Improving Mortality Data

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Presented at *Panel Discussion on Future Directions for the U.S. Vital Statistics System: Mortality Data*
Session 32 at the 2010 National Conference on Health Statistics
Washington, DC, August 16-18, 2010
Objectives

General: To discuss improvements in data quality; analytic potentials of more timely data; and untapped synergies involving data linkages.

Specific: To discuss strengths and weaknesses of DVS’ mortality data pertaining to –
  • Panelists’ experience using these data; and
  • Panelists’ future research plans involving mortality data.

Panelists were asked to provide input on –
  • How the data and the data system (quality, processing, dissemination, etc.) can be improved upon;
  • Other potential uses of these data;
  • Other data systems within the context of linkages (merges) with mortality data; and
  • How these merged data might be used for research.
My Experience 1973–2010

In 1973, my colleagues and I became the first non-NCHS researchers with access to computerized multiple-cause of death (MCD) microdata files: CY 1969 ACME, N = 1,921,990.

Our recommendations at the 1975 NCHS mortality conference led to entity-axis and record-axis MCD coding, still in use today.

Relevant research areas –
- Underlying-cause and multiple-cause of death concepts and data
  - Total and cause-specific mortality
  - Mortality rates and trends
- Mapping cancer death rates by counties
- Linkages between morbidity and mortality, later extended to include disability
- Mortality endpoints for models of cancer initiation and promotion, with differential susceptibilities
### MCD Pairwise O/E Ratios

**Ratios of Observed to Expected Age-Standardized Joint Frequencies of Multiple Causes: Unisex Mortality 1998, Age 65+**

<table>
<thead>
<tr>
<th># Multiple Cause</th>
<th>1 Diseases of heart</th>
<th>2 Malignant neoplasms</th>
<th>3 Cerebrovascular diseases</th>
<th>4 ChrObstructivePulDis</th>
<th>5 Pneumonia and influenza</th>
<th>6 Diabetes mellitus</th>
<th>7 Suicide</th>
<th>8 Nephritis/Nephrosis</th>
<th>9 ChronLiverDis/Cirrhosis</th>
<th>10 Septicemia</th>
<th>11 Alzheimer's disease</th>
<th>12 Atherosclerosis</th>
<th>13 Hypertension</th>
<th>14 Aortic aneurysm</th>
<th>15 Residual causes</th>
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<td>Diseases of heart</td>
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<td>Suicide</td>
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<td>Septicemia</td>
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<td>Residual causes</td>
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<td>1.02</td>
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</table>
1. Diseases of Heart
3. Cerebrovascular Diseases

- Hypertension
- Atherosclerosis
- Diabetes mellitus
- Residual causes
- Pneumonia and influenza
- Diseases of heart
- Septicemia
- Alzheimer's disease
- Nephritis/Nephrosis
- Obstructive Pulmonary Diseases
- Aortic aneurysm
- Malignant neoplasms
- Chronic Liver Disease/Cirrhosis
- Suicide

Q/E Ratio
6. Diabetes Mellitus

O/E Ratio

Disease

1. Diseases of heart
2. Malignant neoplasms
3. Cerebrovascular diseases
4. ChrObstructivePulDis
5. Pneumonia and influenza
6. Septicemia
7. Suicide
8. Nephritis/Nephrosis
9. ChronLiverDis/Cirrhosis
10. Septicemia
11. Alzheimer's disease
12. Atherosclerosis
13. Hypertension
14. Aortic aneurysm
15. Residual causes
11. Alzheimer's Disease

Disease

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<th>O/E Ratio</th>
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<td>10. Septicemia</td>
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<td>6. Diabetes mellitus</td>
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</tr>
<tr>
<td>1. Diseases of heart</td>
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<td>14. Aortic aneurysm</td>
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<td>9. ChronLiverDis/Cirrhosis</td>
<td>0.50</td>
</tr>
<tr>
<td>7. Suicide</td>
<td>0.25</td>
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Cancer Death Rates by County

Empirical Bayes direct age-standardized death rates using special cancer mapping files prepared by the US EPA:

- 3,061 counties
- 18 age groups
- 2 sexes
- 2 races
- 31 cancer sites
Using Ordinary Age-Standardization

