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAR = $p_0 - p_2 = (p_1 - p_2) \cdot \frac{n_1}{n_0}$</td>
</tr>
<tr>
<td>PAF = $\frac{p_0 - p_2}{p_0}$ (x100 to get percent)</td>
</tr>
</tbody>
</table>

Alternate form – use if RR or OR is available

| PAF = $P \cdot (RR - 1) / (1 + P \cdot (RR - 1))$ |
Limitation of PAF: In “real life”, factors do not act independently

Methods to deal with this issue, References from Deborah Rosenberg, PhD and Kristin Rankin, PhD

*Division of Epidemiology and Biostatistics*
*School of Public Health,*
*University of Illinois at Chicago*

**Miettenin (1974)** Adjusted PAF = Proportion of the disease that could be reduced by eliminating one risk factor, after controlling for others factors and accounting for effect modification

**Bruzzi (1985)/Greenland and Drescher (1993)** Summary PAF = Proportion of the disease that could be reduced by simultaneously eliminating multiple risk factors from the population. *Method for using regression modeling to generate PAFs*

**Benichou and Gail (1990)** Variance estimates for the adjusted and summary PAF based on the delta method

**Eide and Gefeller (1995)** Sequential PAF
Questions?
Phase 2 Analytic Methods
Maternal Health/ Prematurity
Period of Risk
Phase 2 Analysis Plan
A separate Phase 2 analysis is completed for each population and period of risk with a large “gap”.
(Urban County vs USA 2000-2002 Reference Group)

EXCESS Fetal-Infant Mortality Rate = 4.4

Excess Mortality

MH/P 44%
IH 25%
NC 18%
MC 13%
Steps for Phase 2 Analysis

1. Identify causal pathways or biologic mechanisms for excess mortality

2. Estimate prevalence of risk and preventive factors by type of mechanism

3. Estimate the impact of the risk and preventive factors.
Maternal Health and Prematurity Risk Period

Phase 1
- MH/P period gap
- Birthweight distribution
  - Birthweight specific mortality

Phase 2
  Step 1
  - Maternal infection
  - Preconception health insurance
  - Maternal stress
  - Referral to level III facility
  - Neonatal specialist availability
  Step 2
Phase 2 Analysis Strategy

- Eliminate consideration of risk and preventive factors that are **UNLIKELY** to be contributing
- Find and target **KNOWN** factors that are likely to be contributing
Steps for Phase 2 Analysis

Step 1. “Causal pathway”

- What causes of death contribute the most to excess mortality in this risk period?

- Can “patterns” in mortality disparities help us understand the underlying mechanism for excess mortality in this risk period?
Step 1: Identify Causal Pathways or Biologic Mechanisms for Excess Mortality

Cause of VLBW fetal and infant deaths is

- Multifactorial
- Complex
- Inconsistent
- Varies by training

ICD-10 Cause of Death Codes are not very helpful
### A Tale of Two Cities

<table>
<thead>
<tr>
<th>Nonicu City</th>
<th>Tinybaby City</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 births</td>
<td>1,000 births</td>
</tr>
<tr>
<td>10 VLBW deaths</td>
<td>10 VLBW deaths</td>
</tr>
</tbody>
</table>

For both cities, the "Blue Box" mortality rate is 10 deaths per thousand live births.

**What can these cities do?**
What is the difference between these two cities . . .
Let’s take a closer look

<table>
<thead>
<tr>
<th>Nonicu City</th>
<th>Tinybaby City</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1,000 births</td>
</tr>
<tr>
<td>10 VLBW births</td>
<td>100 VLBW births</td>
</tr>
<tr>
<td>10 VLBW deaths</td>
<td>10 VLBW deaths</td>
</tr>
</tbody>
</table>

We were missing an important fact. The number of VLBW births sets these two cities apart.
What does this difference mean?

<table>
<thead>
<tr>
<th><strong>Nonicu City</strong></th>
<th><strong>Tinybaby City</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>10 VLBW births</td>
<td>100 VLBW births</td>
</tr>
<tr>
<td>10 VLBW deaths</td>
<td>10 VLBW deaths</td>
</tr>
<tr>
<td><strong>Mortality rate for a baby born VLBW in Nonicu City is 100%</strong></td>
<td><strong>Mortality rate for a baby born VLBW in Tinybaby City is 10%</strong></td>
</tr>
</tbody>
</table>
Kitagawa’s formula tells us:
Which city we resemble, and
What we need to focus on?

93%

7%

Birthweight Distribution

Birthweight Specific Mortality
Phase 2 Analysis—MH/P Period

Partial list of risk factors by contributor

Birthweight Distribution (VLBW Births)
- Smoking
- Prenatal care
- Race
- Maternal age
- Parity
- Multiple Preg.
- SES/Education
- Birth Interval
- Maternal HTN/Diabetes
- Etc.

