

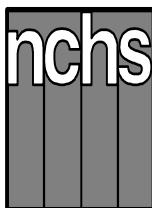
# **A GUIDE TO STATE IMPLEMENTATION OF ICD-10 FOR MORTALITY**

## **Part II: Applying Comparability Ratios**

National Center for Health Statistics

Centers for Disease Control and Prevention

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# **A GUIDE TO STATE IMPLEMENTATION OF ICD-10 FOR MORTALITY**

## **Part II: Applying Comparability Ratios**

National Center for Health Statistics  
Centers for Disease Control and Prevention

### **Introduction**

This is the second guide to implementing ICD-10 for mortality, and is a supplement to the guide distributed to the States on July 16, 1998, and available at the NCHS website [ftp://ftp.cdc.gov/pub/Health\\_Statistics/NCHS/Publications/ICD9\\_10Con/let2.doc](ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Publications/ICD9_10Con/let2.doc).

The first guide provided a general introduction to ICD-10, including the following topics:

Introduction to the International Classification of Diseases (ICD)

Implementation Activities

Tabulation Lists and Redesigning Publications

Developing Mortality Edits

Comparability Ratios and Conversion Tables

ICD-10 Computer Applications

ICD-10 Instruction Manuals

ICD-10 Training

NCHS Contact Persons

Appendices

Appendix I. Vital Statistics Instruction Manuals for Mortality Medical Coding

Appendix II. ICD-10 Super-MICAR Input Record Format

Appendix III. ICD-10 TRANSAX Output Record Format

Appendix IV. Summary of Changes in ICD-10/ICD-9 Record Formats

The purpose of this guide is to provide a description of the main concepts and methods associated with the recent implementation of the World Health Organization's (WHO) Tenth Revision of the International Classification of Diseases (ICD-10) for mortality in the United States (1). The guide focuses on issues of comparability between ICD-9(2) and ICD-10, including methods used to bridge discontinuities in trends of causes of death that result when changing from one classification system to the other. Emphasis is also placed on methods that allow for validly comparing rates across both classification systems.

This report was prepared mainly to address the needs for State health programs to effectively analyze and publish mortality trend data.

## General Concepts

### ICD Revisions

Since the beginning of the century the ICD for mortality has been modified about once every ten years, except for the twenty year interval between the last two revisions, ICD-9 and ICD-10, as shown below:

---

#### ICD IMPLEMENTATION DATES IN U.S.

Revision	Years in Effect
<b>First (ICD-1)</b>	<b>1900-1909</b>
<b>Second (ICD-2)</b>	<b>1910-20</b>
<b>Third (ICD-3)</b>	<b>1921-29</b>
<b>Fourth (ICD-4)</b>	<b>1930-38</b>
<b>Fifth (ICD-5)</b>	<b>1939-48</b>
<b>Sixth (ICD-6)</b>	<b>1949-57</b>
<b>Seventh (ICD-7)</b>	<b>1958-67</b>
<b>Eighth, Adapted (ICDA-8)</b>	<b>1968-78</b>
<b>Ninth (ICD-9)</b>	<b>1979-1998</b>
<b>Tenth (ICD-10)</b>	<b>1999-</b>

---

The rationale for the periodic revisions has been to reflect advances in medical science and changes in diagnostic terminology. Historically, the U.S. accepted the WHO versions of the ICD, except for the Eighth Revision, when the U.S. produced its own “adapted” version, which is symbolized by the “A” in ICDA-8. The U.S.’s rejection of the WHO version reflected principally disagreements on the content of the circulatory chapter. That changes in the ICD for mortality have been made only every ten to twenty years rather than annually promotes comparability over time in mortality trend data.

### Differences between ICD-10 and ICD-9

ICD-10 differs from ICD-9 in a number of respects: 1) ICD-10 is far more detailed than ICD-9; about 8,000 categories compared with 4,000 categories. The expansion was mainly to provide more clinical detail for morbidity applications; 2) ICD-10 uses 4-digit alphanumeric codes compared with 4-digit numeric codes in ICD-9; 3) three additional chapters have been added and some chapters rearranged; 4) cause-of-death titles have been changed, and conditions have been regrouped; 5) some coding rules have been changed. 6) Finally, ICD-10 is published in three volumes compared with two volumes in ICD-9.

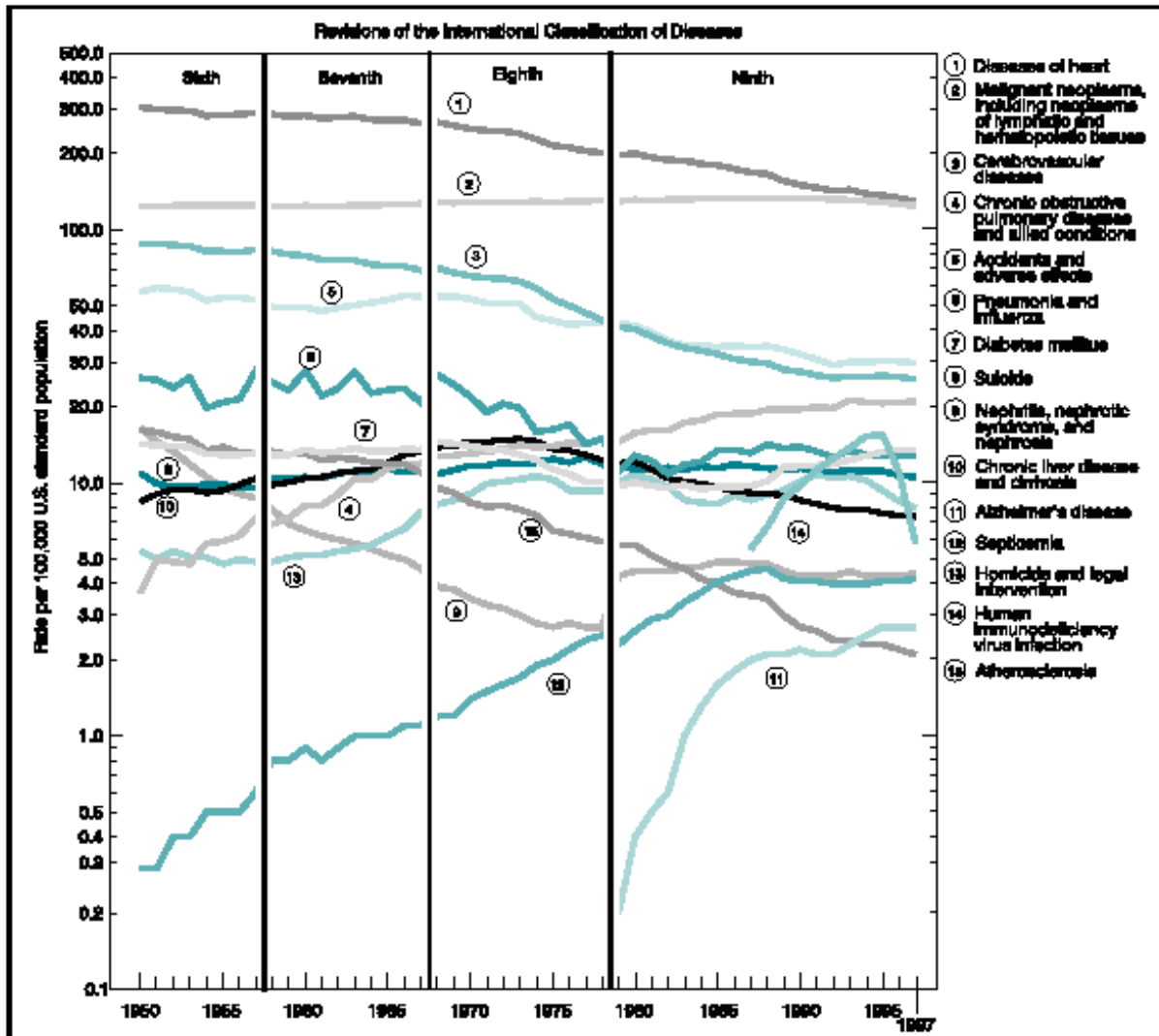
### Statistical Impact and Comparability

The introduction of a new revision of the ICD can create major discontinuities in trend data, as shown in Figure 1. Figure 1 shows trends in leading causes of death in the United States from 1950 to 1997 in terms of age-adjusted death rates. The lines on the chart are not continuous, but rather are broken by vertical lines that represent the introduction of a new revision of the ICD. Thus, ICD-9 was introduced in 1979. Further, the level of the rates is sometimes discontinuous between revisions. For example, a large discontinuity occurred between 1978 and 1979 in mortality for the 11th leading cause of death, “Nephritis, nephrotic syndrome, and nephrosis.” The rate for this cause in 1979 was over 70 percent higher than in the previous year, because of the introduction of ICD-9.

The extent of the discontinuity is measured using a “comparability ratio,” which results from double-coding a large sample of the national mortality file, once by the old revision (ICDA-8), and again by the new revision (ICD-9), and expressing the results of the comparison as a ratio of deaths for a cause of death by the later revision divided by the number of that cause of death coded and classified by the earlier revision. The national Comparability Study for ICD-9 was carried out using a sample of 137,000 deaths (and a special sample of 13,000 deaths for infants) occurring in 1976 (3). The ratios for 1976 were considered applicable to deaths occurring in 1978, and represent the break in trend resulting from introducing the new coding and classification system. The ratio for Nephritis is 1.74 indicating that 74 percent more deaths occurred from this cause in 1979 compared with 1978 only because of the introduction of ICD-9. The comparability ratio for Septicemia of 0.85 indicates that about 15 percent fewer deaths occurred in 1979 compared with 1978, because of the introduction of the new revision of the ICD.

For ICD-10, two sets of comparability ratios are being prepared: a preliminary set scheduled for early release based on a very large sample of deaths (in excess of 1.8 million records) occurring in 1996 that will accompany the publication of preliminary national mortality data for 1999, and a final set of comparability ratios based on the entire national mortality file of 1996 (over 2.3 million records) that will be published one year later. The final comparability ratios are expected to differ little from the preliminary ratios, but will permit calculation of state-specific ratios, cross tabulation by age and sex, and the use of more detailed tabulation lists than the standard ICD-10 tabulation list of 113 Selected Causes of Death (see Appendix I). Preliminary comparability ratios for ICD-10 are shown in a companion document to this Guide.

