Carbon Monoxide
and
Environmental Public Health Tracking

EPHT Brown Bag
June 26, 2006
CO poisoning: an important public health issue

- CO is an odorless, colorless gas
  - Produced by combustion engines
- CO poisoning can occur:
  - During routine activities
    - Domestic, occupational and recreational
  - In the wake of large-scale disasters
    - Morbidity and mortality
CO: An important public health issue

- In US, recognized burden of unintentional, non-fire-related CO poisoning:
  - 15,200 treated annually in EDs\(^1\)
    - Likely underestimated
  - 800 deaths annually \(^2\)

- Estimated persistent neurological injury
  - 10 - 40% of CO poisoning survivors severe poisoning

---

1. CDC. Unintentional non-fire-related carbon monoxide exposures – United States, 2001-2002. MMWR: Jan.21 2005 / 54(02);36-39
CO: An important public health issue

- Evidence based prevention strategies
  - Correct installation/ maintenance potential CO emitting devices
  - CO detectors
  - Legislation/regulation
    - CO emissions
    - CO detectors

- Why AREN’T we conducting public health surveillance?
CO: an important EPHT work area

- Demonstrated links between health and environment
- Feasible to track
  - Measurable and trackable
  - Data sources available in most states
  - Can track in real-time
- Tied to public health objectives
  - Useful and understood
  - Informative
CO: an important EPHT work area

- Established EPHT interest
- The National Workgroup on Carbon Monoxide Surveillance
  - Formed in April 2005
  - Membership:
    - EPHT grantees
    - Academic and other CDC partners
National Workgroup on CO Surveillance

Goals:

1. Build a system for CO surveillance
   - National
   - Sustainable
2. Standardize methodology CO surveillance
3. Promote programs for prevention/education of CO poisoning.
Accomplishments:

- Produced:
  - *Carbon Monoxide: A Model Environmental Public Health Indicator*

- Collaborating with CDC
  - Evaluation of national case definitions
  - Planning a national conference
    - July 12-13th, 2006

- CO surveillance at CSTE (June 2006)
  - Conducted a session
  - 2 roundtable discussions
National Workgroup on CO Surveillance

Contacts:

Steven Macdonald – Washington EPHT
steven.macdonald@doh.wa.gov

Judith Graber – Maine EPHT
judith.graber@maine.gov
Presentations:
Judith Graber, Maine
Making the Best of What’s There: Building a State-Based Surveillance System for CO Poisoning

Kathleen Wheeler, New York City
Preventing CO Poisoning: Tracking the Impact of Legislative and Regulatory Changes in New York City

Brian Toal, Connecticut
Comparison of Three CO Databases in Connecticut
Making the best of what's there: Building a state-based surveillance system for carbon monoxide poisoning

Judith M. Graber, M.S.
Andrew E. Smith, Sc.D.
Maine Department of Health and Human Services
Maine, January 1998 ice storm
Maine, January 1998 ice storm
Maine, January 1998 ice storm
Maine, January 1998 ice storm
Maine, January 1998 ice storm
Maine, January 1998 ice storm
Maine, January 1998 ice storm

CO poisonings excess January 1998:
  • Outpatient settings
    • January 1998 = 289
    • January 1999 = 20
  • Hospitalizations
    • January 1998 = 14
    • January 1999 = 1
  • Deaths
    • January 1998 = 2
    • All of 1999 = 0
Maine’s Surveillance System for Carbon Monoxide Poisoning
A statewide system for unintentional, non-fire-related CO poisoning in Maine

- Approach
- Data sources
- Analysis/results
- Dissemination
- Use of data for public health action

Limitations, next steps
CO Surveillance Logic Model

Environmental Health Tracking Program
CO Logic Model: Planning a Surveillance System

Resources
- Staff
- Contractors (ONE)
- Data
- IT/PHIS
- Planning Consortium

Strategies
- Assess Health Data for CO Poisoning
  - Quality, magnitude, feasibility
  - Conduct pilot validation study
- Assess Power Outage Data
  - Sources (Power outage, TESS)
- Assess Data/Methods for Linkages
  - Sources (all relevant datasets)
- Assess Resources
  - BOH/Other
  - IPHS (HAN, FAMS)
- Assess Legislative Authority
  - Current
  - Future considerations
- Assess Ability to Respond to Events
  - Capacity to mount alert
  - Different levels of alerts
- Assess Prevention Messages
  - Future needs
- Knowledge/actions

Outputs
- Assessments Complete
- Feasibility Determined

Initial Outcomes
- Fully Feasible
  - Link power outage data and health data for enhanced surveillance system
- Partially Feasible
  - Power outage data NOT linked with health data
  - Standard CO surveillance system established

Intermediate Outcomes
- CO surveillance system implemented, maintained, and reviewed
- Communication & response plan developed and evaluated
- Public Health Action or Response
- Target population adopts appropriate behaviors
- CO surveillance system maintained
- Reduced morbidity and mortality associated with carbon monoxide exposure

Long Term Outcomes

Prepared By: Maine Center for Public Health
Revised: August 18, 2004
Data Sources