Figure 1. Direct Age-Standardized Death Rates (DASDR's) for Cancer of Kidney/Ureter per 100,000 Exposed Population According to County: U.S. White Males, 1970–1979. The frequency function in the lower left of the figure is a graph of the unweighted frequencies of the 3,061 county-specific DASDR's. The first tone bar below the graph indicates the range of the distribution (in units of $10^{-5}$) and the locations of the 75th, 90th, 95th, and 98th percentiles, as defined on the second tone bar. The arrowheads below the graph and below the second tone bar indicate the location of the national death rate (MASDR). The bar graph in the lower right is a graph of the age-specific death rates (in units of $10^{-5}$) for ages 35–39 to 85 years and older.
Figure 2. Empirical Bayes Age-Standardized Death Rates (EBASDR’s) for Cancer of Kidney/Ureter per 100,000 Exposed Population According to County: U.S. White Males, 1970–1979. The frequency function in the lower left of the figure is a graph of the unweighted frequencies of the 3,061 county-specific EBASDR’s. The first tone bar below the graph indicates the range of the distribution (in units of $10^{-5}$) and the locations of the 75th, 90th, 95th, and 98th percentiles, as defined on the second tone bar. The arrowheads below the graph and below the second tone bar indicate the location of the national death rate (MASDR). The bar graph in the lower right is a graph of the age-specific death rates (in units of $10^{-5}$) for ages 35–39 to 85 years and older.
Disabled Life Expectancy Beyond Age $x$ in Year $y$ (Sullivan, 1971)

$$e_{D,x,y} = \int_{0}^{\infty} t \pi_{x+t,y} d\pi_{x,y}$$

where

$$t \pi_{x,y} = \frac{l_{x+t,y}}{l_{x,y}}$$

and

$$\pi_{x+t,y} = \text{disability prevalence at age } x + t$$
<table>
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<th>Males</th>
<th></th>
<th>Females</th>
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<td>Life Expectancy</td>
<td>14.46</td>
<td>16.67</td>
<td>2.21</td>
<td>15.3%</td>
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<tr>
<td>ADL Expectancy</td>
<td>1.23</td>
<td>0.98</td>
<td>-0.25</td>
<td>-20.1%</td>
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</table>

Source: Authors’ calculations based on 1984 and 2004 NLTCS, 1984 life tables interpolated from 1980 and 1990 life tables in Bell and Miller (2005), and 2004 life tables from Social Security Online.
Joint Relative Survival at Ages 65+, Meets Any HIPAA Trigger, United States 2004, Males

Percentage Surviving vs. Age

- ADL&CI
- ADL
- CI
- Nondisabled

Age

Percentage Surviving

65 70 75 80 85 90 95 100
Joint Relative Survival at Ages 65+, Meets Any HIPAA Trigger, United States 2004, Females

- ADL&CI
- ADL
- CI
- Nondisabled
Survival Status One Year After Being Assessed for the HIPAA Disability Trigger, and Ratio of Actual to Expected Number of Deaths Assuming that the Nondisabled Death Rates Would Apply in the Absence of Disability, United States 2004, Age 65 and Above, by Age, Sex

<table>
<thead>
<tr>
<th>Meets HIPAA Disability Trigger¹</th>
<th>Status 1 Year After Assessment</th>
<th>Percent s.e.(Percent Dead</th>
<th>Expected A/E Ratio s.e.(A/E)</th>
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<tr>
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<td>Alive</td>
<td>Dead</td>
<td>Total</td>
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<tr>
<td>No</td>
<td>8,122,821</td>
<td>126,522</td>
<td>8,249,343</td>
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<tr>
<td>70-74</td>
<td>8,182,373</td>
<td>171,201</td>
<td>8,353,574</td>
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<tr>
<td>75-79</td>
<td>6,820,477</td>
<td>202,821</td>
<td>7,023,298</td>
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<tr>
<td>80-84</td>
<td>5,046,042</td>
<td>184,157</td>
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<td>85-89</td>
<td>2,425,234</td>
<td>177,691</td>
<td>2,602,925</td>
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<tr>
<td>90-94</td>
<td>883,445</td>
<td>68,289</td>
<td>951,734</td>
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<tr>
<td>95+</td>
<td>152,379</td>
<td>26,268</td>
<td>178,647</td>
</tr>
<tr>
<td>Total</td>
<td>31,632,770</td>
<td>956,949</td>
<td>32,589,719</td>
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</table>