Figure 1. Age-adjusted death rates for the 15 leading causes of death: United States, 1950-97





### Tabulation Lists and Redesigning Publications

Mortality data for 1999 reflect the new cause-of-death classification system under ICD-10, which includes alphanumeric codes, new titles, and reorganized cause-of-death categories. For routine data presentation, NCHS has developed a total of eight new tabulation lists, the most detailed of which includes about 8,000 categories that are valid for underlying cause of death. These lists are published in *NCHS Instruction Manual Part 9*, "ICD-10 Cause-of-Death Lists for Tabulating Mortality Statistics, Effective 1999" (Hyattsville, Maryland, October 1997). Shown in Appendix I is the list that will be most widely used by NCHS, the ICD-10 List of 113 Selected Causes of Death, which corresponds to the ICD-9 List of 72 Selected Causes of Death, which has been in use since 1979. The 113 cause list is also used to identify and rank the leading causes of death in the U.S. Instruction manual *Part 9* can be downloaded from the NCHS Website at the following address:  
<http://www.cdc.gov/nchs/about/major/dvs/im.htm>

### Mortality Edits

*Instruction Manual Part 11*, Computer Edits for Mortality Data, Effective 1999, includes valid and invalid ICD-10 codes, cross edits, consistency edits for age and cause of death, consistency edits for sex and cause of death, rare causes, and edits for injuries (place of occurrence and activity). Instruction manual *Part 11* can also be downloaded from the NCHS Website described above.

## Statistical Methods for Trends in Mortality

Two issues arise in the analysis of mortality data across the boundary of ICD revisions:

1. data presentation and analysis
2. statistical tests to ascertain whether the change in mortality between the last years of the old revision and the first years of the new revision is a statistically significant change.

In terms of mortality data presentation by cause of death for 1999, NCHS will publish death rates for ICD-10 using the tabulation list of 113 Selected Causes of Death, and the list of 130 Selected Causes of Infant Death. These will be compared with rates for 1998 for the most nearly comparable ICD-9 titles (Appendices I and II) multiplied by the ICD-10 : ICD-9 comparability ratios, and called “comparability-modified death rates.” Also shown will be 1998 rates that are not comparability-modified.

The table below shows the most likely presentation of final 1998, comparability-modified final 1998, and preliminary 1999 deaths, death rates, and age-adjusted death rates for the 113 selected causes of death in the United States:

Cause of death (based on the Tenth Revision, International Classification of Diseases, 1992)	1999			1998							
	Number	Rate	Age-adjusted rate	Comparability-modified			Comparability-unmodified				
				Number	Rate	Age-adjusted rate	Number	Rate	Age-adjusted rate		

List of 113 selected causes of death

The second issue is determining whether the change in death rates between 1998 and 1999 was statistically significant, taking into account comparability. This is accomplished in a manner similar to statistical analysis of mortality trends within the same revision (4), but incorporating into the comparisons and the statistical tests explicit regard for comparability. This guide focuses on presenting methods for analyzing differences in mortality *between* revisions. The key difference is that the latter analysis must take explicitly into account comparability ratios that measure the quantitative impact of the new revisions on causes of death.

Formulas shown below address the general problem of evaluating differences between two population-based death rates estimated for successive years, between revisions of the ICD. Rates used throughout the guide are specific for cause of death. Rates computed using data from an initial year ( $R_1$ ) are assumed to be based on ICD-9, while those for the following year ( $R_2$ ) are assumed to be based on ICD-10. A **comparability ratio** ( $C$ ) measures the level of agreement between classification systems. A double-coding exercise using 1996 data provides these ratios, as well as estimates of their variability. The cause-specific comparability ratio will be applied to  $R_1$  to adjust for the change in the way these deaths were classified for the later revision compared with the earlier revision. In addition to 1998 mortality data, this factor ( $C$ ) should also be

applicable to at least 1994, 1995, 1996, 1997. The comparability ratio needs to be considered in statistical tests that compare the changes in rates from one year to a subsequent one between revisions.

In applying the formulas, distinctions are made for cases involving large (100 or more) and small (1-99) numbers of deaths. Formulas for constructing 95% Confidence Intervals for small numbers of deaths are crude approximations and resulting values should be interpreted with caution.

Lastly, because final numbers of deaths for 1999 were not available at the time of this document's distribution, the examples in this guide use fictitious numbers. Preliminary ICD-10 : ICD-9 comparability ratios from the double-coding exercise using 1996 data will be applied to these exercises.

*The Relative Standard Error (RSE) as Measure of the Variability of Statistics*

To be consistent with recent NCHS publications, the variability of most statistics is described in terms of the relative standard error (RSE). The general formula for obtaining (estimated) RSEs for a point-estimate,  $\theta$ , is the following:

**Formula 1: RSE general formula**

$$RSE(\hat{\theta}) = 100 \frac{S(\hat{\theta})}{\hat{\theta}}$$

where...

$S(\theta)$  = standard error of Theta

*Formulas for Age-specific and Crude Death Rates*

*RSE for Age-specific or Crude Death Rate*

The estimated RSE for an age-specific death rate or a crude death rate is given by the formula below:

**Formula 2: RSE for age-specific and crude death rates**

$$RSE(R) = RSE(D) = 100 \sqrt{\frac{1}{D}}$$

where...

$R$  = the cause-specific death rate produced by dividing the number of deaths attributed to a given cause at a given time by the population-at-risk for that same time period

$D$  = the estimated number of deaths due to a given cause on a given time

*Approximate 95% Confidence Limits for Age-specific and Crude Death Rates (100 or more deaths)*

The following procedures for constructing approximate 95% confidence intervals are ordered depending on whether the death rate was computed based on the recently introduced ICD-10 revision or on the previous (ICD-9) revision, respectively. The rate based on the ICD-9 revision is adjusted by the application of a cause-specific comparability ratio.

**Approximate 95% confidence interval for age-specific or crude death rate based on ICD-10 revision**

$$\text{Lower: } R_2 - 1.96 * S(R_2)$$

$$\text{Upper: } R_2 + 1.96 * S(R_2)$$

**Approximate 95% confidence interval for age-specific or crude death rate based on ICD-9 revision**

$$\text{Lower: } C \cdot R_1 - 1.96 * S(C \cdot R_1)$$

$$\text{Upper: } C \cdot R_1 + 1.96 * S(C \cdot R_1)$$

where...

$R_2$  = death rate (per 100,000) computed for data year under ICD-10

$C$  = ICD-10:ICD-9 comparability ratio specific for the cause-of-death of interest

$R_1$  = death rate (per 100,000) computed for data year under ICD-9

$$S(R_2) = R_2 \frac{RSE(R_2)}{100} = \text{standard error of rate based on ICD-10}$$

$$S(C \cdot R_1) = C \cdot R_1 \frac{RSE(C \cdot R_1)}{100} = \text{standard error of ICD-9 rate modified by a comparability ratio}$$

Note: The formula for  $RSE(C \cdot R_1)$  may be found as **Formula 5: RSE for each age-specific comparability ratio and death rate based on the ICD-9 revision** in the section dedicated to formulas for age-adjusted death rates. See page 17.

*Example of Procedure*

Let us suppose that the respective ICD-9 and ICD-10 death rates for a fictitious cause of death were 11.7 ( $R_1$ ) and 6.2 ( $R_2$ ) per 100,000 population. The ICD-10:ICD-9 comparability ratio ( $C$ ) obtained for this cause from a 1996 double-coding study was 1.060. Its standard error,  $S(C)$ , is 0.0096.

Assume that the numbers of deaths for this cause were 31,130 for ICD-9 and 16,516 for ICD-10. By inserting the number of deaths ( $D$ ) into **Formula 2**, we obtain the RSEs for both yearly rates: 0.5668 for the ICD-9 rate and 0.7781 for the ICD-10 rate [ $RSE(R_1)$  and  $RSE(R_2)$ , respectively]. Expressing variations as standard errors, we have  $S(R_1) = 0.0663$  and  $S(R_2) = 0.0482$ , respectively.

By inserting the comparability ratio and its standard error into **Formula 1**, we obtain  
 $RSE(C) = (0.0096 / 1.060) * 100 = 0.9057$ .

Since we wish to modify the ICD-9 rate ( $R_1$ ) to compensate for the difference in classification systems, we must multiply this rate times the comparability ratio;  $C \cdot R_1 = 12.40$ . To obtain the standard error of this modified ICD-9 rate,  $S(C \cdot R_1)$ , we must refer to **Formula 5**. This formula requires knowing the RSEs for the ICD-9 rate and for the comparability ratio. By substituting these values into the formula, we have that  $RSE(C \cdot R_1) = 1.0684$ . Again, we proceed to transform this  $RSE(C \cdot R_1)$  into a standard error:  $S(C \cdot R_1) = (C \cdot R_1) * [RSE(C \cdot R_1) / 100] = 0.1325$ .

Lower 95% confidence interval limit for  $C \cdot R_1 = 12.40 - (1.96 * 0.1325) = 12.14$ .

Upper 95% confidence interval limit for  $C \cdot R_1 = 12.40 + (1.96 * 0.1325) = 12.66$ .

Lower 95% confidence interval limit for  $R_2 = 6.2 - (1.96 * 0.0482) = 6.10$ .

Upper 95% confidence interval limit for  $R_2 = 6.2 + (1.96 * 0.0482) = 6.29$ .

*Approximate 95% Confidence Limits for Age-specific and Crude Death Rates (1 - 99 deaths)*

**Approximate 95% confidence interval for age-specific or crude death rate based on ICD-10 revision**

$$\text{Lower: } R_2 * L(1 - \alpha = .95, D_2)$$

$$\text{Upper: } R_2 * U(1 - \alpha = .95, D_2)$$

**Approximate 95% confidence interval for age-specific or crude death rate based on ICD-9 revision**

$$\text{Lower: } C \cdot R_1 * L(1 - \alpha = .96, D_1) \left( 1 - 2.576 \frac{RSE(C)}{100} \right)$$

$$\text{Upper: } C \cdot R_1 * U(1 - \alpha = .96, D_1) \left( 1 + 2.576 \frac{RSE(C)}{100} \right)$$

where...

$D_2$  = total number of deaths from ICD-10 file upon which rate is based

$D_1$  = total number of deaths from ICD-9 file upon which rate is based

$L(1 - \alpha = .96, D_1)$  and  $U(1 - \alpha = .95, D_2)$  are lower and upper confidence limit factors shown in Appendix III<sup>1</sup>

*Confidence Interval Test (one or both rates based on 1 - 99 deaths)*

To test for statistical significance of differences between rates based on small numbers of deaths, use the method of confidence interval overlap.

