Catalogue no. 84-548-XIE

Comparability of ICD-10 and ICD-9 for Mortality Statistics in Canada

2005

Statistics Canada Statistique Canada

Canada

How to obtain more information

Specific inquiries about this product and related statistics or services should be directed to: Health Statistics Division, Statistics Canada, Ottawa, Ontario, K1A 0T6 (telephone: (613) 951-1746).

For information on the wide range of data available from Statistics Canada, you can contact us by calling one of our toll-free numbers. You can also contact us by e-mail or by visiting our website.

National inquiries line	1 800 263-1136
National telecommunications device for the hearing impaired	1 800 363-7629
Depository Services Program inquiries	1 800 700-1033
Fax line for Depository Services Program	1 800 889-9734
E-mail inquiries	infostats@statcan.ca
Website	www.statcan.ca

Information to access the product

This product, catalogue no. 84-548-XIE, is available for free. To obtain a single issue, visit our website at www.statcan.ca and select Our Products and Services.

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner and in the official language of their choice. To this end, the Agency has developed standards of service that its employees observe in serving its clients. To obtain a copy of these service standards, please contact Statistics Canada toll free at 1 800 263-1136. The service standards are also published on www.statcan.ca under About Statistics Canada > Providing services to Canadians.

Statistics Canada
Health Statistics Division

Comparability of ICD-10 and ICD-9 for Mortality Statistics in Canada

2005

Published by authority of the Minister responsible for Statistics Canada

November 2005

Catalogue no. 84-548-XIE
ISBN 0-662-41940-5

Frequency: Occassional

Ottawa

Cette publication est disponible en français sur demande (nº 84-548-XIF au catalogue).

Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued cooperation and goodwill.

Table of contents

Comparability of ICD-10 and ICD-9 for Mortality Statistics in Canada

Leslie Geran, Patricia Tully, Patricia Wood (Health Statistics Division), Brad Thomas (Household Survey Methods Division), Statistics Canada

Executive summary

Statistics on cause of death are widely used as health indicators: to measure the burden of disease, to compare health outcomes among regions, to monitor population health, and to allocate health care resources. This report describes the design, methodology, and results of the first study undertaken by Statistics Canada to measure the impact on Canadian cause of death trends of a new revision of the World Health Organization's *International Classification of Diseases* (ICD).

New revisions of the ICD are developed periodically, through international collaboration, to maintain the currency of the classification. The Tenth Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) represents a thorough and fundamental change in the classification. Canada implemented ICD-10 for the classification of cause of death beginning in 2000.

Using 1999 Canadian mortality data, Statistics Canada carried out a comparability, or "bridge-coding", study by dual-coding deaths to both the Ninth and Tenth Revisions of the International Classification of Diseases (ICD-9 and ICD-10). The preliminary results of this exercise were used to generate comparability ratios; these ratios measure the net effect of the new revision, with ratios above 1.00 indicating a net increase in deaths classified to a cause of death, and ratios below 1.00 indicating a net decrease.

The introduction of a new classification standard has the potential to disrupt trends in underlying cause of death statistics. Analysts who follow cause of death trends will find this report to be a useful tool in their efforts to use the statistics on deaths classified in ICD-10 in their analyses. Researchers who want to compare cause of death statistics among different countries will also find this report enlightening, as it provides the ratios necessary to adjust Canadian statistics from ICD-9 to ICD-10.

Results for selected causes of death

- **Infectious and parasitic diseases:** Classification in ICD-10 resulted in 12.3% fewer Tuberculosis deaths and 12.7% fewer Viral hepatitis deaths. Septicaemia deaths rose 24.1% and Human Immunodeficiency Virus (HIV) deaths increased by 10.1%.

- **Malignant neoplasms (cancers):** The number of deaths due to Malignant neoplasms of the trachea, bronchus and lung decreased by 1.9% when ICD-10 was used to classify the cause of death. There was no statistically significant

change in the number of deaths due to Malignant neoplasms of the colon, rectum and anus. An increase of 1.3% in the number of deaths due to Malignant neoplasm of breast was the result of classification to the new revision, as was an increase of 3.2% in the number of deaths due to Malignant neoplasm of prostate.

- **Endocrine, nutritional and metabolic diseases:** 4.0% more deaths were classified to Diabetes in ICD-10 than were in ICD-9.

- **Diseases of the nervous system:** Alzheimer's disease deaths shot up 58.4% when classified in ICD-10; deaths due to Parkinson's disease also rose, although more moderately, by 5.5%.

- **Diseases of the circulatory system:** Deaths due to Acute myocardial infarction decreased by 2.6% when classified in ICD-10, while deaths due to Cerebrovascular disease increased by 6.1%.

- **Respiratory system diseases:** Pneumonia deaths were most heavily impacted by ICD-10 implementation; they decreased by 46.8% because of a change between ICD-9 and ICD-10 in one of the rules for selecting the cause of death.

- **Diseases of the digestive system:** Alcoholic liver disease deaths increased 9.5% when classified in ICD-10.

- **Diseases of the genitourinary system:** Implementation of ICD-10 resulted in 6.6% more deaths classified as due to Renal failure.

- **External causes of death:** Accidental deaths rose 3.3% when classified in ICD-10, but this increase was not statistically significant. Within this group of causes, the number of deaths due to Accidental Falls was halved (down 49.8%). ICD-10 had no impact on the number of deaths classified as due to Intentional self-harm (suicide).

- **Causes of infant death:** Deaths due to Perinatal conditions increased by 2.2% when classified in ICD-10. There was no impact on the number of deaths due to Sudden Infant Death Syndrome (SIDS).

The comparability ratios derived from dual-coding medical certificates of cause of death presented in this report estimate the size and direction of the disruption to cause of death trends due to the implementation of ICD-10. Researchers and analysts using Canadian mortality data should use these summary measures to calculate comparability-modified death counts and mortality rates to bridge the gap between ICD-9 and ICD-10.

Comparability study results are applicable only for the data year on which the dual-coding was done; users are cautioned not to apply comparability ratios to other data years in a time series analysis. The results are not applicable to mortality data from other countries, nor to other data, such as morbidity (hospitalization) data.

Section I: Introduction

New revisions of the World Health Organization's *International Classification of Diseases* (ICD) are developed periodically, through international collaboration, to reflect medical advances and current ideas about aetiology and pathology, and to include new diseases. The Tenth Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) represents a thorough and fundamental change in the classification, one that will affect the trends in mortality statistics. Canada implemented ICD-10 for the classification of cause of death beginning in 2000.

This report describes the design, methodology, and results of a comparability, or "bridge-coding", study on Canadian mortality statistics using both the Ninth and Tenth Revisions of the International Classification of Diseases (ICD-9 and ICD-10). This study was carried out to quantify the impact of ICD-10, the latest revision to the standard for the classification of cause of death, on Canadian mortality statistics.

This report begins with a general description of how ICD-10 differs from previous revisions, and how the latest revision was implemented in Canada. The sections that follow present the methodology and the preliminary results of the comparability study that was done, using 1999 data, to measure the impact of the new revision on Canadian mortality statistics. Comparability ratios for selected individual or grouped causes of death are found in Table 4 of this report.

The introduction of a new classification standard has the potential to disrupt trends in underlying cause of death statistics. Analysts who follow cause of death trends will find this report to be a useful tool in their efforts to use the statistics on deaths classified in ICD-10 in their analyses. Researchers who want to compare cause of death statistics among different countries will also find this report enlightening, as it provides the ratios necessary to adjust Canadian statistics from ICD-9 to ICD-10.

The comparability ratios in this report are applicable to Canadian cause of death statistics for the year 1999 only. These results are based on a representative sample of Canadian mortality in 1999 and are the most appropriate available ratios for the analysis of Canadian mortality data at the national, provincial or territorial level. Due to the limited sample size of this study, comparability ratios for causes or grouped causes cannot be calculated with acceptable precision for the sexes separately, for particular age groups, or for smaller geographic areas.

Section II: Mortality classification in Canada with ICD-10

Canadian vital statistics system

In Canada, the provinces and territories are responsible for the registration of vital events. These are births, stillbirths, marriages and deaths. Two Dominion-Provincial conferences in 1918 established a cooperative arrangement, under which the provinces and territories provide data on the vital events and copies of the registration documents to

Statistics Canada. Statistics Canada is responsible for compiling a national database annually for each vital event. These national databases allow for the analysis of vital events based on the residence of the person involved, regardless of the location of the event.

The Canadian vital statistics data impacted by the introduction of ICD-10 are deaths and stillbirths. For the comparability study, only deaths were dual-coded. Due to the comparative rarity of stillbirths (approximately 2,000 a year are registered in Canada) and the limited information provided by medical certifiers on the Medical Certificate of Cause of Stillbirth, dual-coding would not have yielded information of acceptable reliability.

The source document for the underlying cause of death is the Medical Certificate of Cause of Death, which is only one section of the provincial or territorial death registration form. The format of the medical certificate is recommended by the World Health Organization and is designed to promote accurate documentation of the sequence of events leading to death and international comparability of cause of death statistics. Part I of the medical certificate of cause of death is for recording diseases or conditions in the train of events leading directly to death. Part II is for unrelated but contributory conditions (1). The medical certificate is completed by the attending medical practitioner or by a coroner or medical examiner.

History of the International Classification of Diseases (ICD) for mortality statistics in Canada

The purpose of the International Classification of Diseases (ICD) is "to permit the systematic recording, analysis, interpretation and comparison of mortality and morbidity data collected in different countries or areas and at different times" (1). The original ICD was developed in the late nineteenth century, and the Dominion Bureau of Statistics used the Third Revision (ICD-3) to compile the first national mortality statistics for Canada in 1921. Subsequent revisions were adopted roughly every decade, up until the Ninth Revision (ICD-9), which was used for 1979 to 1999 mortality statistics in Canada (Table 1). The revision process is coordinated by the World Health Organization (WHO), and involves many years of planning and expert consultation. ICD-10 was endorsed by the Forty-third World Health Assembly in May 1990 and came into use by WHO member states, starting in 1994 and continuing to the present.

Language versions of ICD-10

The World Health Organization published the Tenth Revision of the International Classification of Diseases in English (1) and in French (2) (ICD-10 and CIM-10 respectively) between 1992 and 1996. CIM-10 is used in Canada to classify cause of death for medical certificates of cause of death completed in French and ICD-10 is used to classify those completed in English. Some member states have translated ICD-10 into other languages.

In this document, ICD refers to both the English and French language versions of the Classification where no differences exist between them. CIM and ICD are specified, as appropriate, where differences exist.

Major changes in ICD-10

The planning for the Tenth Revision was done in the context of the expanded use of and interest in the classification. Combined with the need for expert review, a longer consultation period was required than had been the case for earlier revisions. The expense of adapting data processing systems for each new revision was also a concern of the WHO and its member states. The aim of ICD-10, therefore, was to "devise a stable and flexible classification, which should not require fundamental revision for many years to come" (1).

Changes in the classification

The most obvious innovation in the classification is that the structure of the codes has changed from numeric to alphanumeric. This allows for considerable expansion of the number of categories and sub-categories in ICD-10 and future revisions. There are approximately 12,700 codes in ICD-10, of which about 8,000 are valid as an underlying cause of death, a considerable increase from approximately 5,000 valid codes for underlying cause of death in ICD-9. An example of the expansion of detail in some categories is found in the ICD-10 category for Sequelae of cerebrovascular disease. This example also shows that some category labels for medical conditions have changed to reflect current medical terminology. In ICD-9 the category is 438, Late effects of cerebrovascular disease, with no sub-categories. In ICD-10, code I69, Sequelae of cerebrovascular disease, has six sub-categories. Enhancements in the code structure create the possibility for analysis of more subtle distinctions in outcomes, assuming that the medical certifier has completed the medical certificate of cause of death with sufficient detail to take advantage of these enhancements.