1. Morbidity
   - Maine hospital visits data

2. Mortality
   - Death certificate files

3. Knowledge and prevention behaviors
   - BRFSS

4. Qualitative information
   - Newspaper search engine
Data Sources: 1. Hospital visits

- Hospital billing records available electronically
  - Hospital discharge data
  - Emergency department
  - Hospital-based outpatient

- Reported quarterly
  - 12-18 month delay
## Data sources: Hospital visits

### DATA ELEMENTS INCLUDED:

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Diagnosis</th>
<th>Hospitalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age / DOB</td>
<td>Principal diagnosis (^1)</td>
<td>Admission date</td>
</tr>
<tr>
<td>Sex</td>
<td>Admitting diagnosis (^1)</td>
<td>Payer</td>
</tr>
<tr>
<td>Zipcode (Res.)*</td>
<td>Secondary diagnoses(1-9)(^1)</td>
<td>Source of admission</td>
</tr>
<tr>
<td>County (Res.)</td>
<td></td>
<td>Discharge Date</td>
</tr>
<tr>
<td>Encrypted medical record number</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DATA ELEMENTS NOT INCLUDED:

- Name
- Street address
- Race or ethnicity
Case Definition

- 1998 CSTE definition, for CO included:
  - Confirmed and probable cases
  - Maine residents

- We then excluded cases with E-codes indicating:
  - Fire-related
  - Intentional injury
Data Analysis

1. Measures of person, place and time

2. Methods to estimate work-place exposure
   Verification using a newspaper search

3. Comparison
   Disaster vs. non-disaster-related cases
Maine Hospital Visits Data, 1999 – 2003

- Total 740 cases identified;
  - 47 (6.4%) hospitalized
  - 693 (93.6%) in an outpatient setting
  - Subset of both seen in ED
    - = 442 (60%)
## Demographic Characteristics; 1999 – 2003

Average annual rates / 100,000

<table>
<thead>
<tr>
<th></th>
<th>OUT PATIENT</th>
<th>HOSPITALIZATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Crude Rate</td>
</tr>
<tr>
<td>All</td>
<td>693</td>
<td>10.8</td>
</tr>
<tr>
<td><strong>BY AGE GROUP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-17</td>
<td>140</td>
<td>9.6</td>
</tr>
<tr>
<td>18-34</td>
<td>233</td>
<td>17.4</td>
</tr>
<tr>
<td>35-64</td>
<td>290</td>
<td>10.8</td>
</tr>
<tr>
<td>&gt;=65</td>
<td>30</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>BY SEX</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>380</td>
<td>11.5</td>
</tr>
<tr>
<td>Female</td>
<td>313</td>
<td>10</td>
</tr>
</tbody>
</table>
CO Poisoning – Maine Outpatient data 1999 – 2003

* Orange line shows the three-month moving average
# CO Poisoning – Characterizing Exposure Source

## Frequency of Carbon Monoxide Exposure-related E-codes

Accidental poisoning by....

<table>
<thead>
<tr>
<th>E-code</th>
<th>OUT PATIENT</th>
<th>HOSPITALIZATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Any CO-related E-code</td>
<td>435 (62.8)</td>
<td>27 (57.5)</td>
</tr>
<tr>
<td>E868.2 : Motor vehicle gas exhaust</td>
<td>132 (19.1)</td>
<td>11 (23.4)</td>
</tr>
<tr>
<td>E868.3 : CO domestic fuel</td>
<td>85 (12.3)</td>
<td>4 (8.5)</td>
</tr>
<tr>
<td>E868.8 : CO other sources</td>
<td>90 (13.0)</td>
<td>8 (17.0)</td>
</tr>
</tbody>
</table>
CO Poisoning – Setting
(Included those aged 16 and older)

<table>
<thead>
<tr>
<th>Source of Setting Description</th>
<th>N = 577</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence</td>
<td>100</td>
<td>(17.3)</td>
</tr>
<tr>
<td>Work</td>
<td>77</td>
<td>(13.3)</td>
</tr>
<tr>
<td>Other (Specified)</td>
<td>37</td>
<td>(6.4)</td>
</tr>
<tr>
<td>Missing</td>
<td>363</td>
<td>(62.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E-code for Place of Occurrence (E849)</th>
<th>N = 577</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence</td>
<td>100</td>
<td>(17.3)</td>
</tr>
<tr>
<td>Work</td>
<td>77</td>
<td>(13.3)</td>
</tr>
<tr>
<td>Other (Specified)</td>
<td>37</td>
<td>(6.4)</td>
</tr>
<tr>
<td>Missing</td>
<td>363</td>
<td>(62.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Payer Code</th>
<th>N = 577</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worker's Compensation</td>
<td>77</td>
<td>(13.3)</td>
</tr>
<tr>
<td>Other</td>
<td>500</td>
<td>(86.7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Combined Payer Code And E-Code</th>
<th>N = 577</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work</td>
<td>133</td>
<td>(23.1)</td>
</tr>
<tr>
<td>Other</td>
<td>444</td>
<td>(77.0)</td>
</tr>
</tbody>
</table>
Using E-codes to Identify Work-related Cases – Is it valid?