*Example of Procedure*

To develop a suitable example for the specific cases in which confidence intervals must be defined for rates that have been computed based on less than 100 deaths, we will refer to the previous example while modifying a few figures.

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<sup>1</sup> This table can also be found as Table N in the Vital Statistics of the United States: Mortality 1995 Technical Appendix. <http://www.cdc.gov/nchswww/data/techap95.pdf>

If we were to suppose that the numbers of deaths due to some fictitious cause were much smaller for ICD-9 and ICD-10, say  $D_1 = 40$  and  $D_2 = 50$ , respectively, then the rates<sup>2</sup> computed using the same population estimates would decrease likewise. Using these fictitious numbers,

$$R_1 = (40 / 265,283,783) * 100,000 = 0.0151 \text{ per } 100,000 \text{ population and}$$
$$R_2 = (50 / 267,636,061) * 100,000 = 0.0187 \text{ per } 100,000 \text{ population.}$$

The ICD-9 rate, when modified by the cause-specific comparability ratio, would be  $C \cdot R_1 = 1.060 * 0.0151 = 0.0160$ .

When working with “small” numbers of deaths, we must take into account special confidence limit factors that are based on the probability distribution of a Poisson variable. The figures necessary for this particular example may be found on the table “Lower and upper 95% and 96% confidence limit factors for a death rate based on a Poisson variable of 1 through 99 deaths, D or  $D_{adj}$ ” found in Appendix III:

$$L(1 - \alpha = .96, D_1 = 40) = 0.70266; U(1 - \alpha = .96, D_1 = 40) = 1.37991.$$

$$L(1 - \alpha = .95, D_2 = 50) = 0.74222; U(1 - \alpha = .95, D_2 = 50) = 1.31838.$$

These values, when substituted into the confidence-interval formulas, define the following upper and lower limits for the fictitious ICD-9 and ICD-10 modified and crude death rates, respectively.

$$\text{Lower 95\% confidence interval limit for } C \cdot R_1 = 0.0160 * (0.70266 * 0.9767) = 0.0110.$$

$$\text{Upper 95\% confidence interval limit for } C \cdot R_1 = 0.0160 * (1.37991 * 1.0233) = 0.0226.$$

$$\text{Lower 95\% confidence interval limit for } R_2 = 0.0187 * 0.74222 = 0.0139.$$

$$\text{Upper 95\% confidence interval limit for } R_2 = 0.0187 * 1.31838 = 0.0246.$$

Using the method of confidence interval overlap, one cannot reject the null hypothesis that the rates for ICD-9 and ICD-10 are the same.

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<sup>2</sup> The death counts used are illustrative; NCHS would round the following rates to 0.0 in presenting them officially.

Z-test for  $H_0: C \cdot R_1 - R_2 = 0$  (both rates based on 100 or more deaths)

We can transform the hypothesis test used for within-revision analyses ( $H_0: R_1 - R_2 = 0$ ) into a test that considers the use of a comparability ratio applied to ICD-9 death rates ( $H_0: C \cdot R_1 - R_2 = 0$ )...

**Formula 3: Z-test for  $H_0: C \cdot R_1 - R_2 = 0$**

$$Z = \frac{C \cdot R_1 - R_2}{\sqrt{C^2 \cdot R_1^2 \left[ \left( \frac{RSE(R_1)}{100} \right)^2 + \left( \frac{RSE(C)}{100} \right)^2 \cdot \left( 1 + \left[ \frac{RSE(R_1)}{100} \right]^2 \right) \right] + R_2^2 \left( \frac{RSE(R_2)}{100} \right)^2}}$$

where...

$C$  = ICD-10:ICD-9 comparability ratio for the specific cause category

$R_1, R_2$  = cause-specific death rates based on ICD-9 and ICD-10 years, respectively

$RSE(R_1)$  = relative standard error of the ICD-9 cause-specific death rate

$RSE(R_2)$  = relative standard error of the ICD-10 cause-specific death rate

$RSE(C)$  = relative standard error of the ICD-10:ICD-9 comparability ratio specific for the cause-of-death

### Example of Procedure

The ICD-9 and ICD-10 death rates for a given fictitious cause of death were 11.7 ( $R_1$ ) and 6.2 ( $R_2$ ) per 100,000 population. The ICD-10:ICD-9 cause-of-death comparability ratio ( $C$ ) obtained for this cause from a 1996 double-coding study was 1.060,  $S(C) = 0.0096$ .

The numbers of deaths for this cause were 31,130 for ICD-9 and 16,516 for ICD-10. By inserting the number of deaths ( $D$ ) attributed to the cause into **Formula 2**, we obtain the RSEs for both yearly rates: 0.5668 for the ICD-9 rate and 0.7781 for the ICD-10 rate [ $RSE(R_1)$  and  $RSE(R_2)$ , respectively].

By inserting the comparability ratio and its standard error into **Formula 1**, we obtain  $RSE(C) = (0.0096 / 1.060) * 100 = 0.9052$ .

All of these values (rates, RSEs and comparability ratio) will be substituted into **Formula 3**, the formula for the Z-test for  $H_0: C \cdot R_1 - R_2 = 0$ . The resulting Z statistic value may be looked up in any statistical table for probabilistic interpretation of the test results. In the present example,  $Z = 43.996$  (2-sided  $p < 0.0001$ ), meaning that we reject the hypothesis that the rates are the same.



Formulas for Age-adjusted<sup>3</sup> Death Rates

*RSE for Age-adjusted Death Rate*

The following formulas for computing RSEs are ordered depending on whether the death rate was based on the recently introduced ICD-10 revision or on the previous (ICD-9) revision, respectively. The rate based on the ICD-9 revision is adjusted by the application of a cause-specific comparability ratio.

For 1999 (ICD-10) age-adjusted death rates,  $R'_2$ , relative standard errors  $RSE(R'_2)$  may be computed using the following formula:

**Formula 4: RSE for age-adjusted death rates based on the ICD-10 revision**

$$RSE(R'_2) = 100 \frac{\sqrt{\sum w_i^2 \cdot R_{i2}^2 \left( \frac{1}{D_{i2}} \right)}}{R'_2}$$

where...

$R'_2$  = age-adjusted death rate for a specific cause of interest, based on ICD-10

$i$  = each age group

$R_{i2}$  = age-specific death rate for the  $i$ th age group (ICD-10 file)

$w_i$  =  $i$ th age-specific U.S. Standard Population weight such that  $\sum w_i = 1.000000$

$D_{i2}$  = number of deaths for the  $i$ th age group (ICD-10 file) attributed to the cause of interest

Assuming that we have both an age-specific rate and comparability ratio, we may proceed to compute the RSE for  $C_i R_{i1}$  **for each age group**. This is the first of two steps necessary for obtaining the RSE of an age-adjusted rate based on ICD-9 data that has been modified through a comparability ratio,  $R''_1$ .

**Formula 5: RSE for each age-specific comparability ratio and death rate based on the ICD-9 revision**

$$RSE(C_i R_{i1}) = 100 \sqrt{\left( \frac{RSE(R_{i1})}{100} \right)^2 + \left( \frac{RSE(C_i)}{100} \right)^2 \left( 1 + \left( \frac{RSE(R_{i1})}{100} \right)^2 \right)}$$

where...

$C_i$  = age-specific comparability ratio for the cause of interest

$R_{i1}$  = age-specific death rate for the  $i$ th age group (ICD-9 file)

Let  $R''_1 = \sum w_i C_i R_{i1}$ . The RSE for  $R''_1$  would incorporate all 11 values (corresponding to

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<sup>3</sup> The U.S. projected 2000 population is used as the standard population in the examples that follow.

each age group) computed through the previous formula.

**Formula 6: RSE for age-adjusted and comparability-modified death rates based on the ICD-9 revision**

$$RSE(R''_1) = 100 \frac{\sqrt{\sum \left( w_i^2 (C_i R_{il})^2 \cdot \left( \frac{RSE(C_i R_{il})}{100} \right)^2 \right)}}{R''_1}$$

where...

$R''_1$  = age-adjusted death rate for a specific cause of interest, based on ICD-9 data and modified by a comparability ratio

*Approximate 95% Confidence Limits for Age-adjusted Death Rates (100 or more deaths)*

The following procedures for constructing approximate 95% confidence intervals are ordered depending on whether the age-adjusted death rate was computed based on the recently introduced ICD-10 revision or on the previous (ICD-9) revision, respectively. The rate based on the ICD-9 revision is adjusted by the application of a cause-specific comparability ratio.

**Approximate 95% confidence interval for age-adjusted death rate based on ICD-10 revision**

$$\begin{aligned} \text{Lower: } & R'_2 - 1.96 * S(R'_2) \\ \text{Upper: } & R'_2 + 1.96 * S(R'_2) \end{aligned}$$

**Approximate 95% confidence interval for age-adjusted and comparability-modified death rate based on ICD-9 revision**

$$\begin{aligned} \text{Lower: } & R''_1 - 1.96 * S(R''_1) \\ \text{Upper: } & R''_1 + 1.96 * S(R''_1) \end{aligned}$$

where...

$$S(R'_2) = R'_2 * \frac{RSE(R'_2)}{100} = \text{standard error of age-adjusted rate based on ICD-10}$$

$$S(R''_1) = R''_1 * \frac{RSE(R''_1)}{100} = \text{standard error of ICD-9 age-adjusted rate modified by a comparability ratio}$$

### *Example of Procedure*

For these procedures involving age-adjusted rates, it is assumed that researchers have age-specific data.

To develop this example, we incorporate preliminary age-specific comparability ratios to the data for ICD-9 and ICD-10. Also, the new standard U.S. population (projected year 2000 population of the U.S.) is used for all examples of age-adjusted formulas.

We shall use death rates for some fictitious cause of death for ICD-9 and ICD-10, for eleven age groups. The fictitious ICD-9 age-specific deaths, death rates and preliminary comparability ratios are presented in table I, along with the Standard U.S. population weights and other necessary calculated figures.

As previously defined,  $R''_i = \sum w_i C_i R_{ii}$ . So, by multiplying the age-specific weights, comparability ratios and death rates, and adding up the products, we arrive at the age-adjusted and comparability-modified ICD-9 death rate for the given cause. Here,  $R''_i = 12.38$  per 100,000 standard population.