Other changes include the re-naming and re-ordering of chapter titles (Table 2) in ICD-10 compared with ICD-9, and the labelling of blocks of categories. In the Tenth Revision, the use of codes with the first character "U" is reserved for the provisional assignment of new diseases of uncertain aetiology, and for research purposes, such as studying the effect of alternative classifications on mortality or morbidity statistics. As an example of the former, in early 2003 a provisional category, U04, was created for the newly-identified Severe acute respiratory syndrome (SARS).

Changes in the underlying cause selection and modification rules

In order to prevent a death, the train of events that leads to death must be broken at some point. From a public health perspective, it is most effective to prevent the initiating event or disease from occurring. Mortality statistics are customarily tabulated on the underlying cause of death, which is defined by the World Health Organization as "(a) the disease or injury which initiated the train of morbid events leading directly to death, or (b) the circumstances of the accident or violence which produced the fatal

injury" (1). Statistics Canada has tabulated mortality statistics based on this definition since its introduction with ICD-6, first applied in Canada to 1950 mortality data.

When only one condition is listed on the medical certificate of cause of death, that condition is the underlying cause of death. When more than one condition is listed, a set of rules has been developed by the World Health Organization to select the underlying cause from among all the conditions on the certificate.

Approximately 80% of medical certificates of cause of death have more than one condition reported (3). Selection of the underlying cause begins with the **General Principle**, which states: "when more than one condition is entered on the certificate, select the condition entered alone on the lowest used line of Part I only if it could have given rise to all the conditions entered above it" (1).

When the General Principle cannot be applied because a medical certificate of cause of death has not been completed correctly by the medical certifier, **Selection Rules 1** and **2** are applied in sequence to determine the tentative underlying cause from the conditions listed on the certificate. **Selection Rule 3** is applied to the tentative underlying cause as selected by the General Principle, Rule 1 or Rule 2, if that cause is an obvious consequence of a condition reported elsewhere on the medical certificate. Some studies (4) estimate that up to one-third of certificates contain errors in sequencing of the events leading to death, show causally unrelated diseases in causal sequences, or list non-specific conditions or mechanisms of death as underlying causes.

Once the tentative underlying cause has been selected, six **Modification Rules** are applied to improve the utility of the information. One of these modification rules is applied when a trivial condition unlikely to cause death has been selected as the tentative underlying cause; this rule enables another, more-serious, condition reported on the medical certificate of cause of death to be selected as the underlying cause. Another modification rule is applied where the tentative underlying cause is linked by a provision in the Classification with one or more of the other conditions on the certificate to produce an underlying cause that is a combination of these conditions.

Both the Selection Rules and the Modification Rules differ between ICD-9 and ICD-10. For trend analysis, the rule change with the largest effect on mortality data is the widening of the scope of Selection Rule 3 on obvious consequences, particularly for pneumonia. Pneumonia and bronchopneumonia may now be accepted as complications or obvious consequences of many more diseases than was the case for Selection Rule 3 in ICD-9. Thus, many deaths that would have been classified to pneumonia in ICD-9 will be classified to other conditions when using ICD-10. The effects of changes in Selection and Modification Rules on specific causes of deaths are discussed in the **Comparability study results** section. Detailed information on the application of rules is in the ICD-9 (5) and ICD-10 (1) manuals. A comparison of ICD-9 and ICD-10 rules is presented in Table 3.

Changes in tabulation lists

Mortality statistics are presented in a number of ways, by various groupings of the causes of death. ICD-10 includes four special tabulation lists for international comparisons, along with guidelines for creating country-specific lists. Some international organizations and individual countries have developed their own tabulation lists. For this comparability study, underlying cause of death codes have been grouped in two ways: by chapter for summary ratios, and by the NCHS list of 113 selected causes of death (6). Data users are advised to study carefully the group definitions to determine the appropriate summary group to use when analyzing trends, as some disease conditions have been assigned to new chapters, blocks, cause groups and categories in ICD-10 compared with ICD-9 (Table 4).

Training of mortality classification staff

The implementation date of ICD-10 as the national mortality classification standard in Canada was influenced by a number of factors. During the late 1980s and early 1990s, Statistics Canada and some provincial vital statistics registries began using components of the automated mortality classification system, known collectively as the Mortality Medical Data System (MMDS), developed and maintained by the United States National Center for Health Statistics (NCHS). Implementation of ICD-10 for mortality classification in Canada depended on MMDS being modified by the NCHS to apply ICD-10 codes and rules for determining the underlying cause of death. The United States modified MMDS to implement ICD-10 for their 1999 mortality data. An additional consideration was the World Health Assembly's recommendation for changes to the medical certificate of cause of death for ICD-10: the addition of a fourth line in Part I of the medical certificate of cause of death, and the inclusion of questions on current pregnancy and pregnancy within one year of death for female decedents. Many provincial and territorial registries updated their registration forms and accompanying processing systems for the year 2000; at the same time, they incorporated the recommended changes to the medical certificate of cause of death on their death registration forms. The availability of the ICD-10 version of the U.S. automated mortality classification system for 1999 and the provincial and territorial registration form and processing system updates for 2000 created the right circumstances for Statistics Canada and the provincial and territorial registrars to select 2000 as the implementation year for ICD-10 classification of mortality statistics in Canada.

Statistics Canada is responsible for training mortality classification staff. Because both the English-language ICD-10 and the French-language CIM-10 are used in Canada, separate automated mortality classification systems and training streams are required.

For ICD-10 implementation, the English-language training was done in stages. Pre-classroom computer-based training was distributed to Statistics Canada's mortality classification staff and to mortality classification staff employed by the governments of Ontario, Saskatchewan and British Columbia. Classroom training for mortality classification staff was conducted in Ottawa in 1999. For trained and experienced ICD-9 underlying cause coders, a five-day course on ICD-10 underlying cause classification was

offered. For trained and experienced ICD-9 multiple cause coders, a five-day course on ICD-10 multiple cause classification was presented. A ten-day course on ICD-10 multiple cause classification was offered to staff who were not trained in ICD-9 multiple cause classification. A two-day seminar for analysts on how to use ICD-10-coded mortality data was presented by NCHS staff in June 2000 in Ottawa to representatives of each province and territory, as well as to analysts from Statistics Canada and Health Canada.

In Quebec, the majority of medical certificates of cause of death are completed in French; in the rest of Canada, English is used by the majority of medical certifiers. Up to 1999, mortality classification staff in Quebec did manual underlying cause selection using CIM-9 and the related rules.

The Centre d'épidémiologie sur les causes médicales de décès at the Institut national de la santé et de la recherche médicale (CépiDc-INSERM) in France developed Styx, an automated mortality classification system. Styx incorporates CIM-10, enabling the automated classification of cause of death from medical certificates completed in French. Styx includes the same decision tables as MMDS, and theoretically should provide underlying cause in a manner identical to what MMDS would select, given equivalent medical certification of cause of death in French and in English.

Statistics Canada proposed that Quebec use Styx for the automated classification of medical certificates of cause of death, starting with 2000 data. In March 2000, two analysts from CépiDc-INSERM provided training on mortality classification in CIM-10 and Styx reject resolution to mortality classification staff of the Institut de la statistique du Québec (ISQ). They also offered a technical orientation on the Styx system, providing training on data capture and implementing the STYX software; this technical orientation was attended by ISQ and Statistics Canada staff. ISQ classification staff had also completed pre-classroom French-language computer-based training on CIM-10 and attended the English-language multiple cause and underlying cause training courses for experienced coders.

Additional documentation was developed and distributed to all provinces and territories for their use in editing statistical files and producing tables on death statistics. Bilingual cause of death reference files (with underlying cause, age and sex edits) were sent to all vital statistics registrars in August 2000, and bilingual tabulation lists (based on the NCHS lists) were sent in November 2000.

Section III: Comparability study data and methods

The comparability study

The overall effect of adding new code categories, changing the rules for selecting the underlying cause, and creating new tabulation categories, has been to disrupt trends in the statistics on underlying cause of death. The size of this disruption can be measured by a comparability study, also known as a bridge-coding study. In a comparability study,

mortality records are "dual-coded", that is, classified by both the new and the preceding revision of the ICD. From the resulting database, comparability ratios are derived by comparing the number of deaths classified to a particular cause or group of causes in the new revision to the number classified to the comparable cause or group of causes in the preceding revision.

A question that is often raised by researchers when adapting to the use of ICD-10-coded mortality statistics is whether they can simply use a conversion table of ICD-9 codes with the equivalent ICD-10 codes to analyse the death statistics classified to each revision of ICD. There are two major impacts of ICD-10 that a conversion table cannot measure: the impact of the rule changes between ICD-9 and ICD-10; and the impact of different definitions or concepts for similarly-named disease and external cause categories in the two revisions. Only a comparability study can quantify these impacts.

Comparability studies in the United States have shown that the introduction of a new revision impacts statistical trends (7). This ICD-10 / ICD-9 study, which uses Canadian data, is the first mortality classification comparability study done by Statistics Canada. This study represents a major effort by Statistics Canada's mortality classification staff, methodologists and vital statistics analysts. The study design and schedule were driven in part by the priority given to the regular production of vital statistics data.

Study design

The original study design was to dual-code the entire 1999 Deaths data file. However, the conditions to do so successfully, i.e. with the available resources and in time for the release of 2000 death data, did not exist. A modified study design was developed to:

(1) Dual-code a sample of deaths in provinces for which the MMDS automated system inputs were not available; and

(2) Dual-code all deaths in provinces and territories for which the MMDS inputs were available.

MMDS inputs were not available for deaths in New Brunswick and Quebec, because substantial proportions of the medical certificates of cause of death were completed in French and the underlying cause of death had been classified manually. In Manitoba, the MMDS inputs that had been generated in processing the 1999 deaths had not all been archived, so were no longer available.

MMDS inputs were available for all 1999 deaths in Newfoundland and Labrador, Prince Edward Island, Nova Scotia, Saskatchewan, Alberta, and British Columbia. However, it was discovered during the study that MMDS input files were available for only half of the 1999 Ontario deaths (42,000 out of 81,600 deaths). At that point, the sample design had already been completed and implemented.

Of the 42,000 Ontario deaths on the available MMDS input files, 86% (36,000 out of 42,000) were successfully classified in ICD-10 with the automated system; the remainder were rejected by the system and required manual resolution for classification of the underlying cause of death. For the preliminary comparability study results, it was decided to include only the 36,000 Ontario deaths successfully classified in ICD-10 with MMDS. A similar decision was made by the NCHS for the preliminary U.S. comparability study: the non-rejected records were treated as a simple random sample because, "for most causes, the cause-of-death distribution of the records across revisions should not be substantially different for the excluded records than for those included in the sample" (7).

In this Canadian mortality study, some bias may have been introduced when different versions of the MMDS software were used for dual-coding various batches of the death records. Better version control would have enabled the assessment of system-related anomalies affecting the comparability ratios.

Sample design

The study design called for a sample to be drawn of deaths in New Brunswick, Quebec and Manitoba, the three provinces for which MMDS automated system inputs were not available. A stratified random sample of the deaths that occurred in each province was designed, with the stratification based on the ICD-9 code for the underlying cause of death.

The 1997 death data file was used to determine the required sample size for each province. It was the most recent complete death data file available at the time the sample was designed. The distribution of underlying cause of death codes was assumed to be similar in 1997 and in 1999.

Time and resource constraints necessitated an upper limit of 7,000 records for the total sample size. This represented approximately 10% of the deaths in these three provinces in 1997 and in 1999. The stratified random sample was designed to meet the following requirements:

(1) ICD-9 codes were defined as "rare" if there were 1 to 10 deaths classified to that underlying cause code for all of Canada in 1997. Rare ICD-9 codes became "take-all" strata, that is, all of these deaths would be dual-coded. This generated an estimated sample of 1,121 records over the 3 provinces.