- Online newspaper search
  - *ProQuest Information and Learning Company [Copyright © 2005]*
- Searched for occupational exposure events
  - Search criteria:
    - Major Maine newspapers
    - Articles with the words “carbon monoxide” in the text
    - 1999 through 2003
Using E-codes to Identify Work-related Cases – Is it valid?

- 3 occupational exposure events
- Searched hospital visits data for corresponding records
  - Time – 5-day window around the date
  - Place – facility within HSA
  - Patient age >=16
Case Verification for Approach

- Found cases in ED visits database
  - Range: 7 to 29 people / event

- Payer code for Worker’s Compensation:
  - 5% to 14%

- E-code for place (*Industrial place/premises*)
  - 58% to 96%
Maine, January 1998 ice storm
Outpatient visits for CO poisoning:

*RATE/1,000*
## Disaster vs. Non-disaster-related cases

**Comparison of Case Characteristics**

<table>
<thead>
<tr>
<th>Age group</th>
<th>Ice Storm 1/7 - 1/27/1998</th>
<th>N %</th>
<th>Non-ice storm 1999-2003</th>
<th>N %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;17</td>
<td>64 (23.3)</td>
<td></td>
<td>140 (20.2)</td>
<td></td>
</tr>
<tr>
<td>18-34</td>
<td>69 (25.1)</td>
<td></td>
<td>233 (33.6)</td>
<td></td>
</tr>
<tr>
<td>35-64</td>
<td>109 (39.6)</td>
<td></td>
<td>290 (41.9)</td>
<td></td>
</tr>
<tr>
<td>&gt;=65</td>
<td>33 (12.0)</td>
<td></td>
<td>30 (4.3)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>275</td>
<td></td>
<td>693</td>
<td></td>
</tr>
</tbody>
</table>

**Sex: Female**

<table>
<thead>
<tr>
<th></th>
<th>Ice Storm 1/7 - 1/27/1998</th>
<th>N %</th>
<th>Non-ice storm 1999-2003</th>
<th>N %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>170 (61.8)</td>
<td></td>
<td>313 (45.2)</td>
<td></td>
</tr>
</tbody>
</table>

*All P-values are <0.0001 based on CMH Chi-square tests*
### Disaster vs. Non-disaster-related cases

**Comparison of Exposure Characteristics**

<table>
<thead>
<tr>
<th>Exposure Setting</th>
<th>Ice Storm 1/7 - 1/27/1998</th>
<th>Non-ice storm 1999-2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work place*</td>
<td>4 (1.8)</td>
<td>133 (23.1)</td>
</tr>
<tr>
<td>Motor vehicle exhaust</td>
<td>17 (6.2)</td>
<td>132 (19.1)</td>
</tr>
<tr>
<td>Domestic fuel</td>
<td>78.0 (28.4)</td>
<td>85.0 (12.3)</td>
</tr>
</tbody>
</table>

*All P-values are <0.0001 based on CMH Chi-square tests*
BRFSS

- BRFSS – random digit dial survey
- 9 questions Module
  - CO monitor presence in household (3)
  - Generators (6)
    - Use
    - Placement
    - Ownership
BRFSS: Generator use

- Ever use a generator during a power outage?
  25.1% (95% CI: 23.2-26.9)

- Where was the generator usually placed when it is running?
  - Risk = in an attached or detached structure
  - Women were more likely then men
    - P = <0.0206
  - Especially during rain or snow
    - P = <0.0001
BRFSS: CO Detector in Household

■ Have a CO detector in the household?
  ◆ 33.0%
  ◆ > 95% have a smoke detector

■ Less likely to have a CO detector: \( P \leq 0.001 \)
  ◆ Older - 65+
  ◆ Lower income
  ◆ Female head of household
  ◆ Not married or living as a couple

■ More likely to have a CO detector: \( P \leq 0.001 \)
  ◆ Have children
  ◆ Own a generator
Limitations

- Lack of national standards for surveillance
  - National Workgroup on CO surveillance
- Data sources not designed for this use
- Health outcome only
- Comparability with other states
  - 90% of states have hospitalization
  - 50% ED
  - Few have other outpatient visits
Conclusions

- Conducting EPHT for CO poisoning is:
  - Feasible
  - Useful
  - Fills an existing PH gap

- Can track/describe person, place time
  - Conduct other useful analyses

- Can detect specific exposure events
  - Type and place of exposure event
Next Steps: Maine

- Incorporate poison control data
- Broader dissemination of results
- Educate public / policy makers
- Apply to prevention and control
  - Legislative CO detectors
  - Make CO a reportable condition
  - Issue health alerts to clinicians
    - During large-scale power outage
Next Steps: Nationally

- Continue working on surveillance standards
- Consider developing model legislation
  - Requirement for CO detectors
    - Residences
    - Work places
- Improve labeling on potential CO emitting devices
  - e.g. generators, boat engines