It is also necessary to compute the variability of this rate. The 9<sup>th</sup> column of table I (RSE of C·R) was obtained by applying **Formula 5** to each age row. Adding up (per age group) these and other elements found on the table according to **Formula 6** results in an estimate of the RSE for the age-adjusted and comparability-modified ICD-9 rate,  $R''_i$ . On this particular example,  $RSE(R''_i) = 1.0722$ . When expressed as a standard error,  $S(R''_i) = 0.1327$ .

Lower 95% confidence interval limit for  $R''_i = 12.38 - (1.96 * 0.1327) = 12.12$ .

Upper 95% confidence interval limit for  $R''_i = 12.38 + (1.96 * 0.1327) = 12.64$ .

**Table I- Deaths, death rates, populations, comparability ratios and age-specific relative standard errors for a fictitious cause of death (ICD-9), by age.**

Age group	1	2	3	4	5	6	7	8	9
	ICD-10:ICD-9 age-specific comparability ratio	RSE of age-group-specific comparability ratio	Deaths	Estimated population	ICD-9 age-specific death rate	RSE of age-specific death rate	Proportionate distribution of U.S. population year 2000	RSE of C*R	
under 1 year	0.95833	29.1797	40	3,769,485	1.1	15.8114	0.013818	33.5073	
1-4 years	1.06452	14.4408	147	15,516,482	0.9	8.2479	0.055317	16.6728	
5-14 years	1.02679	13.2756	177	38,422,227	0.5	7.5165	0.145565	15.2884	
15-24 years	1.01577	7.9121	413	36,221,881	1.1	4.9207	0.138646	9.3256	
25-34 years	1.04717	1.7740	8048	40,368,234	19.9	1.1147	0.135573	2.0952	
35-44 years	1.05993	1.3685	13637	43,393,341	31.4	0.8563	0.162613	1.6143	
45-54 years	1.07591	2.0087	6259	32,369,791	19.3	1.2640	0.134834	2.3734	
55-64 years	1.07727	3.8034	1794	21,361,460	8.4	2.3610	0.087247	4.4775	
65-74 years	1.07732	7.0496	503	18,669,337	2.7	4.4588	0.066037	8.3472	
75-84 years	1.09231	17.1665	87	11,429,984	0.8	10.7211	0.044842	20.3229	
85 years and over	1	35.3553	18	3,761,561	0.5	23.5702	0.015508	43.3013	

**Table I- Deaths, death rates, populations, comparability ratios and age-specific relative standard errors for a fictitious cause of death (ICD-9), by age –Con.**

Age group	$w^2(C \cdot R)^2 \cdot \left( \frac{RSE(C \cdot R)}{100} \right)^2$
under 1 year	0.014052
1-4 years	0.055787
5-14 years	0.068854
15-24 years	0.160576
25-34 years	2.830340
35-44 years	5.416618
45-54 years	2.805049
55-64 years	0.789344
65-74 years	0.191678
75-84 years	0.037282
85 years and over	0.007421

Constructing a confidence interval for the age-adjusted death rate of the following year,  $R'_2$ , also requires performing operations on age-specific figures for that year. Table II shows ICD-10 age-specific deaths and death rates for the given fictitious cause of death. The estimated U.S. population for the ICD-10 year is also included.

**Table II-** Deaths, death rates and populations for a fictitious cause of death (ICD-10), by age.

Age group	Deaths	Estimated population	Proportionate distribution of U.S. population year 2000	ICD-10 age-specific death rate	1/Deaths	$w^2 \cdot R^2 \cdot \left(\frac{1}{D}\right)$
1	2	3	4	5	6	7
under 1 year	19	3,796,593	0.013818	0.5	0.0526	0.00000252
1-4 years	54	15,353,002	0.055317	0.4	0.0185	0.00000701
5-14 years	102	38,778,068	0.145565	0.3	0.0098	0.00001437
15-24 years	276	36,579,724	0.138646	0.8	0.0036	0.00003965
25-34 years	3993	39,609,511	0.135573	10.1	0.0003	0.00046779
35-44 years	7073	43,997,928	0.162613	16.1	0.0001	0.00096616
45-54 years	3513	33,632,634	0.134834	10.4	0.0003	0.00056462
55-64 years	1065	21,812,990	0.087247	4.9	0.0009	0.00017038
65-74 years	336	18,498,550	0.066037	1.8	0.0030	0.00004282
75-84 years	72	11,705,713	0.044842	0.6	0.0139	0.00001057
85 years and over	7	3,871,348	0.015508	0.2	0.1429	0.00000112

Applying the U.S. Standard Population (year 2000 projected) weights to the age-specific death rates yields the age-adjusted ICD-10 death rate of  $R'_2 = 6.13$  per 100,000 standard population. To produce  $RSE(R'_2)$ , we must substitute age-specific weights, rates and deaths into **Formula 4**. The resulting  $RSE(R'_2) = 0.7795$ ; expressed as standard error,  $S(R'_2) = 0.0478$ .

Lower 95% confidence interval limit for  $R'_2 = 6.13 - (1.96 * 0.0478) = 6.04$ .

Upper 95% confidence interval limit for  $R'_2 = 6.13 + (1.96 * 0.0478) = 6.23$ .

*Approximate 95% Confidence Limits for Age-adjusted Death Rates (1 - 99 deaths)*

Constructing a 95% confidence interval for  $R'_2$ , the age-adjusted death rate based on ICD-10 data, requires the following three steps:

$$\text{Let } R'_2 = \sum w_i R_{i2}$$

Step 1: Compute  $RSE(R'_2)$  using **Formula 4: RSE for age-adjusted death rates based on the ICD-10 revision**

Step 2: Approximate pseudo- $D_{adj-2}$  (round to integer)

**Formula 7: pseudo-number of deaths for the ICD-10 rate**

$$D_{adj-2} = \frac{1}{\left[ \frac{RSE(R'_2)}{100} \right]^2}$$

Step 3: Use...

**Approximate 95% confidence interval for age-adjusted death rate based on ICD-10 revision**

$$\text{Lower: } R'_2 \cdot L(1 - \alpha = .95, D_{adj-2})$$

$$\text{Upper: } R'_2 \cdot U(1 - \alpha = .95, D_{adj-2})$$

where...

$R'_2$  = the age-adjusted death rate based on ICD-10 data

$D_{adj-2}$  = pseudo number of deaths (on the ICD-10 file) for a given cause of interest computed to facilitate standard error estimation for the ICD-10 rate

$L(1 - \alpha = .95, D_{adj-2})$  and  $U(1 - \alpha = .95, D_{adj-2})$  are, respectively, lower and upper 95% confidence limit factors shown in Appendix III.

To construct an approximate 95% Confidence Interval for  $R''_1$ , the age-adjusted and comparability-modified death rate based upon 1998 (ICD-9) data with small  $D_i$ 's, we follow a similar procedure:

$$\text{Let } R''_1 = \sum w_i C_i R_{i1}$$

Step 1: Use Formula 6 to compute  $RSE(R''_1)$

Step 2: Compute pseudo- $C_{adj} = \sum w_i C_i$ . Compute its RSE.

**Formula 8: RSE of pseudo-comparability ratio**

$$RSE(C_{adj}) = 100 \frac{\sqrt{\sum \left( w_i^2 C_i^2 \cdot \left[ \frac{RSE(C_i)}{100} \right]^2 \right)}}{C_{adj}}$$

Step 3: Compute pseudo- $D_{adj-1} =$  smaller of  $\sum D_{i1}$  or...

**Formula 9: pseudo-number of deaths for the modified ICD-9 rate**

$$D_{adj-1} = \frac{1 + \left( \frac{RSE(C_{adj})}{100} \right)^2}{\left( \frac{RSE(R''_1)}{100} \right)^2 - \left( \frac{RSE(C_{adj})}{100} \right)^2}$$

If this value is negative, then set  $D_{adj-1}$  to  $\sum D_{i1}$ .

Step 4: Use...

**Approximate 95% confidence interval for age-adjusted and comparability-modified death rate based on ICD-9 revision**

$$\text{Lower: } R''_1 \cdot L(1-\alpha=.95, D_{adj-1})$$

$$\text{Upper: } R''_1 \cdot U(1-\alpha=.95, D_{adj-1})$$

where...

$C_{adj}$  = pseudo-comparability ratio computed to facilitate standard error estimation

$D_{adj-1}$  = pseudo-number of deaths expected (on the ICD-9 file) for a given cause of interest computed to facilitate standard error estimation

$\sum D_{i1}$  = sum of age-specific deaths (on the ICD-9 file), for a given cause of interest

To test for statistical significance of differences among rates computed upon small numbers of deaths, use the method of confidence interval overlap.

*Example of Procedure*

For the proper development of examples focusing on age-adjusted rates that are based on small (1 - 99) numbers of deaths, we shall replace the age-specific numbers of deaths and populations that we used on previous examples for ICD-9 and ICD-10 with smaller numbers to illustrate the procedures.

Following the procedure described for the construction of confidence intervals for  $R''_1$  when the numbers of deaths are small, we may notice that first we should compute the values for  $C_{adj_1} = \sum w_i C_i$  and for  $RSE(C_{adj_1})$  using **Formula 8: RSE of pseudo-comparability ratio**. Table III shows fictitious ICD-9 deaths with age-specific death rates,  $R_{il}$ , their RSEs, and other figures.

According to the definition of an age-adjusted and comparability-modified death rate for the former ICD revision,  $R''_1 = \sum w_i C_i R_{il}$ . In the present example dealing with small numbers of deaths,  $R''_1 = 4.46$  per 100,000 standard population. The value for  $C_{adj_1}$  can be found by multiplying the age-specific standard population weights,  $w_i$ , times each age-specific comparability ratio,  $C_i$ , and then adding up the products across the age groups. For this example,  $C_{adj_1} = 1.0514$ ;  $RSE(C_{adj_1}) = 15.81$ .

The next step consists of selecting the smallest (non-negative) possible value for  $D_{adj_1}$ . The options are  $D_{adj_1} = \sum D_{i1}$  and the resulting value of **Formula 9**. The resulting options for  $D_{adj_1}$  for this example are 95 and -105.8, respectively. Given that the latter value is negative, 95 is then selected for  $D_{adj_1}$ . We shall use this value to look up  $L(1 - \alpha = .95, D_{adj_1})$  and  $U(1 - \alpha = .95, D_{adj_1})$  in Appendix III.

$$L(1 - \alpha = .95, D_{adj_1} = 95) = 0.80906; U(1 - \alpha = .95, D_{adj_1} = 95) = 1.22245.$$

$$\text{Lower 95\% confidence interval limit for } R''_1 = 4.46 * 0.80906 = 3.61.$$

$$\text{Upper 95\% confidence interval limit for } R''_1 = 4.46 * 1.22245 = 5.45.$$



**Table III-** Deaths, death rates, populations, comparability ratios and age-specific relative standard errors for a fictitious cause of death (ICD -9), by age.