(2) For the non-rare ICD-9 codes that were used in the 1997 death data file (11 or more deaths classified to an ICD-9 code), at least 2 deaths classified to each ICD-9 code within each province were included in the sample, so that variance estimates would be possible for every ICD-9 code within each province. This required an additional 2,917 sampled records.

(3) For the remaining part of the sample of 7,000 deaths, the sample size for each non-rare ICD-9 code was increased so that:

- comparability ratios (ICD-10/ICD-9) of 0.625 or higher could be estimated accurately;
- any ICD-9 code used in the 1999 data file that had not been used in the 1997 data file in the sampled provinces would become take-all strata; and
- the sample weight of any one death record (size of stratum divided by number of records sampled from the stratum) would not exceed 200.

When this design was applied to the 1999 deaths data file, the final sample size was 7,073 records, distributed as shown:

Sampled provinces	Sample size	1997 deaths
New Brunswick	849	5,989
Quebec	4,982	54,138
Manitoba	1,242	9,531
Total	7,073	69,658

For this preliminary report, the Manitoba and New Brunswick samples have been dual-coded, but the Quebec sample has not.

Dual-coding procedures

In general, the same procedures were used to dual-code 1999 deaths to ICD-10 as were used to produce the ICD-9 underlying cause of death data. This had the advantage of increasing the validity of the comparability study results because they were generated in a similar way to the regularly-produced mortality statistics. The procedures for the dual-coding of records in ICD-10 differed by jurisdiction, as they did for ICD-9 coding and continue to differ for ICD-10 production coding. For example, 1999 deaths certified in English in the Atlantic provinces, Ontario, the Prairie provinces and British Columbia were coded using MMDS for ICD-9 with manual resolution of rejects, and the records were dual-coded using MMDS for ICD-10 with manual resolution of rejects. The small number of deaths that occurred in the territories was classified manually in both the 1999 production in ICD-9 and for the comparability study in ICD-10.

The dual-coding was done by staff who had been trained and were experienced in ICD-9 mortality classification; at the time they were dual-coding for this study, they had only recently been trained in ICD-10 mortality classification. Their experience and expertise in underlying cause classification using ICD-10 matched neither their ICD-9 coding competence nor their current-day ICD-10 classification skill. In this respect, the situation mirrors the conditions seen in classifying the first year of data after ICD-10 implementation, but not the conditions of the years since then as the mortality classification personnel and reviewers have become more experienced with ICD-10. This underlines the limited validity of the results from this study: they are valid only for 1999 mortality data for Canada, its provinces and territories. Comparability study results are

applicable only for the data year on which the dual-coding was done; users are cautioned not to apply comparability ratios to other data years in a time series analysis. The results are not applicable to mortality data from other countries, nor to other data, such as morbidity (hospitalization) data.

In the study, some deaths were coded to unknown cause in ICD-10 because the final medical certificates of cause of death (from which the ICD-9 cause had been classified to a disease or an external cause) were not available to Statistics Canada. Most of these cases were excluded from this study. However, some were not found in time to be excluded; their impact is noted where it has been measured (for example, in the discussion of the comparability ratio for influenza).

The preliminary dual-coded death data file consists of 98,847 records; these are weighted to represent 157,158 deaths, which equals the number of deaths in 1999 of Canadian residents outside Quebec (the Quebec sample has not been dual-coded). Each record on the file consists of the following variables: a unique identification number, composed of a numeric code for the province or territory of occurrence, concatenated with the death registration number issued by that province or territory; ICD-9 underlying cause of death code; ICD-10 underlying cause of death code; stratum indicator; sample weight; and summary group and chapter indicators for both ICD-9 and ICD-10. This file was used to calculate the comparability ratios and variance estimates reported here.

Calculation of comparability ratios

The comparability ratio (*C*) for a cause or group of causes (*i*) is defined as the number of deaths (*D*) due to a cause in ICD-10, divided by the number of deaths due to a comparable cause in ICD-9.

$$C_i = \frac{D_{i,ICD-10}}{D_{i,ICD-9}}$$

A comparability ratio of 1.00 does not necessarily mean that a cause was unaffected by the implementation of ICD-10, but rather could mean that any increase in allocation was offset by a decrease of equal magnitude. A comparability ratio greater than 1.00 means that the net effect of classification in ICD-10 was more deaths being classified to a cause (or group of causes) compared with the comparable cause classified in ICD-9. A comparability ratio of less than 1.00 means that a net of fewer deaths were classified in ICD-10 to a cause compared with the comparable cause in ICD-9. On a record-level basis, fewer deaths classified to a cause does not imply that deaths "disappeared". These deaths were classified to another cause, and the total number of deaths classified in ICD-10 remains equal to the total number of deaths classified in ICD-9.

Data users should note the definition of a comparable cause. Due to the movement of some diseases and external causes to different chapters or to different blocks or categories within chapters in ICD-10, some causes or groups of causes are conceptually different from the causes or groups of causes used in trend analysis in ICD-

9. For example, a leading cause of death in Canada is cerebrovascular disease. In Statistics Canada's publications for data years 1979 to 1999, cerebrovascular disease was represented by the ICD-9 block of categories 430-438. In ICD-10, cerebrovascular disease is represented by the block of categories I60-I69. The comparable ICD-9 categories to this ICD-10 block are 430-434 and 436-438, excluding the category 435, Transient cerebral ischaemia. The conditions that were classified in ICD-9 to the category 435 are classified in ICD-10 to Chapter VI, Diseases of the Nervous System, in the category G45 and its sub-categories. For the convenience of users, comparability ratios have been calculated for both code groups. Alternate code group definitions such as this are denoted by (Alt) in Table 4.

Calculation of confidence intervals

Variability in the comparability ratio estimates is introduced because of the sampling of death records. To measure this variability, an approximate 95% confidence interval can be calculated for large sample sizes using the following formula:

$$(r - 1.96 * SE(r), r + 1.96 * SE(r))$$

where:

- r is the comparability ratio
- SE(r) is the Standard Error associated with r (the square root of its estimated sampling variance)
- 1.96 is the 97.5 percentile of the standard normal distribution

The formula for SE(r) is pre-programmed into Statistics Canada's Generalized Estimation System. More information on the calculation of SE(r) is presented in the **Technical notes** section. In Table 4, the estimated comparability ratios are reported, along with the lower and upper estimated comparability ratios, calculated using the 95% confidence limits. For example, the comparability ratio for malignant neoplasm of breast is 1.0134, with lower and upper 95% confidence limits of 1.0073 and 1.0194. This is interpreted as knowing with 95% certainty that the true value of the comparability ratio is within the range of 1.0073 to 1.0194.

Section IV: Comparability study results

This section of the report presents detailed explanations of the impact of the introduction of ICD-10 for selected causes of death, particularly those causes used as health indicators. These are preliminary results of the bridge-coding study, based on the sample dual-coded as of October 2004.

At the chapter level, it is evident that the implementation of ICD-10 has resulted in the re-allocation of some deaths among the chapters (Table 4). Nevertheless, the relative proportions of deaths among chapters have not changed. The largest proportion of deaths continue to be those classified to the chapter on Diseases of the circulatory system, followed by those deaths classified to the chapter on Neoplasms. The rarest

events remain the deaths classified to the chapter on Pregnancy, childbirth and the puerperium.

Table 4 presents estimated comparability ratios by detailed causes or groups of causes as well as by chapter. Not all the comparability ratios calculated from the study data are presented in the table. Ratios were suppressed where they were too unreliable for use because of high sampling variability or small number of deaths. Estimates based on small numbers of deaths are likely to be biased.

All results represent the **net** impact of ICD-10, that is, the sum of the movements into and out of the chapters, blocks, groups and categories reported. A comparability ratio at or close to 1.0000 does not necessarily indicate that there was no movement into or out of the group; unless otherwise stated, it indicates only that the movements into the group equalled or approximately equalled the movements out.

Note on the impact of changes to selection Rule 3: Direct consequences

One of the largest impacts of ICD-10 implementation is the effect that the revised scope of selection Rule 3 has had on deaths previously classified in ICD-9 as due to pneumonia (ICD-9 codes 480-486). The large reduction in deaths classified as due to pneumonia, and the corresponding increases in deaths classified as due to a wide variety of other conditions, including Septicaemia, HIV disease, Alzheimer's disease, Parkinson's disease, and external causes, merit describing the impact of this rule change in detail.

In ICD-9, pneumonia was considered to be a direct sequel of a relatively narrow range of conditions: under certain circumstances, as a direct sequel of surgery and trauma; and as a direct sequel of a few infectious and parasitic diseases, such as chicken pox. When ICD-10 was implemented in Canada in 2000, Rule 3 stated that pneumonia could be accepted as a complication of *any* disease, thus broadening the range of primary causes that could be selected as the underlying cause. Application of Rule 3 as originally published by WHO resulted in large decreases in the number of deaths classified as due to pneumonia, and corresponding increases in the number of deaths classified as due to the primary conditions.

In the countries that implemented ICD-10, the decreases in deaths classified as due to pneumonia were so extreme that the Mortality Reference Group, a WHO advisory body on mortality classification issues, recommended narrowing the scope of Rule 3 in pneumonia as a consequence of other diseases. The WHO accepted the group's recommendation; the revised rule is effective as of 2003 (Table 3). This change will moderate the impact of ICD-10 on deaths classified as due to pneumonia and on deaths classified as due to the primary conditions, from 2003 on. Analysts should refer to the selection rule changes when interpreting data for time series covering this period of flux. The Updating and Revision Committee (formerly the Update Reference Committee) (URC), a WHO advisory group on updates to ICD-10, maintains the cumulative and annual lists of approved updates to the classification (8).

Note on the impact of changes to modification Rule A: Senility and other ill-defined conditions

Another rule change that has a wide-ranging impact on mortality statistics is the change to the modification rule on ill-defined conditions. ICD-9 Rule 5 and ICD-10 Rule A have the same purpose: to modify the selected cause of death when it is an ill-defined condition. These are defined in the WHO ICD-9 (5) and ICD-10 (1) manuals as conditions classified to, respectively, ICD-9 codes 780-799 and ICD-10 codes R00-R94 and R96-R99 (ICD-10 code R95, Sudden infant death syndrome is not considered to be ill-defined).

The Mortality Reference Group recommended the expansion of Rule A in ICD-10 to include ill-defined conditions classified to categories outside the range WHO had originally specified; this recommendation was approved by WHO in 1999 and implemented in 2001 (8). One of the conditions included in the expanded list of ill-defined causes of death subject to modification by this rule is unspecified cardiac arrest (ICD-9 code 427.5, ICD-10 code I46.9). This resulted in a sizeable decrease in cardiac arrest deaths in ICD-10 and an increase in the number of deaths across a wide range of categories.

Preliminary results for selected causes of death

Infectious Diseases

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Certain infectious and parasitic diseases	**A00-B99**	**1.0871**	**8.7%**
Tuberculosis	A16-A19	0.8772	-12.3%
Septicaemia	A40-A41	1.2413	24.1%
Viral hepatitis	B15-B19	0.8733	-12.7%
Human immunodeficiency virus (HIV) disease	B20-B24	1.1013	10.1%

The preliminary comparability ratio for ICD-10 Chapter I, Certain infectious and parasitic diseases is 1.0871, signifying that 8.7% more deaths are classified as due to a condition in this chapter in ICD-10 than in the corresponding chapter in ICD-9. The comparability ratios for major blocks and groups within the chapter display considerable differences.

The preliminary comparability ratio for tuberculosis is 0.8772, signifying that 12.3% fewer deaths are classified as due to this disease in ICD-10 when compared to ICD-9. Analysis of the death records revealed that some of the deaths classified to tuberculosis in ICD-9 were erroneously dual-coded by the automated mortality coding software (MMDS) to the sequelae of tuberculosis (ICD-10 code B90.9) because of an

error in the decision tables. This classification error was also made by the software in the 2000 Canadian cause of death data, and thus the comparability ratio accurately represents the impact of the implementation of ICD-10 on the classification of tuberculosis in 2000. The ratio should not be applied to years other than 1999, however, as the error was corrected for the 2001 data year.