<table>
<thead>
<tr>
<th>Yes</th>
<th>Alive</th>
<th>Dead</th>
<th>Total</th>
<th>Expected</th>
<th>A/E Ratio</th>
<th>s.e.(A/E)</th>
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<td>65-69</td>
<td>203,427</td>
<td>35,869</td>
<td>239,296</td>
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<tr>
<td>70-74</td>
<td>314,968</td>
<td>68,605</td>
<td>383,573</td>
<td>17.89%</td>
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<td>75-79</td>
<td>496,634</td>
<td>104,002</td>
<td>600,636</td>
<td>17.32%</td>
<td>2.73%</td>
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<td>80-84</td>
<td>604,920</td>
<td>193,728</td>
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<td>2.41%</td>
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<td>644,989</td>
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<td>2.01%</td>
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<td>90-94</td>
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<td>95+</td>
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<td>Total</td>
<td>2,800,044</td>
<td>855,563</td>
<td>3,655,606</td>
<td>23.40%</td>
<td>1.06%</td>
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</table>

Note 1: The HIPAA disability trigger requires 2+ ADL disabilities or severe cognitive impairment requiring substantial supervision.

Source: Author's calculations based on the 2004 NLTCS.
Cancer Compartment Models

Representative applications:


- Manville Trust asbestos claims data for mesothelioma and lung cancer (Stallard 2001; Stallard et al. 2005).
States and Transitions: Compartment Model of Asbestos-Related Disease Claims

Born in year \( y_b \)

- Dies before age \( a_0 \)
- Initial exposure to asbestos at age \( a_0 \) in year \( y_0 = y_b + a_0 \)
- Dies before age \( a_1 \)
- Diagnosis of asbestos-related disease at age \( a_1 \) in year \( y_1 = y_0 + a_1 - a_0 \)
- Dies before age \( a_2 \); no claim filed
- Files claim against Manville Trust at age \( a_2 \) in year \( y_2 = y_1 + a_2 - a_1 \)
  - Dies before age \( a_2 \); claim filed by estate in year \( y_2 \)
  - Dies at age \( a_3 > a_2 \) in year \( y_3 = y_1 + a_3 - a_1 \)
Mesothelioma Claims Model

For fixed $a$, $y$, and $t_0$; with $t > t_0$:

$$C_{a,y}^{y+t_0} = N_{a,y} \times Q_{a,y}^{t_0} \quad \text{and} \quad C_{a,y}^{y+t} = N_{a,y} \times Q_{a,y}^{t}$$

which implies that

$$C_{a,y}^{y+t} = C_{a,y}^{y+t_0} \times Q_{a,y}^{t} / Q_{a,y}^{t_0}$$
Qualified Male Mesothelioma Claims, 1990-1992, by R2 Occupation Group and Date of First Exposure
(Source: Authors' Calculations)
Estimated Number of Exposed Male Workers by Occupation and Date of Start of Exposure (Source: Authors' Calculations)
Future Research Plans Involving Mortality Data

Mortality is a major endpoint in my future research plans. For example –

1. NLTCS:
   - Currently linked to Medicare files, including vital statistics;
   - Also linked to VHA files, with healthcare information for services outside of the Medicare program;
   - NDI Plus linkage would provide MCD data to complement Medicare and VHA diagnoses of significant medical conditions.

2. Framingham Heart Study and Framingham Offspring Study data:
   - Longitudinal modeling of the development of major morbidity and mortality outcomes;
   - Currently compartmentalizing pre- and post-morbidity processes with endpoints/startpoints based on CHD, stroke, cancer, diabetes, hypertension disease and mortality;
   - Accurate tracking of mortality is essential.
Future Research Plans Involving Mortality Data

3. Alzheimer’s Disease Predictors Study:
   - Supplemented with population-based cohorts of Alzheimer’s patients
     - Incidence of Alzheimer’s among disease-free persons;
   - Longitudinal modeling of the progression of Alzheimer’s among newly diagnosed cases;
   - Need genetic markers and newly measured biomarkers;
   - Accurate tracking of mortality is essential.

4. Supplemented with data from: HRS, MCBS, SEER, HHS
References


Bell FC, Miller ML. “Life Tables for the United States Social Security Area 1900–2100.” Actuarial Study No. 120, Social Security Administration, 2005.


References


References