Age group	1	2	3	4	5	6	7	8	9
	ICD-10:ICD-9 age-group-specific comparability ratio	RSE of age-group-specific comparability ratio	Deaths	Estimated population	ICD-9 age-specific death rate	RSE of age-specific death rate	Proportionate distribution of U.S. population year 2000	RSE of C*R	
under 1 year	0.95833	29.1797	1	27,912	3.6	100.0000	0.013818	108.1800	
1-4 years	1.06452	14.4408	1	135,028	0.7	100.0000	0.055317	102.0641	
5-14 years	1.02679	13.2756	1	359,577	0.3	100.0000	0.145565	101.7471	
15-24 years	1.01577	7.9121	1	332,952	0.3	100.0000	0.138646	100.6241	
25-34 years	1.04717	1.7740	1	372,850	0.3	100.0000	0.135573	100.0315	
35-44 years	1.05993	1.3685	2	405,139	0.5	70.7107	0.162613	70.7305	
45-54 years	1.07591	2.0087	3	296,959	1.0	57.7350	0.134834	57.7816	
55-64 years	1.07727	3.8034	20	179,855	11.1	22.3607	0.087247	22.6978	
65-74 years	1.07732	7.0496	30	180,121	16.7	18.2574	0.066037	19.6134	
75-84 years	1.09231	17.1665	25	90,157	27.7	20.0000	0.044842	26.5796	
85 years and over	1	35.3553	10	35,904	27.9	31.6228	0.015508	48.7340	

**Table III-** Deaths, death rates, populations, comparability ratios and age-specific relative standard errors for a fictitious cause of death (ICD -9), by age –Con.

Age group	$w^2(C \cdot R)^2 \cdot \left( \frac{RSE(C \cdot R)}{100} \right)^2$
under 1 year	0.002634
1-4 years	0.001981
5-14 years	0.001789
15-24 years	0.001812
25-34 years	0.001451
35-44 years	0.003622
45-54 years	0.007171
55-64 years	0.056277
65-74 years	0.054011
75-84 years	0.130329
85 years and over	0.044309

Table IV shows fictitious ICD-10 deaths for the same given cause of death.

**Table IV-** Deaths, death rates and populations for a fictitious cause of death (ICD-10), by age.

Age group	Deaths	Estimated population	Proportionate distribution of U.S. population year 2000	ICD-10 age-specific death rate	1/Deaths	$w^2 \cdot R^2 \cdot \left(\frac{1}{D}\right)$
1	2	3	4	5	6	7
under 1 year	1	37,965	0.013818	2.6	1.0000	0.00132472
1-4 years	1	153,530	0.055317	0.7	1.0000	0.00129817
5-14 years	1	387,780	0.145565	0.3	1.0000	0.00140910
15-24 years	1	365,797	0.138646	0.3	1.0000	0.00143660
25-34 years	1	396,095	0.135573	0.3	1.0000	0.00117151
35-44 years	2	439,979	0.162613	0.5	0.5000	0.00273197
45-54 years	5	336,326	0.134834	1.5	0.2000	0.00803615
55-64 years	21	218,129	0.087247	9.6	0.0476	0.03359646
65-74 years	27	184,985	0.066037	14.6	0.0370	0.03440847
75-84 years	25	117,057	0.044842	21.4	0.0400	0.03668725
85 years and over	12	38,713	0.015508	31.0	0.0833	0.01925658

Substituting these small numbers into the formulas for the ICD-10 age-adjusted death rate,  $R'_2$ , and relative standard error  $RSE(R'_2)$ , we come up with the following results:  $R'_2 = 3.70$ ,  $RSE(R'_2) = 10.1651$ .

According to **Formula 7**,  $D_{adj,2} = 96.78$  (rounded up to  $D_{adj,2} = 97$ ). We shall then use this number to look up the appropriate confidence limit factors in Appendix III.

$$L(1 - \alpha = .95, D_{adj,2} = 97) = 0.81093; U(1 - \alpha = .95, D_{adj,2} = 97) = 1.21992.$$

$$\text{Lower 95\% confidence interval limit for } R'_2 = 3.70 * 0.81093 = 3.00.$$

$$\text{Upper 95\% confidence interval limit for } R'_2 = 3.70 * 1.21992 = 4.51.$$

Z-test for  $H_0: R''_1 - R'_2 = 0$  (both rates based on 100 or more deaths)

The results from **Formula 4** and **Formula 6** would be used as variability estimates to compute a Z value to test our original hypothesis  $H_0: R''_1 - R'_2 = 0$ .

**Formula 10: Z-test for  $H_0: R''_1 - R'_2 = 0$**

$$Z = \frac{R''_1 - R'_2}{\sqrt{R''_1{}^2 \left( \frac{RSE(R''_1)}{100} \right)^2 + R'_2{}^2 \left( \frac{RSE(R'_2)}{100} \right)^2}}$$

#### *Example of Procedure*

Refer to the example on page 20 and assume the same data found in tables I and II. The difference between the age-adjusted rates,  $R''_1 - R'_2$ , results in 6.239 per 100,000. To test whether this difference is significantly different from zero, we perform the Z-test described above. By substituting 1.0721 and 0.7795 for  $RSE(R''_1)$  and  $RSE(R'_2)$ , respectively, we can compute a Z statistic. In this particular example,  $Z = 44.26$ . We reject the null hypothesis, two-sided  $p < 0.0001$ , and conclude that the rates are different.

## References

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**APPENDIX I: LIST OF 113 SELECTED CAUSES OF DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
	All causes.....	
1#	Salmonella infections.....	A01-A02 (002-003)
2#	Shigellosis and amebiasis.....	A03,A06 (004,006)
3	Certain other intestinal infections.....	A04,A07-A09 (007-009)
#	Tuberculosis.....	A16-A19 (010-018)
4	Respiratory tuberculosis.....	A16 (010-012)
5	Other tuberculosis.....	A17-A19 (013-018)
6#	Whooping cough.....	A37 (033)
7#	Scarlet fever and erysipelas.....	A38,A46 (034.1-035)
8#	Meningococcal infection.....	A39 (036)
9#	Septicemia.....	A40-A41 (038)
10#	Syphilis.....	A50-A53 (090-097)
11#	Acute poliomyelitis.....	A80 (045)
12#	Arthropod-borne viral encephalitis.....	A83-A84,A85.2 (062-064)
13#	Measles.....	B05 (055)
14#	Viral hepatitis.....	B15-B19 (070)
15#	Human immunodeficiency virus (HIV) disease.....	B20-B24 (042-044)
16#	Malaria.....	B50-B54 (084)

**APPENDIX I: LIST OF 113 SELECTED CAUSES OF DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
17	Other and unspecified infectious and parasitic diseases and their sequelae .....A00,A05,A20-A36,A42-A44,A48-A49,A54-A79, A81-A82,A85.0-A85.1,A85.8,A86-B04,B06-B09,B25-B49,B55-B99 (001,005,020-032,037,039-041,046-054,056-061,065-066,071-083,085-088,098-134,136-139,771.3)	
#	Malignant neoplasms.....	C00-C97 (140-208)
18	Malignant neoplasms of lip, oral cavity and pharynx.....	C00-C14 (140-149)
19	Malignant neoplasm of esophagus.....	C15 (150)
20	Malignant neoplasm of stomach.....	C16 (151)
21	Malignant neoplasms of colon, rectum and anus.....	C18-C21 (153-154)
22	Malignant neoplasms of liver and intrahepatic bile ducts.....	C22 (155)
23	Malignant neoplasm of pancreas.....	C25 (157)
24	Malignant neoplasm of larynx.....	C32 (161)
25	Malignant neoplasms of trachea, bronchus and lung.....	C33-C34 (162)
26	Malignant melanoma of skin.....	C43 (172)
27	Malignant neoplasm of breast.....	C50 (174-175)
28	Malignant neoplasm of cervix uteri.....	C53 (180)
29	Malignant neoplasms of corpus uteri and uterus, part unspecified.....	C54-C55 (179,182)
30	Malignant neoplasm of ovary.....	C56 (183.0)
31	Malignant neoplasm of prostate.....	C61 (185)
32	Malignant neoplasms of kidney and renal pelvis.....	C64-C65 (189.0-189.1)
33	Malignant neoplasm of bladder.....	C67 (188)

**APPENDIX I: LIST OF 113 SELECTED CAUSES OF DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
34	Malignant neoplasms of meninges, brain and other parts of central nervous system.....	C70-C72 (191-192)
	Malignant neoplasms of lymphoid, hematopoietic and related tissue.....	C81-C96 (200-208)
35	Hodgkin's disease.....	C81 (201)
36	Non-Hodgkin's lymphoma.....	C82-C85 (200,202)
37	Leukemia.....	C91-C95 (204-208)
38	Multiple myeloma and immunoproliferative neoplasms.....	C88,C90 (203)
39	Other and unspecified malignant neoplasms of lymphoid, hematopoietic and related tissue.....	C96 (???)
40	All other and unspecified malignant neoplasms.....	C17,C23-C24,C26-C31, C37-C41,C44-C49,C51-C52,C57-C60,C62-C63,C66,C68-C69,C73-C80,C97 (152,156,158-160,163-171,173,181,183.2-184,186-187,189.2-190,193-199)
41#	In situ neoplasms, benign neoplasms and neoplasms of uncertain or unknown behavior.....	D00-D48 (210-239)
42#	Anemias.....	D50-D64 (280-285)
43#	Diabetes mellitus.....	E10-E14 (250)
#	Nutritional deficiencies.....	E40-E64 (260-269)
44	Malnutrition.....	E40-E46 (260-263)
45	Other nutritional deficiencies.....	E50-E64 (264-269)
46#	Meningitis.....	G00,G03 (320-322)
47#	Parkinson's disease.....	G20-G21 (332)
48#	Alzheimer's disease.....	G30 (331.0)