The preliminary comparability ratio for the Septicaemia cause group is 1.2413, signifying that 24.1% more deaths were classified to this cause group in ICD-10 than in ICD-9. There are two reasons for this increase. The first is that the change to Rule 3 results in many deaths formerly classified as due to pneumonia being classified to conditions in ICD-10 Chapter I, particularly to septicaemia. In addition, in ICD-10 the condition septic shock is included in the septicaemia category, whereas in ICD-9 it was a condition in Chapter XVI and thus considered to be a symptom, sign and ill-defined condition subject to re-selection by application of Rule 5.

The preliminary comparability ratio for the Viral hepatitis block is 0.8733, signifying that 12.7% fewer deaths were classified to this block in ICD-10 than in ICD-9. Most of the decrease was related to a corresponding increase in deaths classified to Human Immunodeficiency Virus (HIV) disease in ICD-10. The causal and direct sequel relationships between viral hepatitis and HIV disease were not recognised in ICD-9, but are in ICD-10.

A factor contributing to movements of deaths into the Viral hepatitis block in ICD-10 is the inclusion of deaths due to chronic viral hepatitis in the same block as those due to the acute phase of the disease. In ICD-9, chronic viral hepatitis was classified as a disease of the digestive system. This change augments the increase in the number of deaths classified to viral hepatitis as a result of the migration of ICD-9 pneumonia deaths. Even more deaths would have been classified to the viral hepatitis block had there not been confusion in the Canadian mortality classification community about the definition of the new ICD-10 Sequelae of viral hepatitis category. Some records were dual-coded to the sequelae category rather than to one of the chronic viral hepatitis categories. Subsequent work by the WHO's Mortality Reference Group produced a new instruction that brings more clarity to the classification of viral hepatitis as chronic or sequelae. The WHO approved the recommended clarification, with an effective date of January 2005 (8). Statistics Canada applied the clarification earlier, beginning with the 2002 mortality data.

The preliminary comparability ratio for the Human Immunodeficiency Virus (HIV) disease block is 1.1013, indicating that 10.1% more deaths are classified as due to this disease in ICD-10 than in ICD-9. In ICD-9, Rule 3 was not applied when certain causes were reported with HIV disease on the same line or a lower line of Part I, or in Part II of the medical certificate of cause of death. ICD-10 Rule 3 specifies a direct sequel relationship between HIV disease and these conditions. Most notably, deaths classified to viral hepatitis, pulmonary oedema, bacterial endocarditis, and pneumonia in ICD-9 moved to the HIV disease block when classified in ICD-10, by application of ICD-10

Rule 3. Of note, no deaths classified as due to HIV disease in ICD-9 were classified elsewhere in ICD-10 in the dual-coding for the comparability study.

Malignant Neoplasms

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Malignant neoplasms	**C00-C97**	**1.0124**	**1.2%**
Malignant neoplasm of colon, rectum and anus	C18-C21	0.9955	-0.4%
Malignant neoplasm of trachea, bronchus and lung	C33-C34	0.9810	-1.9%
Malignant neoplasm of breast	C50	1.0134	1.3%
Malignant neoplasm of prostate	C61	1.0319	3.2%

The preliminary comparability ratio for Malignant neoplasms is 1.0124, which signifies that approximately 1.2% more deaths are classified as due to malignant neoplasms in ICD-10 than were in ICD-9

The largest influence on the comparability ratio for deaths due to Malignant neoplasms is the increase caused by the application of ICD-10 Rule 3, the rule for direct sequels. In ICD-10, pneumonia is considered to be a consequence of a much wider range of conditions than was the case in ICD-9. The result is that many deaths classified in ICD-9 as due to pneumonia are classified as due to malignant neoplasms in ICD-10. The impact of ICD-10 Rule A, for ill-defined conditions, on deaths classified in ICD-9 as due to cardiac arrest (an ill-defined condition), is also observed to cause an increase in the number of deaths classified as due to malignant neoplasms in ICD-10.

A smaller impact on the comparability ratio in the opposite direction was the result of the movement of some deaths out of the malignant neoplasms group. The implementation of ICD-10 means that some deaths formerly classified as due to malignant neoplasms are now classified as due to Human Immunodeficiency Virus (HIV) Infection. In ICD-9, with the exception of Kaposi's sarcoma and lymphoma of the brain, a malignant neoplasm caused by HIV infection was considered to be highly improbable, however, this reported sequence is accepted in ICD-10.

To understand the impact of the implementation of ICD-10 on mortality statistics for specific sites of malignant neoplasms, it must be noted that the rules and guidelines for selecting the primary site of a malignant neoplasm in ICD-10 are very different from those in ICD-9. Most significantly, the order of entry of malignant neoplasms in Part I of the medical certificate of cause of death, a main principle in the selection of the primary site of a malignant neoplasm in ICD-9, is not taken into account in the selection of the primary site of a malignant neoplasm in ICD-10. The impact of this change is movement in the classification of deaths among the primary sites of malignant neoplasms, and into a new category, ICD-10 code C97, Malignant neoplasms of independent (primary) multiple sites.

Detailed explanations for four selected sites are presented below: deaths due to malignant neoplasms of these sites represent over half (51%) of the 61,500 malignant neoplasm deaths in 1999.

The preliminary comparability ratio for deaths due to Malignant neoplasms of the colon, rectum and anus is 0.9955, signifying no statistically significant change in the number of deaths classified to this cause group. Some deaths that had been classified to this cause group in ICD-9 were classified to three other groups of sites in ICD-10: (1) malignant neoplasms of other primary sites, particularly breast; (2) malignant neoplasms of ill-defined sites within the digestive system; and (3) malignant neoplasms of independent (primary) multiple sites. Each of these shifts is the result of the application of ICD-10 guidelines for selecting the primary site of a malignant neoplasm when more than one site is certified.

The movement of deaths out of the Malignant neoplasms of the colon, rectum and anus cause group is mostly offset by the movement of deaths into this cause group that were formerly classified as due to cardiac arrest, to pneumonia, and to malignant neoplasms of trachea, bronchus and lung.

The preliminary comparability ratio for deaths due to Malignant neoplasms of the trachea, bronchus and lung is 0.9810, indicating a net decrease of 1.9% in the number of deaths classified to this cause group. There are two main reasons for this net decrease. The first is that in the ICD-10 guidelines for selecting a primary site, the lung is considered to be a common site of metastases. This means that malignant neoplasms of the lung are interpreted as being secondary when reported with other sites not considered to be common sites of metastases, for example, breast and prostate. The second reason for movement out of this cause group is the new ICD-10 category C45, Mesothelioma. In ICD-9, mesothelioma was classified as a malignant neoplasm of the site specified; often this was the lung. Although some deaths moved into this cause group as a result of the application of ICD-10 Rule 3 (deaths formerly classified to pneumonia), and ICD-10 Rule A (deaths formerly classified to cardiac arrest), their numbers did not offset the impact of the ICD-10 guidelines on selecting the primary site of a malignant neoplasm.

The preliminary comparability ratio for deaths due to Malignant neoplasm of breast is 1.0134, signifying an increase of 1.3% in the number of deaths classified as due to this category. Most of the increase can be attributed to the movement of deaths that had been classified in ICD-9 as due to cardiac arrest, to pneumonia, and to malignant neoplasms of trachea, bronchus and lung.

The preliminary comparability ratio for deaths due to Malignant neoplasm of prostate is 1.0319, signifying an increase of 3.2% in the number of deaths classified to this category. Movements into this category came primarily from deaths classified in ICD-9 as due to cardiac arrest, to pneumonia, and to malignant neoplasm of trachea, bronchus and lung. This category saw few shifts to other cancer sites; there was some

movement to malignant neoplasms of independent (primary) multiple sites, but few other movements.

Endocrine, nutritional and metabolic diseases

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Endocrine, nutritional and metabolic diseases	**E00-E90**	**1.0360**	**3.6%**
Diabetes mellitus	E10-E14	1.0404	4.0%

The preliminary comparability ratio for ICD-10 Chapter IV, Endocrine, nutritional and metabolic diseases is 1.0360, signifying that 3.6% more deaths are classified as due to a cause in this chapter in ICD-10 than were to the corresponding chapter in ICD-9. Over three-quarters of the deaths in this chapter are classified to one block of categories: Diabetes mellitus.

The preliminary comparability ratio for Diabetes mellitus is 1.0404, which signifies that 4.0% more deaths are classified to this block in ICD-10 than were in ICD-9. Almost one-third of the increase in the number of deaths classified to diabetes is due to the application of ICD-10 Rule 3 to pneumonia and Rule A to cardiac arrest. Another one-third of the increase was the result of the application of ICD-10 Rule 3, which allows a direct sequel relationship between peripheral vascular disease (PVD) (ICD-10 code I73.9) and diabetes. In ICD-9 these two conditions were only combined if the PVD was reported as due to the diabetes. The remaining one-third of the increase came from a variety of other causes, particularly from diseases of the circulatory system.

Moderating the increase in the number of deaths classified to diabetes in ICD-10 is the outflow of deaths that were classified to diabetes in ICD-9 into Septicaemia (ICD-10 category A41). The movement to septicaemia is likely due to the inclusion of the condition septic shock in the Septicaemia category within ICD-10 Chapter I, because septic shock is no longer considered to be an ill-defined condition (as it was in ICD-9).

Diseases of the nervous system

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Parkinson's disease	G20-G21	1.0551	5.5%
Alzheimer's disease	G30	1.5845	58.4%

The preliminary comparability ratio for Parkinson's disease is 1.0551, signifying an increase of 5.5% in the number of deaths classified to this cause in ICD-10. Almost all of the increase is the result of the influx of deaths classified in ICD-9 as due to pneumonia.

The preliminary comparability ratio for Alzheimer's disease is 1.5845, signifying that 58.4% more deaths are classified as due to this disease in ICD-10 than were in ICD-9. Most of the increase is due to the movement of deaths that had been classified to the ICD-9 category 290, Senile and presenile organic psychotic conditions, in particular to sub-category 290.1, Presenile dementia, which included dementia in Alzheimer's disease. In ICD-10, dementia in and due to Alzheimer's disease are classified to Alzheimer's disease. The shift was augmented by the migration into Alzheimer's disease of many deaths formerly classified as due to pneumonia.

Although the net impact of ICD-10 was a large increase in deaths classified to Alzheimer's disease, some deaths which had been classified in ICD-9 as Alzheimer's disease were classified elsewhere in ICD-10, most of them to J69.0, Pneumonitis due to food and vomit (aspiration pneumonia). This shift is due to the deletion in ICD-10 of a direct sequel relationship between aspiration pneumonia and Alzheimer's disease that was present in ICD-9.

Diseases of the circulatory system

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Diseases of the circulatory system	**I00-I99**	**0.9974**	**-0.3%**
Major cardiovascular diseases	I00-I78	1.0003	0.0%
Ischaemic heart diseases	I20-I25	1.0318	3.2%
Acute myocardial infarction	I21-I22	0.9739	-2.6%
Cerebrovascular diseases	I60-I69	1.0610	6.1%

The preliminary comparability ratio for ICD-10 Chapter IX, Diseases of the circulatory system is 0.9974, signifying no statistically significant change in the number of deaths classified to conditions in this chapter than were to the corresponding chapter in ICD-9. The preliminary comparability ratio for Major cardiovascular diseases in ICD-10 is 1.0003, signifying that the net impact of ICD-10 classification on this group of conditions is essentially nil.