Birthweight-Specific Mortality
- Gestational age
- Referral system
- Perinatal care
- NICU system
- Mat. complications
- Neonatal conditions
- Pay source
- Etc.
Kitagawa’s Formula Uses Algebra to PARTITION Excess Mortality into

1. **Birthweight distribution**

2. **Birthweight specific mortality**

\[ \sum_{1}^{n} \left( \left( \frac{P_{1n} + P_{2n}}{2} \times (M_{1n} - M_{2n}) \right) + \left( \frac{M_{1n} + M_{2n}}{2} \times (P_{1n} - P_{2n}) \right) \right) \]

An excel sheet at [www.citymatch.org](http://www.citymatch.org) will do these calculations for you, if you give it some local data.
# Table 1: Target Population

<table>
<thead>
<tr>
<th>Birthweight</th>
<th>Number of Live Births</th>
<th>Number of Infant Deaths</th>
<th>Number of Fetal Deaths 24+ wks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-499</td>
<td>39</td>
<td>37</td>
<td>10</td>
</tr>
<tr>
<td>500-749</td>
<td>55</td>
<td>36</td>
<td>13</td>
</tr>
<tr>
<td>750-999</td>
<td>70</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>1,000-1,249</td>
<td>82</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>1,250-1,499</td>
<td>101</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1,500-1,999</td>
<td>372</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>2,000-2,499</td>
<td>1,081</td>
<td>22</td>
<td>10</td>
</tr>
<tr>
<td>2,500+</td>
<td>21,438</td>
<td>62</td>
<td>29</td>
</tr>
</tbody>
</table>

**Urban County**

**Omaha, Nebraska**

Phase 2 MHP period
<table>
<thead>
<tr>
<th>Urban Healthy Start Area</th>
<th>Reference</th>
<th>Opportunity Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.7</td>
<td>2.1</td>
<td>8.6</td>
</tr>
<tr>
<td>3.8</td>
<td>0.85</td>
<td>2.3</td>
</tr>
<tr>
<td>2.7</td>
<td>0.85</td>
<td>1.9</td>
</tr>
<tr>
<td>3.6</td>
<td>0.61</td>
<td>3.0</td>
</tr>
<tr>
<td>20.8</td>
<td>-</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>= 15.8</td>
</tr>
</tbody>
</table>
Urban Healthy Start Area 1997-1999

Kitagawa Partitioning of Excess Mortality in the MH/P Period of Risk

- Birthweight Distribution: 73%
- Birthweight Specific Mortality: 27%
Maternal Health/Prematurity Period

Kitagawa Analysis (Birthweight under 1500 grams) African Americans in Example City vs U.S. Reference Group

- 92.5%
- 7.5%

Birthweight Distribution

Birthweight Specific Mortality
Contribution to the Difference in Excess Mortality Rates

- Birthweight Distribution
- Birthweight Specific Mortality

Using National Reference Group

Chart depicting the contribution to the difference in excess mortality rates across different birthweight categories.
Contribution to the Difference in Excess Mortality Rates

Using Internal Reference Group
Example City can focus on causes for “TOO MANY VLBW BIRTHS”

- Smoking
- Prenatal care
- Race
- Maternal age
- Parity
- Multiple Preg.
- SES/Education
- Birth Interval
- Maternal HTN/Diabetes
- Etc.

Birthweight Distribution (VLBW Births)

Birthweight-Specific Mortality

- Gestation Age
- Referral System
- Perinatal care
- NICU system
- Mat. complications
- Neonatal conditions
- Pay source
- Etc.
Step 2: Analysis plan depends on result of Kitagawa

Maternal Health/Prematurity

OUTCOME

- Percent VLBW
- Mortality Rate

POPULATION AT RISK

- All Births And Fetal Deaths
- VLBW Births and Fetal Deaths
Steps for Phase 2 Analysis

1. Identify causal pathways or biologic mechanisms for excess mortality

2. Estimate prevalence of risk and preventive factors by type of mechanism

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Questions?
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- MC 13%
Phase 2 Analysis Strategy

- Eliminate consideration of risk and preventive factors that are **UNLIKELY** to be contributing
- Find and target **KNOWN** factors that are likely to be contributing
Maternal Care Period
Phase 2 Analytic Strategy

- Less needed information on fetal death certificates
- More data is missing/not reported on certificate
- Missing major causal pathways on certificate
  - Chromosomal abnormalities
  - Severe congenital anomalies
  - Placental vascular abnormalities
  - Antibodies
- Need to adjust PPOR Phase 2 analytic strategy and steps
Steps for Phase 2 Analysis

1. Identify causal pathways or biologic mechanisms for excess mortality

2. Estimate prevalence of risk and preventive factors by type of mechanism

3. Estimate the impact of the risk and preventive factors.
Maternal Care Period

Step 2: Prevalence Comparison of Risk and Preventive Factors

Potential known reliable risk & preventive factors:

- Maternal age and race
- Education and socioeconomic
- Parity and previous fetal loss
- Inter-pregnancy interval
- Smoking
- Prenatal care
- Multiple gestation
- Birthweight and Gestational age
- Medical Conditions (Diabetes, hypertension, RH disease)
- BMI and gestational weight gain
- Genetic testing
Disparities in prevalence of risk factors (Urban County BRFSS—represents all females age 18-44)

Phase 2 MHP period

- Current smoker
- Heavy drinking
- Report good health
- Health Insurance
- HS/GED

- Black N.H.
- Reference Group
Disparities in prevalence of risk factors,
(Urban County vital records data – PPOR eligible live births plus fetal deaths)
Steps for Phase 2 Analysis

1. Identify causal pathways or biologic mechanisms for excess mortality

2. Estimate prevalence of risk and preventive factors by type of mechanism

3. Estimate the impact of the risk and preventive factors.
Questions?