**APPENDIX I: LIST OF 113 SELECTED CAUSES OF DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
	Major cardiovascular diseases.....	I00-I78 (390-434,436-448)
#	Diseases of heart.....	I00-I09,I11,I13,I20-I51 (390-398,402,404,410-429)
49	Acute rheumatic fever and chronic rheumatic heart diseases.....	I00-I09 (390-398)
50	Hypertensive heart disease.....	I11 (402)
51	Hypertensive heart and renal disease.....	I13 (404)
	Ischemic heart diseases.....	I20-I25 (410-414,429.2)
52	Acute myocardial infarction.....	I21-I22 (410)
53	Other acute ischemic heart diseases.....	I24 (411)
	Other forms of chronic ischemic heart disease.....	I20,I25 (412-414,429.2)
54	Atherosclerotic cardiovascular disease, so described.....	I25.0 (429.2)
55	All other forms of chronic ischemic heart disease.....	I20,I25.1-I25.9 (412-414)
	Other heart diseases.....	I26-I51 (415-429.1,429.3-429.9)
56	Acute and subacute endocarditis.....	I33 (421)
57	Diseases of pericardium and acute myocarditis.....	I30-I31,I40 (420,422-423)
58	Heart failure.....	I50 (428)
59	All other forms of heart disease.....	I26-I28,I34-I38,I42-I49,I51 (415-417,424-427,429.0-429.1,429.3-429.9)
60#	Essential (primary) hypertension and hypertensive renal disease.....	I10,I12 (401,403)
61#	Cerebrovascular diseases.....	I60-I69 (430-434,436-438)
62#	Atherosclerosis.....	I70 (440)



**APPENDIX I: LIST OF 113 SELECTED CAUSES OF DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
	Other diseases of circulatory system.....	I71-I78 (441-448)
63#	Aortic aneurysm and dissection.....	I71 (441)
64	Other diseases of arteries, arterioles and capillaries.....	I72-I78 (442-448)
65	Other disorders of circulatory system.....	I80-I99 (451-459)
#	Influenza and pneumonia.....	J10-J18 (480-487)
66	Influenza.....	J10-J11 (487)
67	Pneumonia.....	J12-J18 (480-486)
	Other acute lower respiratory infections.....	J20-J22 (466)
68#	Acute bronchitis and bronchiolitis.....	J20-J21 (466)
69	Unspecified acute lower respiratory infection.....	J22 (?)
#	Chronic lower respiratory diseases.....	J40-J47 (490-494,496)
70	Bronchitis, chronic and unspecified.....	J40-J42 (490-491)
71	Emphysema.....	J43 (492)
72	Asthma.....	J45-J46 (493)
73	Other chronic lower respiratory diseases.....	J44, J47 (494,496)
74#	Pneumoconioses and chemical effects.....	J60-J66, J68 (500-506)
75#	Pneumonitis due to solids and liquids.....	J69 (507)
76	Other diseases of respiratory system.....	J00-J06, J30-J39, J67, J70-J98 (034.0, 460-465, 470-478, 495, 508-519)
77#	Peptic ulcer.....	K25-K28 (531-534)

**APPENDIX I: LIST OF 113 SELECTED CAUSES OF DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
78#	Diseases of appendix.....	K35-K38 (540-543)
79#	Hernia.....	K40-K46 (550-553)
#	Chronic liver disease and cirrhosis.....	K70,K73-K74 (571)
80	Alcoholic liver disease.....	K70 (571.0-571.3)
81	Other chronic liver disease and cirrhosis.....	K73-K74 (571.4-571.9)
82#	Cholelithiasis and other disorders of gallbladder.....	K80-K82 (574-575)
#	Nephritis, nephrotic syndrome and nephrosis.....	N00-N07,N17-N19,N25-N27 (580-589)
83	Acute and rapidly progressive nephritic and nephrotic syndrome.....	N00-N01,N04 (580-581)
84	Chronic glomerulonephritis, nephritis and nephropathy not specified as acute or chronic, and renal sclerosis unspecified.....	N02-N03,N05-N07,N26 (582-583,587)
85	Renal failure.....	N17-N19 (584-586)
86	Other disorders of kidney.....	N25,N27 (588-589)
87#	Infections of kidney.....	N10-N12,N13.6,N15.1 (590)
88#	Hyperplasia of prostate.....	N40 (600)
89#	Inflammatory diseases of female pelvic organs.....	N70-N76 (614-616)
#	Pregnancy, childbirth and the puerperium.....	.000-099 (630-676)
90	Pregnancy with abortive outcome.....	.000-007 (630-639)
91	Other complications of pregnancy, childbirth and the puerperium.....	.010-099 (640-676)
92#	Certain conditions originating in the perinatal period.....	P00-P96 (760-771.2,771.4-779)

**APPENDIX I: LIST OF 113 SELECTED CAUSES OF DEATH**

Number	Cause of death	ICD-10 (ICD-9)
93#	Congenital malformations, deformations and chromosomal abnormalities.....	Q00-Q99 (740-759)
94	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified.....	R00-R99 (780-799)
95	All other diseases (Residual)..	D65-E07, E15-E34, E65-F99, G04-G12, G23-G25, G31-H93, K00-K22, K29-K31, K50-K66, K71-K72, K75-K76, K83-M99, N13.0-N13.5, N13.7-N13.9, N14, N15.0, N15.8-N15.9, N20-N23, N28-N39, N41-N64, N80-N98 (135,240-246,251-259,270-279,286-319,323-330,331.1-331.9,333-389,435,520-530,535-537,555-570,572-573,576-579,591-599,601-611,617-629,680-739)
#	Accidents.....	V01-X59, Y85-Y86 (E800-E869, E880-E929)
	Transport accidents.....	V01-V99, Y85 (E800-E848, E929.0-E929.1)
96	Motor vehicle accidents....	V02-V04, V09.0, V09.2, V12-V14, V19.0-V19.2, V19.4-V19.6, V20-V79, V80.3-V80.5, V81.0-V81.1, V82.0-V82.1, V83-V86, V87.0-V87.8, V88.0-V88.8, V89.0, V89.2 (E810-E825)
97	Other land transport accidents.....	V01, V05-V06, V09.1, V09.3-V09.9, V10-V11, V15-V18, V19.3, V19.8-V19.9, V80.0-V80.2, V80.6-V80.9, V81.2-V81.9, V82.2-V82.9, V87.9, V88.9, V89.1, V89.3, V89.9 (E800-E807, E826-E829)
98	Water, air and space, and other and unspecified transport accidents and their sequelae.....	V90-V99, Y85 (E830-E848, E929.0-E929.1)
	Nontransport accidents.....	W00-X59, Y86 (E850-E869, E880-E928, E929.2-E929.9)
99	Falls.....	W00-W19 (E880-E888)
100	Accidental discharge of firearms.....	W32-W34 (E922)
101	Accidental drowning and submersion.....	W65-W74 (E910)
102	Accidental exposure to smoke, fire and flames.....	X00-X09 (E890-E899)
103	Accidental poisoning and exposure to noxious substances.....	X40-X49 (E850-E869, E924.1)
104	Other and unspecified nontransport accidents and their sequelae.....	W20-W31, W35-W64, W75-W99, X10-X39, X50-X59, Y86 (E900-E909, E911-E921, E923-E924.0, E924.8-E928, E929.2-E929.9)
#	Intentional self-harm (suicide).....	X60-X84, Y87.0 (E950-E959)

**APPENDIX I: LIST OF 113 SELECTED CAUSES OF DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
105	Intentional self-harm (suicide) by discharge of firearms.....	X72-X74 (E955.0-E955.4)
106	Intentional self-harm (suicide) by other and unspecified means and their sequelae.....	X60-X71,X75-X84,Y87.0 (E950-E954,E955.5-E959)
#	Assault (homicide).....	X85-Y09,Y87.1 (E960-E969)
107	Assault (homicide) by discharge of firearms.....	X93-X95 (E965.0-E965.4)
108	Assault (homicide) by other and unspecified means and their sequelae.....	X85-X92,X96-Y09,Y87.1 (E960-E964,E965.5-E969)
109#	Legal intervention.....	Y35,Y89.0 (E970-E978)
	Events of undetermined intent.....	Y10-Y34,Y87.2,Y89.9 (E980-E989)
110	Discharge of firearms, undetermined intent.....	Y22-Y24 (E985.0-E985.4)
111	Other and unspecified events of undetermined intent and their sequelae.....	Y10-Y21,Y25-Y34,Y87.2,Y89.9 (E980-E984,E985.5-E989)
112#	Operations of war and their sequelae.....	Y36,Y89.1 (E990-E999)
113#	Complications of medical and surgical care.....	Y40-Y84,Y88 (E870-E879,E930-E949)

**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

Number	Cause of death	ICD-10 (ICD-9)
	All causes.....	
	Certain infectious and parasitic diseases.....	A00-B99 (001-033,034.1-134,136-139,771.3)
1	Certain intestinal infectious diseases.....	A00-A08 (001-008)
2#	Diarrhea and gastroenteritis of presumed infectious origin.....	A09 (009)
3#	Tuberculosis.....	A15-A19 (010-018)
4#	Tetanus.....	A33,A35 (037,771.3)
5#	Diphtheria.....	A36 (032)
6#	Whooping cough.....	A37 (033)
7#	Meningococcal infection.....	A39 (036)
8#	Septicemia.....	A40-A41 (038)
9#	Congenital syphilis.....	A50 (090)
10#	Gonococcal infection.....	A54 (098)
	Viral diseases.....	A80-B34 (042-079)
11#	Acute poliomyelitis.....	A80 (045)
12#	Varicella (chickenpox).....	B01 (052)
13#	Measles.....	B05 (055)
14#	Human immunodeficiency virus (HIV) disease.....	B20-B24 (042-044)
15#	Mumps.....	B26 (072)
16	Other and unspecified viral diseases.....	A81-B00,B02-B04,B06-B19,B25,B27-B34 (046-051,053-054,056-071,073-079)

**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

Number	Cause of death	ICD-10 (ICD-9)
17#	Candidiasis.....	B37 (112)
18#	Malaria.....	B50-B54 (084)
19#	Pneumocystosis.....	B59 (136.3)
20	Other and unspecified infectious and parasitic diseases and their sequelae.....	A20-A32,A38,A42-A49,A51-A53,A55-A79,B35-B36,B38-B49,B55-B58,B60-B99 (020-031,034.1-035,039-041,080-083,085-088,091-097,099-111,114-134,136.0-136.2,136.4-139)