The preliminary comparability ratio for Ischaemic heart diseases is 1.0318, signifying that 3.2% more deaths are classified to this group of conditions in ICD-10 than were in ICD-9. It is important to note that included in the block of ICD-10 codes for Ischaemic heart disease is I25.0, Atherosclerotic cardiovascular disease, so described. In ICD-9 this cause of death was not included in the Ischaemic heart diseases block of codes, but rather in ICD-9 code 429.2, Cardiovascular disease, unspecified. An alternate comparability ratio was calculated for the Ischaemic heart diseases block by including deaths classified to ICD-9 code 429.2 with those classified to the ICD-9 Ischaemic heart diseases block; this has the effect of increasing the comparability ratio to 0.9988. This signifies that the number of deaths classified to this block of codes in ICD-10 is not statistically significantly different from the number classified to the corresponding block plus code 429.2 in ICD-9.

The preliminary comparability ratio for Acute myocardial infarction is 0.9739, signifying that 2.6% fewer deaths are classified to this category in ICD-10 than in ICD-9. The most significant impact of the application of ICD-10 to deaths classified in ICD-9 as due to acute myocardial infarction is the movement of many of these deaths to ICD-10 categories I24, Other acute ischaemic heart disease and I25, Chronic ischaemic heart disease.

In ICD-9 coronary (artery) disease was classified to code 410, Acute myocardial infarction, if specified as acute or stated with duration of 8 weeks or less. In ICD-10 coronary (artery) disease is classified to code I25.1, Atherosclerotic heart disease, regardless of specification as acute or chronic or a stated duration. This accounts for 40% of the net decrease in the number of deaths classified as due to acute myocardial infarction in ICD-10.

Almost 25% of the net decrease in the number of deaths classified as due to acute myocardial infarction in ICD-10 is caused by movement to the new ICD-10 code I24.9, Acute ischaemic heart disease, unspecified. In ICD-9 Ischaemic heart (disease) specified as acute or stated with duration of 8 weeks or less, was classified to code 410, Acute myocardial infarction. In ICD-10 this cause of death is classified to code I24.9.

Another 10% of the net decrease in the number of deaths classified as due to acute myocardial infarction in ICD-10 is a result of a change in the duration qualified as acute or chronic. In ICD-9, category 410 includes myocardial infarctions and other inclusion terms not specified as acute, but with a stated duration of 8 weeks or less. In ICD-10 the stated duration used to qualify an unspecified myocardial infarction as acute is 4 weeks or less, resulting in fewer deaths classified as due to acute myocardial infarctions.

The preliminary comparability ratio for Cerebrovascular diseases is 1.0610, signifying that 6.1% more deaths are classified to this block in ICD-10 than were in ICD-9. This is primarily due to a change in the classification of deaths due to arteriosclerotic or vascular dementia. In ICD-9, these deaths were classified to the category 290, Senile and presenile organic psychotic conditions. The comparable ICD-10 category F01, Vascular dementia, is not used in mortality classification when the underlying physical condition is known. Augmenting this increase is the inflow of many deaths classified in ICD-9 as due to pneumonia or to cardiac arrest.

Deaths classified in ICD-9 to the category Transient cerebral ischaemia (ICD-9 code 435) are classified in ICD-10 to the category Transient cerebral ischaemic attacks and related syndromes (ICD-10 code G45); the latter is outside the Cerebrovascular diseases block. The impact of this change can be estimated by calculating an alternate comparability ratio that excludes deaths classified to the ICD-9 category Transient cerebral ischaemia from the Cerebrovascular diseases block. The result is a comparability ratio of 1.0688, signifying that 6.9% more deaths are classified to the Cerebrovascular diseases block in ICD-10 than were in ICD-9 when the deaths classified to ICD-9 category 435 are excluded from the calculation.

Respiratory system diseases

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Diseases of the respiratory system	**J00-J99**	**0.8556**	**-14.4%**
Influenza and pneumonia	J10-J18	0.5623	-43.8%
Influenza	J10-J11	0.9606	- 3.9%
Pneumonia	J12-J18	0.5317	-46.8%
Chronic lower respiratory diseases	J40-J47	1.0862	8.6%

The preliminary comparability ratio for ICD-10 Chapter X, Diseases of the respiratory system is 0.8556, signifying that 14.4% fewer deaths are classified to conditions in this chapter than were to the corresponding chapter in ICD-9.

While there was a net outflow of deaths classified to ICD-10 Chapter X, Diseases of the respiratory system, in the dual-coding exercise a small number of deaths moved into the chapter; this movement was due to the inclusion of the condition Respiratory failure, not elsewhere classified (ICD-10 code J96). In ICD-9, this condition was classified to a sub-category (ICD-9 code 799.1) in Chapter XVI, Symptoms, signs and ill-defined conditions. Its location in Chapter XVI made it subject to ICD-9 Rule 5; this rule modifies the cause of death when it is an ill-defined condition. In ICD-10, this condition was not subject to Rule A for senility and other ill-defined conditions because of its location outside the range of codes originally specified by WHO as ill-defined (ICD-10 codes R00-R94 and R96-R99). WHO approved an expansion to Rule A, effective for 2001, that makes ill-defined conditions classified to codes outside the range R00-R94 and R96-R99 subject to the application of this rule (8); respiratory failure is one of the affected conditions, thus establishing it once again as an ill-defined condition.

The preliminary comparability ratio for Influenza and pneumonia is 0.5623, signifying that 43.8% fewer deaths are classified to conditions in this block in ICD-10 than were in ICD-9. Deaths due to influenza are affected to a much smaller degree than are deaths due to pneumonia. The preliminary comparability ratio for Influenza is 0.9606, signifying that 3.9% fewer deaths are classified as due to this cause in ICD-10 than were in ICD-9. This ratio overestimates the decrease, almost half of which can be attributed to deaths that were dual-coded to unknown cause (R99, Other ill-defined and unspecified causes of mortality) in ICD-10 because only interim medical certificates of cause of death were available to Statistics Canada. The deaths had been classified in ICD-9 using final medical certificates of cause of death with more complete information than the interim certificates.

The preliminary comparability ratio for Pneumonia was 0.5317, signifying that 46.8% fewer deaths are classified as due to this cause in ICD-10 than were in ICD-9. As described in the **Note on the impact of changes to Selection Rule 3: Direct consequences**, the most profound impact of the implementation of ICD-10 on mortality trends is the reduction in the number of pneumonia deaths. Rule 3 in ICD-10 establishes that pneumonia can be accepted as the consequence of any disease; this is much broader

than the corresponding rule in ICD-9. Application of ICD-10 Rule 3 results in substantial outflows of deaths from this cause group. Of the deaths classified to pneumonia in ICD-9 but to another cause in ICD-10, 12.5% were classified to ICD-10 category F03, Unspecified dementia. An additional 15.5% were classified to ICD-10 category J44.9, Chronic obstructive pulmonary disease (COPD), unspecified. In ICD-9, there was no direct sequel relationship between pneumonia and COPD.

The preliminary comparability ratio for Chronic lower respiratory diseases is 1.0862, signifying that 8.6% more deaths are classified as due to a condition in this block in ICD-10 than were in ICD-9. Over 85% of the increase is due to the application of ICD-10 Rule 3 to deaths classified in ICD-9 to pneumonia, and the application of ICD-10 Rule A to deaths classified in ICD-9 to cardiac arrest.

Diseases of the digestive system

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Diseases of the digestive system	**K00-K93**	**1.0192**	**1.9%**
Chronic liver disease and cirrhosis	K70, K73-K74	1.0632	6.3%
Alcoholic liver disease	K70	1.0951	9.5%
Other chronic liver disease and cirrhosis	K73-K74	1.0322	3.2%

The preliminary comparability ratio for ICD-10 Chapter XI, Diseases of the digestive system is 1.0192, signifying that 1.9% more deaths are classified to conditions in this chapter in ICD-10 than were to the corresponding chapter in ICD-9. An important group within this chapter is Chronic liver disease and cirrhosis, itself composed of two sub-groups, Alcoholic liver disease, and Other chronic liver disease and cirrhosis.

The preliminary comparability ratio for Alcoholic liver disease is 1.0951, signifying that 9.5% more deaths are classified as due to conditions in this category in ICD-10 than were to the corresponding category in ICD-9. The primary reason for this increase is deaths caused by liver failure due to alcoholism that were classified in ICD-9 as due to alcoholism, in Chapter V, Mental Disorders. In ICD-10 such deaths are classified as due to alcoholic liver failure (ICD-10 code K70.4). Deaths formerly classified as due to pneumonia and cardiac arrest also contribute to the increase in the number of deaths classified as due to alcoholic liver disease in ICD-10. In turn, these shifts affect the comparability ratios at the group and chapter level.

Of note, there was evidence of some shifting from ICD-9 alcoholic liver disease as the underlying cause of death to ICD-10 non-alcoholic liver disease. A review of a small sample of such deaths revealed an underlying cause of death of Laennec's cirrhosis, classified in ICD-9 as alcoholic liver cirrhosis, but initially classified in ICD-10 as non-alcoholic liver cirrhosis. The Mortality Reference Group considered this classification issue and proposed changing the classification of Laennec's cirrhosis from non-alcoholic

to alcoholic liver cirrhosis; the WHO accepted this update to ICD-10, which is effective for the 2003 data year (8).

Diseases of the genitourinary system

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Diseases of the genitourinary system	**N00-N99**	**1.0106**	**1.1%**
Nephritis, nephrotic syndrome and nephrosis	N00-N07, N17-N19, N25-N27	1.0487	4.9%
Renal failure	N17-N19	1.0663	6.6%

The preliminary comparability ratio for ICD-10 Chapter XIV, Diseases of the genitourinary system is 1.0106, signifying that 1.1% more deaths are classified as due to conditions in this chapter than were to the corresponding chapter in ICD-9. However, this increase is not statistically significant. The preliminary comparability ratio for the group of conditions comprising Nephritis, nephrotic syndrome and nephrosis is 1.0487, signifying that 4.9% more deaths are classified as due to conditions in this group in ICD-10 than were in ICD-9.

Within this group, the preliminary comparability ratio for the Renal failure block is 1.0663, signifying that 6.6% more deaths are classified as due to renal failure in ICD-10 than were in ICD-9. The largest part of the increase (30%) is the result of a change in the classification of a single cause of death: End-stage renal disease. In ICD-9, this term was not indexed; a classification decision was made to classify deaths from this condition to ICD-9 sub-category 593.9, Other disorders of kidney and ureter, unspecified. In ICD-10, this condition has its own sub-category, N18.0, End-stage renal disease, which is now within the Renal failure block of codes. Because Renal failure is within the group of codes for Nephritis, nephrotic syndrome and nephrosis, this change in the Classification also accounts for much of the 4.9% increase in the number of deaths classified to this group in ICD-10.

Changes to the application of Rule 3, affecting deaths previously classified to pneumonia, and Rule A, affecting deaths previously classified to cardiac arrest, were also factors in the increased number of deaths classified as due to Renal failure in ICD-10 than were in ICD-9.

External causes of death

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
External causes of morbidity and mortality	**V01-Y98**	**1.0186**	**1.9%**
Accidents (unintentional injuries)	V01-X59, Y85-Y86	1.0327	3.3%
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	0.9813	- 1.9%
Falls	W00-W19	0.5018	-49.8%
Intentional self-harm (suicide)	X60-X84, Y87.0	1.0000	0.0%

The preliminary comparability ratio for ICD-10 Chapter XX, External causes of morbidity and mortality is 1.0186, signifying that 1.9% more deaths are classified to causes in this chapter than were to the corresponding chapter in ICD-9. This increase was not statistically significant. There are substantial differences in the comparability ratios among groups of causes in this chapter.

The preliminary comparability ratio for Accidents (unintentional injuries) is 1.0327, signifying that 3.3% more deaths are classified as due to causes in this group in ICD-10 than were to the corresponding group in ICD-9. However, this increase was not statistically significant. As noted in the comparability studies of other countries (7) (9) (10), the increase is largely due to the application of ICD-10 Rule 3 to deaths classified in ICD-9 to pneumonia and ICD-10 Rule A to deaths classified in ICD-9 to cardiac arrest. An unexpected result in this Canadian study was the movement of deaths classified in ICD-9 to heart failure into the ICD-10 category X59, Exposure to unspecified factor. This category includes deaths certified as due to “accidents” with no further specification of the cause. Although this shift represents 25% of the inflow to the Accidents (unintentional injuries) group, its impact on the comparability ratio is small because of the large number of deaths in the group.

The preliminary comparability ratio for Motor vehicle accidents is 0.9813, signifying that 1.9% fewer deaths are classified to this group in ICD-10 than were to the corresponding group in ICD-9. In the U.S. comparability study (7), the preliminary comparability ratio for deaths due to Motor vehicle accidents was 0.8527, signifying a 15% decrease in this cause group. The reason for this substantial drop is the requirement in ICD-10 for the certification of cause of death to explicitly state that the accident involved a "motor" vehicle. In CIM-10, the equivalent term "à moteur" is not required to be explicitly stated. Accidents involving unspecified vehicles are to be classified to the Other land transport accidents block of codes. The U.S. made a classification decision to classify accidents involving unspecified vehicles to the Motor vehicles accidents group of codes when the accidents occur on a highway or road, as they had been classified in ICD-9. The effect of this decision on the U.S. comparability ratio was to increase it to 0.9527. In Canada, this U.S. classification decision was implemented for both the dual-coding for this study and for the 2000 mortality data production coding.

The preliminary comparability ratio for Falls is 0.5018, signifying that 49.8% fewer deaths are classified as due to conditions in this ICD-10 block than were in ICD-9. This extremely large decrease in deaths classified to Falls in ICD-10 is substantially the result of a change in how fractures of unspecified cause are classified. In ICD-9, the Accidental falls block (E880-E888) included the category E887, Fracture, cause unspecified. In ICD-10, the block for Falls (W00-W19) does not include such a category. For this reason a death certified as due to a fracture (of a site, such as hip) without information about the external cause would be classified as a fall in ICD-9, but not in ICD-10.

In ICD-10, deaths from fractures without mention of a fall or specification of any other external cause are classified to X59, Accidental exposure to unspecified factor. Once ICD-10 was implemented, the WHO's Mortality Reference Group began to study expansion of this category to uniquely identify this subset of deaths, in response to public health analysis needs. WHO has accepted the group's proposal to add a new sub-category, X59.0, Exposure to unspecified factor causing fracture, effective for the 2006 data year (8).

There is considerable variability in the comparability ratios estimated for deaths due to falls among studies conducted in different countries. In England and Wales, the comparability ratio for Falls was similar to Canada's, at 0.5555 (11). Other countries reported higher ratios: in the U.S., the ratio was 0.7720 (7); in Scotland, the ratio was 1.00 (9). In England and Wales, as in Canada, the substantial decrease in deaths due to falls was primarily the result of deaths being classified in ICD-9 to the category E887, Fracture, cause unspecified and in ICD-10 to the category X59, Accidental exposure to unspecified factor. In Canada, the decrease in deaths classified to falls was slightly moderated by the movement of deaths classified as due to pneumonia and cardiac arrest in ICD-9 into the Falls block of codes in ICD-10, whereas in Scotland, the outflow to X59 was entirely offset by the inflow of deaths from other categories by the application of Rule 3. Differences among countries in certification may account for this wide range

of results, not only in deaths due to fracture, cause unspecified, but also for other causes of death.

The preliminary comparability ratio for Intentional self-harm (suicide) is 1.0000 in ICD-10, signifying that as many deaths are classified to codes in this block in ICD-10 as were to the comparable block of codes in ICD-9. For this particular block, the net ratio is also the actual ratio, as each and every death that was classified as due to suicide (including its late effects) in ICD-9 is also classified as due to intentional self-harm (suicide) or its late effects in ICD-10.

Causes of infant death

Cause of death	ICD-10 codes	Comparability ratio	Percentage increase/decrease
Certain conditions originating in the perinatal period	P00-P96	1.0225	2.2%
Congenital malformations, deformations and chromosomal abnormalities	Q00-Q99	0.9128	-8.7%
Sudden infant death syndrome	R95	1.0000	0.0%

Conditions originating in the perinatal period, congenital malformations, deformations and chromosomal abnormalities, and sudden infant death syndrome are causes of death that predominate in infant deaths (that is, deaths of children under one year of age). It should be noted that these preliminary comparability ratios were calculated on deaths of persons of all ages, not restricted to deaths of infants. By definition, all deaths classified to Sudden infant death syndrome are of children under one year of age. Deaths due to perinatal conditions are also heavily weighted toward those under one year of age; the proportion was 99% in each of 2000 to 2002. In contrast, deaths due to congenital conditions are less skewed to the first year of life; 52% to 53% of the deaths classified as due to conditions in this Chapter in 2000 to 2002 were of infants, with the remainder occurring in children age one year and older and adults of all ages.

The preliminary comparability ratio for ICD-10 Chapter XVI, Certain conditions originating in the perinatal period is 1.0225, signifying that 2.2% more deaths are classified to conditions in this chapter in ICD-10 than were to the corresponding chapter in ICD-9. Some deaths classified in ICD-9 to sub-category 748.5, Agenesis, hypoplasia and dysplasia of lung in Chapter XIV, Congenital anomalies are classified in ICD-10 to sub-category P28.0, Primary atelectasis of newborn in Chapter XVI; this sub-category includes pulmonary hypoplasia associated with short gestation.

The preliminary comparability ratio for ICD-10 Chapter XVII, Congenital malformations, deformations and chromosomal abnormalities is 0.9128, signifying that 8.7% fewer deaths are classified to conditions in this chapter in ICD-10 than were to the corresponding chapter in ICD-9. In large part, the net decrease is the result of a change to

the indexing and classification of myelodysplasia. In ICD-9, deaths certified as due to myelodysplasia were classified to sub-category 742.5, Other specified anomalies of spinal cord in Chapter XIV, Congenital anomalies. In ICD-10, deaths certified as myelodysplasia are classified to sub-category Q06.1, Hypoplasia and dysplasia of spinal cord in Chapter XVII only if the myelodysplasia is specified as spinal cord (congenital); those deaths not specified as due to spinal cord myelodysplasia are classified to a sub-category in Chapter II, Neoplasms. Another factor in the decrease in the number of deaths classified to congenital anomalies in ICD-10 is the movement of deaths due to pulmonary hypoplasia into Chapter XVI, Certain conditions originating in the perinatal period (for a more detailed explanation, see the paragraph on Chapter XVI).

The comparability ratio for Sudden Infant Death Syndrome (SIDS) was 1.0000, with no movement into or out of this cause of death. This was an unexpected result; in ICD-9, SIDS was considered to be an ill-defined condition, and the application of Rule 5 would modify the selected cause of death to another cause on the medical certificate. ICD-10 Rule A excludes the category R95, Sudden Infant Death Syndrome from the list of conditions considered to be ill-defined and therefore subject to modification. This rule change might have resulted in an increase in the number of deaths classified to SIDS in ICD-10 in Canada; the U.S. comparability study showed a 5.7% increase in deaths classified to SIDS in ICD-10 (7). Canada's results were identical to those of Scotland, where there were no movements into or out of the SIDS category (9); this suggests a Canadian certification practice that precludes the mention of other conditions with SIDS.

Section V: Discussion

Impact of ICD-10 implementation

The implementation of ICD-10 has had a significant impact on mortality trends for many causes of death. This study has explored the reasons for the large decreases in the number of deaths due to pneumonia and influenza, accidental falls, viral hepatitis and tuberculosis, the significant increases in the number of deaths due to Alzheimer's disease and septicaemia, and the more moderate impacts on many other causes of death. This section will illustrate how comparability ratios can be used in analysis of mortality statistics and explain the updating mechanisms for ICD-10.

Use of comparability ratios

The comparability ratios derived from dual-coding medical certificates of cause of death presented in this report estimate the size and direction of the disruption to cause of death trends. Researchers and analysts using Canadian mortality data should use these summary measures to calculate comparability-modified death counts and mortality rates to bridge the gap between ICD-9 and ICD-10. Using the unmodified death counts and mortality rates would be misleading, as this table illustrates.

Cause of death	1999	2000	Percentage increase/decrease
	Unmodified ICD-9	ICD-10	1999 to 2000
Pneumonia and influenza			
Number of deaths	9,011	4,966	- 44.9%
Age-standardized mortality rate (deaths per 100,000 standard population)	25.1	13.2	- 47.4%
Alzheimer's disease			
Number of deaths	2,858	5,007	75.2%
Age-standardized mortality rate (deaths per 100,000 standard population)	7.9	13.2	67.1%

The decrease in the number of deaths due to Pneumonia and influenza from 1999 to 2000, using the unmodified counts, is a startling 44.9%. Similarly, deaths due to Alzheimer's disease increased a hefty 75.2% from 1999 to 2000 when the unmodified counts are used. As the following analysis will show, the large fluctuation in the frequency of these causes of death between 1999 and 2000 is an artefact of the change in the classification standard.

To calculate comparability-adjusted death counts for 1999, multiply the number of deaths due to a particular cause by the comparability ratio for that cause (Table 4). Similarly, to calculate comparability-adjusted mortality rates (for example, crude, age-specific, or, age-standardized mortality rates) for 1999, multiply the mortality rate for a particular cause by the comparability ratio for that cause. The table below illustrates the adjustment to death counts and age-standardized mortality rates.

Cause of death	1999			2000	Percentage increase/ decrease
	Unmodified ICD-9	Comparability ratio ICD-10/ICD-9	Modified (ICD-10)	ICD-10	1999 to 2000
Pneumonia and influenza					
Number of deaths	9,011	Multiply by 0.5623	5,067	4,966	- 2.0%
Age-standardized mortality rate (deaths per 100,000 standard population)	25.1		14.1	13.2	- 6.4%
Alzheimer's disease					
Number of deaths	2,858	Multiply by 1.5845	4,529	5,007	10.6%
Age-standardized mortality rate (deaths per 100,000 standard population)	7.9		12.5	13.2	8.0%

Using the comparability-modified counts shows only a 2.0% decrease in deaths classified to pneumonia and influenza from 1999 to 2000. The comparability-modified

counts show a more modest 10.6% increase for Alzheimer's disease for the same period. Both results are in sharp contrast to those obtained without using the comparability ratios to adjust the death statistics.

Charts 1 to 4 show the impact of the implementation of ICD-10 on mortality trends of some major cause of death groups for the 1979 to 2002 period in Canada. Charts 1 and 2 illustrate the impact of the large decreases in the number of deaths due to Pneumonia and influenza and Accidental falls on the trends for these causes of death. Charts 3 and 4 illustrate the impact of the large increases in the number of deaths due to Alzheimer's disease and Septicaemia on those trends. Adding the comparability-modified data point for 1999 to the graphs shows that most of the change in the trend lines was due to the implementation of the new revision.