**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

Number	Cause of death	ICD-10 (ICD-9)
	Neoplasms.....	C00-D48 (140-239)
#	Malignant neoplasms.....	C00-C97 (140-208)
21	Hodgkin's disease and non-Hodgkin's lymphomas.....	C81-C85 (200-202)
22	Leukemia.....	C91-C95 (204-208)
23	Other and unspecified malignant neoplasms.....	C00-C80,C88-C90,C96-C97 (140-199,203)
24#	In situ neoplasms, benign neoplasms and neoplasms of uncertain or unknown behavior.....	D00-D48 (210-239)
#	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism.....	D50-D89 (135,279-289)
25	Anemias.....	D50-D64 (280-285)
26	Other diseases of blood and blood-forming organs.....	D65-D76 (286-289)
27	Certain disorders involving the immune mechanism.....	D80-D89 (135,279)
	Endocrine, nutritional and metabolic diseases.....	E00-E88 (240-278)
28#	Short stature, not elsewhere classified.....	E34.3 (259.4)
29#	Malnutrition and other nutritional deficiencies.....	E40-E64 (260-269)
30#	Cystic fibrosis.....	E84 (277.0)
31#	Volume depletion, disorders of fluid, electrolyte and acid-base balance.....	E86-E87 (276)
32	Other endocrine, nutritional and metabolic diseases.....	E00-E32,E34.0-E34.2,E34.4-E34.9,E65-E83,E85,E88 (240-259.3,259.8-259.9,270-275,277.1-278)
	Diseases of the nervous system.....	G00-G98 (320-359,435)
33#	Meningitis.....	G00,G03 (320-322)

**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

Number	Cause of death	ICD-10 (ICD-9)
34#	Infantile spinal muscular atrophy, type I (Werdnig-Hoffman).....	G12.0 (335.0)
35#	Infantile cerebral palsy.....	G80 (343)
36#	Anoxic brain damage, not elsewhere classified.....	G93.1 (348.1)
37	Other diseases of nervous system.....	G04,G06-G11,G12.1-G12.9,G20-G72,G81-G92,G93.0,G93.2-G93.9,G95-G98 (323-334,335.1-342,344-348.0,348.2-359,435)
38#	Diseases of the ear and mastoid process.....	H60-H93 (380-389)
#	Diseases of the circulatory system.....	I00-I99 (390-434,436-459)
39	Pulmonary heart disease and diseases of pulmonary circulation.....	I26-I28 (415-417)
40	Pericarditis, endocarditis and myocarditis.....	I30,I33,I40 (420-422)
41	Cardiomyopathy.....	I42 (425)
42	Cardiac arrest.....	I46 (427.5)
43	Cerebrovascular diseases.....	I60-I69 (430-434,436-438)
44	Other diseases of circulatory system.....	I00-I25,I31,I34-I38,I44-I45,I47-I51,I70-I99 (390-414,423-424,426-427.4,427.6-429,440-459)
	Diseases of the respiratory system.....	J00-J98 (034.0,460-519)
45#	Acute upper respiratory infections.....	J00-J06 (034.0,460-465)
#	Influenza and pneumonia.....	J10-J18 (480-487)
46	Influenza.....	J10-J11 (487)
47	Pneumonia.....	J12-J18 (480-486)
48#	Acute bronchitis and acute bronchiolitis.....	J20-J21 (466)
49#	Bronchitis, chronic and unspecified.....	J40-J42 (490-491)



**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

Number	Cause of death	ICD-10 (ICD-9)
50#	Asthma.....	J45-J46 (493)
51#	Pneumonitis due to solids and liquids.....	J69 (507)
52	Other and unspecified diseases of respiratory system.....	J22,J30-J39,J43-J44,J47- J68,J70-J98 (470-479,492,494-506,508-519)
	Diseases of the digestive system.....	K00-K92 (520-579)
53#	Gastritis, duodenitis, and noninfective enteritis and colitis.....	K29,K50-K55 (535,555-558)
54#	Hernia of abdominal cavity and intestinal obstruction without hernia.....	K40-K46,K56 (550-553,560)
55	Other and unspecified diseases of digestive system.....	K00-K28,K30-K38,K57-K92 (520-534,536-543,562-579)
	Diseases of the genitourinary system.....	N00-N98 (580-629)
56#	Renal failure and other disorders of kidney.....	N17-N19,N25,N27 (584-589)
57	Other and unspecified diseases of genitourinary system....	N00-N15,N20-N23,N26,N28-N98 (580-583,590-629)
	Certain conditions originating in the perinatal period.....	P00-P96 (760-771.2,771.4-779)
	Newborn affected by maternal factors and by complications of pregnancy, labor and delivery.....	P00-P04 (760-763)
58#	Newborn affected by maternal hypertensive disorders.....	P00.0 (760.0)
59#	Newborn affected by other maternal conditions which may be unrelated to present pregnancy.....	P00.1-P00.9 (760.1-760.6,760.8-760.9)
#	Newborn affected by maternal complicatons of pregnancy.....	P01 (761)
60	Newborn affected by incompetent cervix.....	P01.0 (761.0)
61	Newborn affected by premature rupture of membranes.....	P01.1 (761.1)
62	Newborn affected by multiple pregnancy.....	P01.5 (761.5)

**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

Number	Cause of death	ICD-10 (ICD-9)
63	Newborn affected by other maternal complications of pregnancy.....	P01.2-P01.4,P01.6-P01.9 (761.2-761.4,761.6-761.9)
#	Newborn affected by complications of placenta, cord and membranes.....	P02 (762)
64	Newborn affected by complications involving placenta.....	P02.0-P02.3 (762.0-762.3)
65	Newborn affected by complications involving cord.....	P02.4-P02.6 (762.4-762.6)
66	Newborn affected by chorioamnionitis.....	P02.7 (762.7)
67	Newborn affected by other abnormalities of membranes.....	P02.8-P02.9 (762.8-762.9)
68#	Newborn affected by other complications of labor and delivery.....	P03 (763.0-763.4,763.6-763.9)
69#	Newborn affected by noxious influences transmitted via placenta or breast milk..	P04 (760.7,763.5)
	Disorders related to length of gestation and fetal malnutrition.....	P05-P08 (764-766)
70#	Slow fetal growth and fetal malnutrition.....	P05 (764)
#	Disorders related to short gestation and low birth weight, not elsewhere classified.....	P07 (765)
71	Extremely low birth weight or extreme immaturity .....	P07.0,P07.2 (765.0)
72	Other low birth weight or preterm.....	P07.1,P07.3 (765.1)
73#	Disorders related to long gestation and high birth weight.....	P08 (766)
74#	Birth trauma.....	P10-P15 (767)
#	Intrauterine hypoxia and birth asphyxia.....	P20-P21 (768)
75	Intrauterine hypoxia.....	P20 (768.2-768.4)
76	Birth asphyxia.....	P21 (768.5-768.9)

**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
77#	Respiratory distress of newborn.....	P22 (769)
	Other respiratory conditions originating in the perinatal period.....	P23-P28 (770)
78#	Congenital pneumonia.....	P23 (770.0)
79#	Neonatal aspiration syndromes.....	P24 (770.1)
80#	Interstitial emphysema and related conditions originating in the perinatal period.....	P25 (770.2)
81#	Pulmonary hemorrhage originating in the perinatal period.....	P26 (770.3)
82#	Chronic respiratory disease originating in the perinatal period.....	P27 (770.7)
83#	Atelectasis.....	P28.0-P28.1 (770.4-770.5)
84	All other respiratory conditions originating in the perinatal period....	P28.2-P28.9 (770.6,770.8)
	Infections specific to the perinatal period.....	P35-P39 (771.0-771.2,771.4-771.8)
85#	Bacterial sepsis of newborn.....	P36 (771.8)
86#	Omphalitis of newborn with or without mild hemorrhage.....	P38 (771.4)
87	Other infections specific to the perinatal period.....	P35,P37,P39 (771.0-771.2,771.5-771.7)
	Hemorrhagic and hematological disorders of newborn.....	P50-P61 (772-774,776)
88#	Neonatal hemorrhage.....	P50-P52,P54 (772)
89#	Hemorrhagic disease of newborn.....	P53 (776.0)
90#	Hemolytic disease of newborn due to isoimmunization and other perinatal jaundice.....	P55-P59 (773-774)
91	Other hematological disorders of newborn.....	P60-P61 (776.1-776.9)

**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

<b>Number</b>	<b>Cause of death</b>	<b>ICD-10 (ICD-9)</b>
92#	Syndrome of infant of a diabetic mother and neonatal diabetes mellitus....	P70.0-P70.2 (775.0-775.1)
93#	Necrotizing enterocolitis of newborn.....	P77 (777.5)
94#	Hydrops fetalis not due to hemolytic disease.....	P83.2 (778.0)
95	Other perinatal conditions.....	P29,P70.3-P76,P78-P81,P83.0-P83.1,P83.3-P96 (775.2-775.9,777.0-777.4,777.6-777.9,778.1-779)
#	Congenital malformations, deformations and chromosomal abnormalities.....	Q00-Q99 (740-759)
96	Anencephaly and similar malformations.....	Q00 (740)
97	Congenital hydrocephalus.....	Q03 (742.3)
98	Spina bifida.....	Q05 (741)
99	Other congenital malformations of the nervous system.....	Q01-Q02,Q04,Q06-Q07 (742.0-742.2,742.4-742.9)
100	Congenital malformations of heart.....	Q20-Q24 (745-746)
101	Other congenital malformations of the circulatory system.....	Q25-Q28 (747)
102	Congenital malformations of the respiratory system.....	Q30-Q34 (748)
103	Congenital malformations of the digestive system.....	Q35-Q45 (749-751)
104	Congenital malformations of the genitourinary system.....	Q50-Q64 (752-753)
105	Congenital malformations and deformations of musculoskeletal system, limbs and integument.....	Q65-Q85 (754-757)
106	Down's syndrome.....	Q90 (758.0)
107	Edward's syndrome.....	Q91.0-Q91.3 (758.2)
108	Patau's syndrome.....	Q91.4-Q91.7 (758.1)
109	Other congenital malformations and deformations.....	Q10-Q18,Q86-Q89 (743-744,759)

**APPENDIX II: LIST OF 130 SELECTED CAUSES OF INFANT DEATH**

Number	Cause of death
110	Other chromosomal abnormalities, not elsewhere classified.....Q92-Q99 (758.3-758.9)
	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified .....R00-R99 (780-799)
111#	Sudden infant death syndrome.....R95 (798.0)
112	Other symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified.....R00-R53, R55-R94, R96-R99 (780-796, 798.1-799)
113	All other diseases.....F01-F99, H00-H59, L00-L98, M00-M99 (290-319, 360-379, 680-739)
	External causes of mortality.....V01-Y89 (E800-E999)
#	Accidents.....V01-X59, Y85-Y86 (E800-E869, E880-E929)
	Transport accidents.....V01-V99, Y85 (E800-E848, E920-E929.1)
114	Motor vehicle accidents.....V02-V04, V09.0, V09.2, V12-V14, V19.0-V19.2, V19.4-V19.6, V20-V79, V80.3-V80.5, V83-V86, V87.0-V87.8, V88.0-V88.8, V89.0, V89.2 (E810-E825)
115	Other and unspecified transport accidents and their sequelae.....V01, V05-V06, V09.1, V09.3-V09.9, V10-V11, V15-V18, V19.3, V19.8- V19.9, V80.0-V80.2, V80.6-V80.9, V81-V82, V87.9, V88.9, V89.1, V89.3, V89.9, V90-V99, Y85 (E800-E807, E826-E848, E929.0-E929.1)
116	Falls.....W00-W19 (E880-E888)
117	Accidental discharge of firearms.....W32-W34 (E922)
118	Accidental drowning and submersion.....W65-W74 (E910)
119	Accidental suffocation and strangulation in bed.....W75 (E913.0)
120	Other accidental suffocation and strangulation.....W76-W77, W81-W84 (E913.1-E913.9)
121	Accidental inhalation and ingestion of food or other objects causing obstruction of respiratory tract.....W78-W80 (E911-E912)
122	Accidents caused by exposure to smoke, fire and flames.....X00-X09 (E890-E899)

123	Accidental poisoning and exposure to noxious substances.....	X40-X49 (E850-E869,E924.1)
124	All other accidents and their sequelae.....	W20-W31,W35-W64,W85-W99,X10-X39,X50-X59,Y86 (E900-E909,E914-E921,E923-E924.0,E924.8-E929)
#	Assault (homicide).....	X85-Y09,Y87.1 (E960-E969)
125	Assault (homicide) by hanging, strangulation and suffocation.....	X91 (E963)
126	Assault (homicide) by discharge of firearms.....	X93-X95 (E965.0-E965.4)
127	Neglect, abandonment and other maltreatment syndromes.....	Y06-Y07 (E967,E968.4)
128	Assault (homicide) by all other and unspecified means and their sequelae.....	X85-X90,X92,X96-X99,Y00-Y05,Y08-Y09,Y87.1 (E960-E962,E964,E965.5-E966,E968.0-E968.3,E968.8-E968.9)
129#	Complications of medical and surgical care.....	Y40-Y84,Y88 (E870-E879,E930-E949)
130	Other external causes and their sequelae.....	X60-X84,Y10-Y36,Y87.0,Y87.2,Y89 (E970-E979)

Appendix III: Lower and upper 95% and 96% confidence limit factors for a death rate based on a Poisson variable of 1 through 99 deaths,  $D$  or  $D_{adj}$

$D$ or $D_{adj}$	$L(1 - \alpha = .95, D)$	$U(1 - \alpha = .95, D)$	$L(1 - \alpha = .96, D)$ or $L(1 - \alpha = .96, D_{adj})$	$U(1 - \alpha = .96, D)$ or $U(1 - \alpha = .96, D_{adj})$
1	0.02532	5.57164	0.02020	5.83392
2	0.12110	3.61234	0.10735	3.75830
3	0.20622	2.92242	0.18907	3.02804
4	0.27247	2.56040	0.25406	2.64510
5	0.32470	2.33367	0.30591	2.40540
6	0.36698	2.17658	0.34819	2.23940
7	0.40205	2.06038	0.38344	2.11666
8	0.43173	1.97040	0.41339	2.02164
9	0.45726	1.89831	0.43923	1.94553
10	0.47954	1.83904	0.46183	1.88297
11	0.49920	1.78928	0.48182	1.83047
12	0.51671	1.74680	0.49966	1.78566
13	0.53246	1.71003	0.51571	1.74688
14	0.54671	1.67783	0.53027	1.71292
15	0.55969	1.64935	0.54354	1.68289
16	0.57159	1.62394	0.55571	1.65610
17	0.58254	1.60110	0.56692	1.63203
18	0.59266	1.58043	0.57730	1.61024
19	0.60207	1.56162	0.58695	1.59042
20	0.61083	1.54442	0.59594	1.57230
21	0.61902	1.52861	0.60435	1.55563
22	0.62669	1.51401	0.61224	1.54026
23	0.63391	1.50049	0.61966	1.52602
24	0.64072	1.48792	0.62666	1.51278
25	0.64715	1.47620	0.63328	1.50043
26	0.65323	1.46523	0.63954	1.48888

Appendix III: Lower and upper 95% and 96% confidence limit factors for a death rate based on a Poisson variable of 1 through 99 deaths,  $D$  or  $D_{adj}$

$D$ or $D_{adj}$	$L(1 - \alpha = .95, D)$	$U(1 - \alpha = .95, D)$	$L(1 - \alpha = .96, D)$ or $L(1 - \alpha = .96, D_{adj})$	$U(1 - \alpha = .96, D)$ or $U(1 - \alpha = .96, D_{adj})$
27	0.65901	1.45495	0.64549	1.47805
28	0.66449	1.44528	0.65114	1.46787
29	0.66972	1.43617	0.65652	1.45827
30	0.67470	1.42756	0.66166	1.44922
31	0.67945	1.41942	0.66656	1.44064
32	0.68400	1.41170	0.67125	1.43252
33	0.68835	1.40437	0.67575	1.42480
34	0.69253	1.39740	0.68005	1.41746
35	0.69654	1.39076	0.68419	1.41047
36	0.70039	1.38442	0.68817	1.40380
37	0.70409	1.37837	0.69199	1.39743
38	0.70766	1.37258	0.69568	1.39134
39	0.71110	1.36703	0.69923	1.38550
40	0.71441	1.36172	0.70266	1.37991
41	0.71762	1.35661	0.70597	1.37454
42	0.72071	1.35171	0.70917	1.36938
43	0.72370	1.34699	0.71227	1.36442
44	0.72660	1.34245	0.71526	1.35964
45	0.72941	1.33808	0.71816	1.35504
46	0.73213	1.33386	0.72098	1.35060
47	0.73476	1.32979	0.72370	1.34632
48	0.73732	1.32585	0.72635	1.34218
49	0.73981	1.32205	0.72892	1.33818
50	0.74222	1.31838	0.73142	1.33431
51	0.74457	1.31482	0.73385	1.33057
52	0.74685	1.31137	0.73621	1.32694



Appendix III: Lower and upper 95% and 96% confidence limit factors for a death rate based on a Poisson variable of 1 through 99 deaths,  $D$  or  $D_{adj}$

$D$ or $D_{adj}$	$L(1-a=.95,D)$	$U(1-a=.95,D)$	$L(1-a=.96,D)$ or $L(1-a=.96,D_{adj})$	$U(1-a=.96,D)$ or $U(1-a=.96,D_{adj})$
53	0.74907	1.30802	0.73851	1.32342
54	0.75123	1.30478	0.74075	1.32002
55	0.75334	1.30164	0.74293	1.31671
56	0.75539	1.29858	0.74506	1.31349
57	0.75739	1.29562	0.74713	1.31037
58	0.75934	1.29273	0.74916	1.30734
59	0.76125	1.28993	0.75113	1.30439
60	0.76311	1.28720	0.75306	1.30152
61	0.76492	1.28454	0.75494	1.29873
62	0.76669	1.28195	0.75678	1.29601
63	0.76843	1.27943	0.75857	1.29336
64	0.77012	1.27698	0.76033	1.29077
65	0.77178	1.27458	0.76205	1.28826
66	0.77340	1.27225	0.76373	1.28580
67	0.77499	1.26996	0.76537	1.28340
68	0.77654	1.26774	0.76698	1.28106
69	0.77806	1.26556	0.76856	1.27877
70	0.77955	1.26344	0.77011	1.27654
71	0.78101	1.26136	0.77162	1.27436
72	0.78244	1.25933	0.77310	1.27223
73	0.78384	1.25735	0.77456	1.27014
74	0.78522	1.25541	0.77598	1.26810
75	0.78656	1.25351	0.77738	1.26610
76	0.78789	1.25165	0.77876	1.26415
77	0.78918	1.24983	0.78010	1.26223
78	0.79046	1.24805	0.78143	1.26036

Appendix III: Lower and upper 95% and 96% confidence limit factors for a death rate based on a Poisson variable of 1 through 99 deaths,  $D$  or  $D_{adj}$

$D$ or $D_{adj}$	$L(1-a=.95,D)$	$U(1-a=.95,D)$	$L(1-a=.96,D)$ or $L(1-a=.96,D_{adj})$	$U(1-a=.96,D)$ or $U(1-a=.96,D_{adj})$
79	0.79171	1.24630	0.78272	1.25852
80	0.79294	1.24459	0.78400	1.25672
81	0.79414	1.24291	0.78525	1.25496
82	0.79533	1.24126	0.78648	1.25323
83	0.79649	1.23965	0.78769	1.25153
84	0.79764	1.23807	0.78888	1.24987
85	0.79876	1.23652	0.79005	1.24824
86	0.79987	1.23499	0.79120	1.24664
87	0.80096	1.23350	0.79233	1.24507
88	0.80203	1.23203	0.79344	1.24352
89	0.80308	1.23059	0.79453	1.24201
90	0.80412	1.22917	0.79561	1.24052
91	0.80514	1.22778	0.79667	1.23906
92	0.80614	1.22641	0.79771	1.23762
93	0.80713	1.22507	0.79874	1.23621
94	0.80810	1.22375	0.79975	1.23482
95	0.80906	1.22245	0.80074	1.23345
96	0.81000	1.22117	0.80172	1.23211
97	0.81093	1.21992	0.80269	1.23079
98	0.81185	1.21868	0.80364	1.22949
99	0.81275	1.21746	0.80458	1.22822

Note: The previous table was generated using the SAS<sup>®</sup> code below. Users can compute other level Confidence Intervals by changing the alpha-value. The previous table is a modified version of Table 40 (5).

```
* Program to compute confidence intervals for expectations of Poisson variables ;
* Specify alpha for alpha*100% Confidence Interval ;

%let alpha = .95;

data CI ;

  alo = (1-&alpha)/2 ;
  ahi = (&alpha+1)/2 ;

do n = 1 to 99;

  L = Gaminv ( alo,n )/n ;
  U = Gaminv ( ahi,n+1 )/n ;

output;
end;

proc print data= CI;
  var n L U ;

run;
```