Chart 1
Deaths due to pneumonia and influenza, 1979 to 2002, Canada

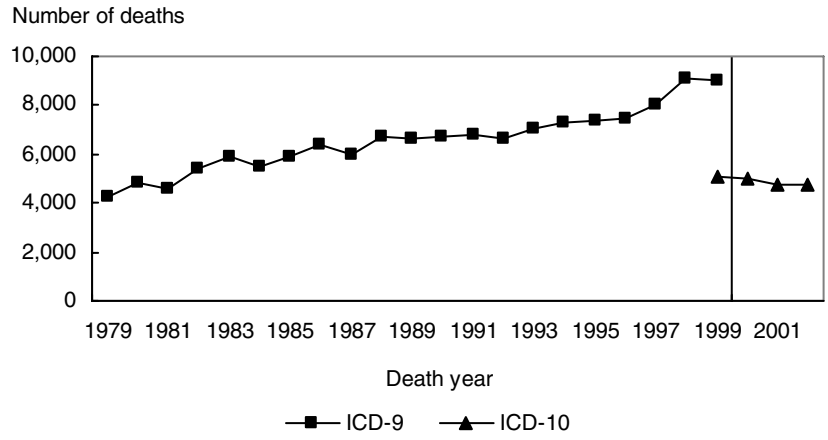


Chart 2
Deaths due to accidental falls, 1979 to 2002, Canada

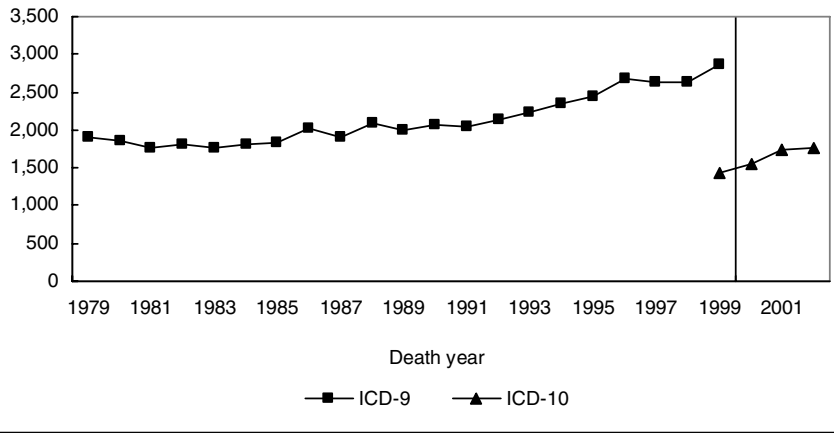


Chart 3
Deaths due to Alzheimer's disease, 1979 to 2002, Canada

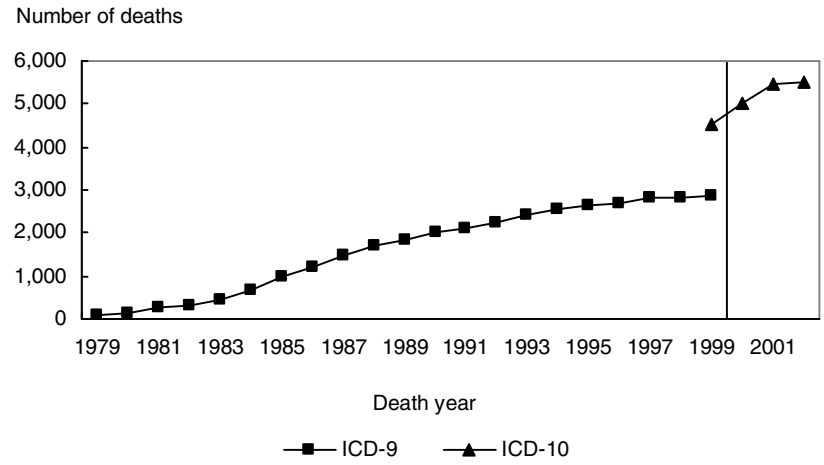
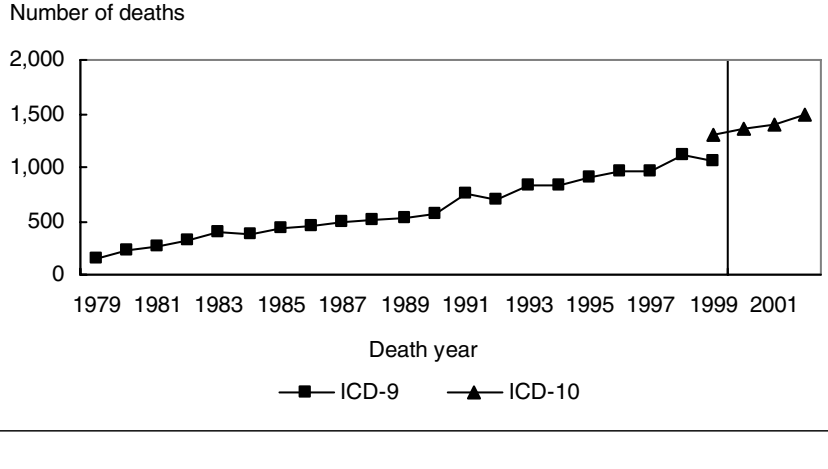


Chart 4
Deaths due to septicaemia, 1979 to 2002, Canada



Readers are cautioned that comparability ratios cannot and should not be used to convert historical data to ICD-10. Given the changes in categories, in Selection Rules and in Modification Rules, the only way to produce valid historical data in ICD-10 is to dual-code the original records. Comparability ratios are valid only for the year of the study, in this case, 1999. Changes in certification practices and disease mortality patterns over a relatively short period of time, from 1996 to 1999, were shown to bias the comparability ratios for Human immunodeficiency virus (HIV) disease, Alzheimer's disease, and Nephritis, nephrotic syndrome and nephrosis in the U.S. comparability study (7).

Future changes to ICD-10

ICD-10 is an updateable classification; this allows changes to be made to the Classification between revisions. Once approved by the WHO, updates to ICD-10 are made on a regular schedule. Statistics Canada participates in all the WHO groups working to achieve the aim of having a stable, yet flexible classification.

Essential to the updating process of ICD-10 are the on-going activities of three World Health Organization-Family of International Classifications (WHO-FIC) Network working and advisory groups (12). The Mortality Forum is an international group that discusses mortality classification issues on-line; selected issues are referred to the Mortality Reference Group. The Mortality Reference Group (MRG) makes decisions on the application and interpretation of ICD-10 for mortality classification, as well as recommending changes to the Classification to the Updating and Revision Committee (formerly the Update Reference Committee) (URC). The URC considers proposals for updates to ICD-10 for both mortality and morbidity, and submits the proposals accepted by the URC to the World Health Organization at the annual meeting of the WHO-FIC Network. Proposals for updates come from the MRG as well as from URC members.

Discussion among the countries participating in these WHO-FIC Network activities underlines the differences among countries in the legislative and operational aspects of certifying and classifying deaths, and implementing new ICD revisions. These differences must be taken into account when comparing data from different countries. For example, the United States implemented ICD-10 for 1999 mortality data, Canada and Scotland for 2000 data, and England and Wales for 2001 data. Data users should exercise caution when comparing international data over these implementation years, especially for causes of death that have comparability ratios not equal to 1.00 (9) (13) (14) (15). Documentation on ICD-10 implementation for each country should be consulted.

In addition, the flexibility envisioned for ICD-10 will mean, operationally and analytically, that new codes and changes to Selection Rules and Modification Rules may be implemented at different times by different countries. At present, the Updating and Revision Committee maintains the cumulative and annual lists of official updates to ICD-10; updates to other language versions of the Classification (such as CIM-10, the French language version) are not yet as accessible.

Mortality versus morbidity classification

In Canada, ICD-10 is used for the classification of cause of death for mortality statistics. Other related, but separate, classifications are used in the coding for morbidity (hospital) statistics. ICD-10-CA was developed by the Canadian Institute for Health Information (CIHI), and is a modified version of ICD-10 "for Canadian Government purposes" (16); this modified version is used by Canadian hospitals and other health care providers for the classification of diseases and conditions requiring health care intervention. ICD-10-CA uses the basic structure of ICD-10, but adds a fifth-character to some sub-categories to capture more detail. Another classification developed by CIHI is the Canadian Classification of Health Interventions (CCI) (17); this classification system for surgical procedures and other interventions complements ICD-10-CA.

It cannot be stressed enough that morbidity statistics are not equivalent to mortality statistics and, therefore, the comparability ratios of this study cannot be used to modify morbidity statistics.

Section VI: Technical notes

Calculation of confidence intervals

For the provinces in which 100% of deaths were dual-coded to ICD-9 and to ICD-10, the comparability ratio, R, is calculated. For the provinces in which a sample of deaths was taken for dual-coding, or for national-level data which include the provinces in which a sample was dual-coded, only a sample based estimate, r, is available for the comparability ratio, R. For the provinces in which a sample was dual-coded, a confidence interval is constructed about r, which is expected to cover the true R with a certain probability. For large sample sizes, one can construct an approximate 95% confidence interval:

$$(r - 1.96 * SE(r), r + 1.96 * SE(r))$$

where (18):

- r is the comparability ratio
- SE(r) is the Standard Error associated with r (the square root of its sampling variance)
- 1.96 is the 97.5 percentile of the standard normal distribution

1. Standard approach to the calculation of standard error

R is the ratio of two population totals:

$$R = Y/X$$

where, for example, $\chi = \sum_i \chi_i$ and the sum runs over i = 1 to N (the population size).

For R, the sample estimate is:

$$r = y/x$$

where, for example, x is the corresponding sample total, $\chi = \sum_i \chi_i$ and the sum now runs over just i = 1 to n (the sample size).

In order to get at least an approximate expression for SE(r), the common practice in sampling texts is to start with a linear approximation to r by doing a Taylor series expansion around R, thus:

$$r = R + (y - Rx)/X, \text{ approximately}$$

Then the sampling variance of r can be approximated by the sampling variance of (y – Rx)/X, (there is no sampling variance associated with the R by itself) which sampling texts give as:

$$\text{Var}\,[(y - Rx)/X] = (1 - n/N)(N^2/X^2)(1/n)\left(\sum_i (Y_i - R*X_i)^2\right)/(N-1)$$

Where N is the population size and n the sample size, and the sum runs over i = 1 to N, the standard error is just the square root of variance, so:

$$SE(r) = SE[(y - Rx)/X], \quad \text{approximately}$$

Where:

$$SE[(y-Rx)/X] = \sqrt{Var\left(\frac{y - R_x}{X}\right)}$$

As a further approximation, however, since R cannot be measured, use:

$$\text{Var}\,[(y - Rx)/X] = (1 - n/N)(N^2/X^2)(1/n)\left(\sum_i (y_i - r*x_i)^2\right)/(n-1)$$

in place of Var [(y – Rx)/X], hence the lowercase "v" in "var" instead of "Var". This sum runs over i = 1 just to n (the sample size) instead of to N (the population size). The square root of this "var" used to estimate "Var" becomes "se" to estimate "SE", so the 95% confidence interval is:

$$(r - 1.96 * se[(y - Rx)/X],\ r + 1.96 * se[(y - Rx)/X])$$

which approximates the 95 % confidence interval:

$$(r - 1.96 * SE[(y - Rx)/X],\ r + 1.96 * SE[(y - Rx)/X])$$

which in turn approximates the 95 % confidence interval:

$$(r - 1.96 * SE(r), r + 1.96 * SE(r))$$

which itself is an approximate 95% confidence interval for R.

2. The GES approach to the calculation of standard error

The calculation of these se[(y – Rx)/X] was actually done using the "cesrs1e" function of the Statistics Canada *Generalized Estimation System (GES)*. This system is designed to accommodate a variety of different estimators, so the calculations are done with a more general technique known as Generalized Regression (GREG) estimation. The details are spared here, but in the case of ratio estimation, it boils down to a slightly different estimate of Var [(y – Rx)/X], namely:

$$\text{var}_{GES}\,[(y - Rx)/X] = (1 - n/N)(N^2/[X\text{-hat}]^2)(1/n)\left(\sum_i \; (y_i - r*x_i)^2\right)/(n-1)$$

The difference between this var_{GES} and the var in the previous section is that whereas the var used the population total, X, the var_{GES} uses an expansion estimator X-hat, where:

$$X\text{-hat} = \sum_i \; w_i\, x_i$$

Where the sum runs over i = 1 to n, and the w_i are the sampling weights.

In the case where the estimator is just over a single stratum or in the case of a self-representing sample where the weights are simply N/n for all sample units, then it can be seen that the N/n factors out of the sum for X-hat, and one gets:

$$X\text{-hat} = N/n * x$$

If this equation is put back into the formula for var_{GES}, one gets:

$$\text{var}_{GES}\,[(y - Rx)/X] = (1 - n/N)(n^2/x^2)(1/n)\left(\sum_i \; (y_i - r*x_i)^2\right)/(n-1)$$

which can be looked at as simply taking the formula for var [(y – Rx)/X] and substituting n/x (the inverse of the sample mean) for N/X (the inverse of the population mean).

Section VII: References

1. World Health Organization. *International Statistical Classification of Diseases and Related Health Problems; Tenth Revision*, Volumes 1 to 3. Geneva: World Health Organization, 1992 to 1994.

2. Organisation mondiale de la Santé. *Classification statistique internationale des maladies et des problèmes de santé connexes; Dixième révision*, Volumes 1 to 3. Genève: Organisation mondiale de la Santé, 1993 to 1996.

3. Wilkins K, Wysocki M, Morin C, Wood P. Multiple causes of death. *Health Reports* (Statistics Canada, Catalogue 82-003-XPB) 1997; 9(2): 19-29.

4. Myers KA, Farquhar DRE. Improving the accuracy of death certification. *Canadian Medical Association Journal* 1998; 158(10): 1317-1323.

5. World Health Organization. *Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death; Ninth Revision*, Volume 1. Geneva: World Health Organization, 1977.

6. National Center for Health Statistics. *Instruction Manual; Part 9; ICD-10 Cause-of-Death Lists for Tabulating Mortality Statistics.* Hyattsville, Maryland: October 2002. Available at: *http://www.cdc.gov/nchs/data/dvs/im9_2002.pdf.pdf*

7. Anderson RN, Miniño AM, Hoyert DL, Rosenberg HM. Comparability of cause of death between ICD-9 and ICD-10: Preliminary estimates. *National Vital Statistics Reports* (National Center for Health Statistics) 2001; 49(2): 1-32. Report available at: *http://www.cdc.gov/nchs/data/nvsr/nvsr49/nvsr49_02.pdf*. Final estimates available at: *ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/Comparability/icd9_icd10/*

8. World Health Organization. *Cumulative list of Official Updates to ICD-10 (1996-2001) and Annual list of Official Updates to ICD-10*. Available at: *http://www2.fhs.usyd.edu.au/ncch/WHO%20URC/who_urc.html*

9. General Register Office for Scotland. *2000 Annual Report; Appendix 2; The introduction of ICD10 for cause of death coding in Scotland*. 2003. Available at: *http://www.gro-scotland.gov.uk/statistics/library/annrep/00annrep/00app2.html*

10. Office for National Statistics. Report: Results of the ICD-10 bridge coding study, England and Wales, 1999. *Health Statistics Quarterly* 2002; 14: 75-83. Available at: *http://www.statistics.gov.uk/downloads/theme_health/HSQ14_v4.pdf*

11. Griffiths C, Rooney C. The effect of the introduction of ICD-10 on trends in mortality from injury and poisoning in England and Wales. *Health Statistics Quarterly* (Office for National Statistics) 2003; 19: 10-21. Available at: *http://www.statistics.gov.uk/downloads/theme_health/HSQ19.pdf*

12. Pan American Health Organization. Updating the International Classification of Diseases, Tenth Revision. *Epidemiological Bulletin / PAHO* 2003; 24(2). Available at: *http://www.paho.org/english/dd/ais/EB_v24n2.pdf*

13. Hoyert DL, Arias E, Smith BL, Murphy SL, Kochanek KD. Deaths: Final data for 1999. *National Vital Statistics Reports* (National Center for Health Statistics) 2001; 49(8): 1-15. Available at: *http://www.cdc.gov/nchs/data/nvsr/nvsr49/nvsr49_08.pdf*

14. Statistics Canada. *Causes of Death, 2000*. (Statistics Canada, catalogue 84-208-XIE) 2003. Available at: *http://www.statcan.ca/english/freepub/84-208-XIE/84-208-XIE2003001.htm*

15. Gastrell, J. Annual update: 2001 Mortality Statistics: Cause (England and Wales). *Health Statistics Quarterly* (Office for National Statistics) 2003; 17:77-79. Available at: *http://www.statistics.gov.uk/downloads/theme_health/HSQ17.pdf*

16. Canadian Institute for Health Information. *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Canada* (ICD-10-CA), Volumes 1 and 2. Ottawa: Canadian Institute for Health Information, 2003.

17. Canadian Institute for Health Information. *Canadian Classification of Health Interventions* (CCI), Volumes 3 and 4. Ottawa: Canadian Institute for Health Information, 2003.

18. Lohr, S. *Sampling: Design and Analysis*. Brooks/Cole Publishing Co., Pacific Grove, CA: 1999.

More information

Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

This report is the culmination of the efforts of many people. The methodologists Sylvie Auger, Jocelyne Marion, and Caroline Veilleux (Household Survey Methods Division) designed the sample and calculated the comparability ratios and confidence intervals. Denise Macdonald and Colette Brassard (Operations and Integration Division) produced the ICD-9 and ICD-10 output files. Their contributions to this study are much appreciated. The authors of this report greatly appreciate the assistance and advice received from international colleagues, in particular Dr. Harry Rosenberg (retired) (National Center for Health Statistics, United States) and Gérard Pavillon (Centre d'épidémiologie sur les causes médicales de décès, Institut national de la santé et de la recherche médicale [CépiDc-INSERM], France).

The cooperation of provincial and territorial Vital Statistics registries who supply to Statistics Canada the death registration information on which this report is based is gratefully acknowledged. Of particular note, the provision of ICD-9 input files by the Ontario, Saskatchewan and British Columbia vital statistics registries was essential.

The report has benefited from the comments of many reviewers. The authors wish to express their gratitude for the valuable comments of Lars Age Johansson (National Board of Health and Welfare, Sweden; Chair, Mortality Reference Group) and Dr. Donna Hoyert (National Center for Health Statistics, United States; Secretary, Mortality Reference Group).

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner and in the official language of their choice. To this end, the agency has developed standards of service which its employees observe in serving its clients. To obtain a copy of these service standards, please contact us.

How to obtain more information

To enquire about the concepts, methods and data quality of the report, please contact Client and Technical Services at 613-951-1746, Health Statistics Division.

Appendix tables

Table 1. ICD revisions used in Canada

ICD revisions used in Canada	
ICD-3	1921-1930
ICD-4	1931-1940
ICD-5	1941-1949
ICD-6	1950-1957
ICD-7	1958-1968
ICDA-8	1969-1978
ICD-9	1979-1999
ICD-10	2000 to present

Table 2. ICD chapter titles

ICD-9			ICD-10		
Chapter	**Title**	**Category range**	**Chapter**	**Title**	**Category range**
I	Infectious and parasitic diseases	001-139	I	Certain infectious and parasitic diseases	A00-B99
II	Neoplasms	140-239	II	Neoplasms	C00-D48
III	Endocrine, nutritional and metabolic diseases and immunity disorders	240-279	III	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	D50-D89
IV	Diseases of blood and blood-forming organs	280-289	IV	Endocrine, nutritional and metabolic diseases	E00-E90
V	Mental disorders	290-319	V	Mental and behavioral disorders	F00-F99
VI	Diseases of the nervous system and sense organs	320-389	VI	Diseases of the nervous system	G00-G99
VII	Diseases of the circulatory system	390-459	VII	Diseases of the eye and adnexa	H00-H59
VIII	Diseases of the respiratory system	460-519	VIII	Diseases of the ear and mastoid process	H60-H95
IX	Diseases of the digestive system	520-579	IX	Diseases of the circulatory system	I00-I99
X	Diseases of the genitourinary system	580-629	X	Diseases of the respiratory system	J00-J99
XI	Complications of pregnancy, childbirth and the puerperium	630-676	XI	Diseases of the digestive system	K00-K93
XII	Diseases of the skin and subcutaneous tissue	680-709	XII	Diseases of the skin and subcutaneous tissue	L00-L99
XIII	Diseases of the musculoskeletal system and connective tissue	710-739	XIII	Diseases of the musculoskeletal system and connective tissue	M00-M99
XIV	Congenital	740-759	XIV	Diseases of the	N00-N99

Table 2. ICD chapter titles

ICD-9			ICD-10		
Chapter	**Title**	**Category range**	**Chapter**	**Title**	**Category range**
	anomalies			genitourinary system	
XV	Certain conditions originating in the perinatal period	760-779	XV	Pregnancy, childbirth and the puerperium	O00-O99
XVI	Symptoms, signs and ill-defined conditions	780-799	XVI	Certain conditions originating in the perinatal period	P00-P96
XVII	Injury and poisoning	800-999	XVII	Congenital malformations, deformations and chromosomal abnormalities	Q00-Q99
No chapter number	Supplementary classification of external causes of injury and poisoning	E800-E999	XVIII	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	R00-R99
No chapter number	Supplementary classification of factors influencing health status and contact with health services	V01-V82	XIX	Injury, poisoning and certain other consequences of external causes	S00-T98
			XX	External causes of morbidity and mortality	V01-Y98
			XXI	Factors influencing health status and contact with health services	Z00-Z99
			XXII	Codes for special purposes	U00-U99

Table 3. Comparison of ICD-9 and ICD-10 rules for selection of underlying cause of death

ICD-9	ICD-10
Selection rules	
General Rule: Select the condition entered alone on the lowest used line of Part I unless it is highly improbable that this condition could have given rise to all the conditions entered above it.	**General Principle**: When more than one condition is entered on the certificate, the condition entered alone on the lowest used line of Part I should be selected only if it could have given rise to all the conditions entered above it.
Rule 1: If there is a reported sequence terminating in the condition first entered on the certificate, select the underlying cause of this sequence. If there is more than one such sequence, select the underlying cause of the first-mentioned sequence.	**Rule 1**: If the General Principle does not apply and there is a reported sequence terminating in the condition first entered on the certificate, select the originating cause of this sequence. If there is more than one sequence terminating in the condition mentioned first, select the originating cause of the first-mentioned sequence.
Rule 2: If there is no reported sequence terminating in the condition first entered on the certificate, select this first mentioned condition.	**Rule 2**: If there is no reported sequence terminating in the condition first entered on the certificate, select this first-mentioned condition.
Rule 3: If the condition selected by the G*eneral rule* or R*ules 1 or 2* can be considered a direct sequel of another reported condition, whether in Part I or Part II, select this primary condition. If there are two or more such primary conditions, select the first mentioned cause.	**Rule 3**: If the condition selected by the G*eneral Principle* or by R*ule 1 or Rule 2* is obviously a direct consequence of another reported condition, whether in Part I or Part II, select this primary condition.
Modification Rules	
Rule 4, Senility: Where the selected underlying cause is classifiable to 797 (Senility) and a condition classifiable elsewhere than to 780-799 is reported on the certificate, reselect the underlying cause as if the senility had not been reported, except to take account of the senility if it modifies the coding. **Rule 5, Ill-defined conditions**: Where the selected underlying cause is classifiable to 780-796, 798-799 (the ill-defined conditions) and a condition classifiable elsewhere than to 780-799 is reported on	**Rule A, Senility and other ill-defined conditions**: Where the selected cause is classifiable to Chapter XVIII (Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified) except for R95 (Sudden infant death syndrome), and a condition classified elsewhere than to R00-R94 or R96-R99 is reported on the certificate, reselect the cause of death as if the condition classified to Chapter XVIII had not been reported, except to take account of that condition if it modifies the coding.

Table 3. Comparison of ICD-9 and ICD-10 rules for selection of underlying cause of death

ICD-9	ICD-10
the certificate, reselect the underlying cause as if the ill-defined condition had not been reported, except to take account of the ill-defined condition if it modifies the coding.	
Rule 6, Trivial conditions: Where the selected underlying cause is a trivial condition unlikely to cause death, proceed as follows: (a) if the death was the result of an adverse reaction to treatment of the trivial condition, select the adverse reaction; (b) if the trivial condition is not reported as the cause of a more serious complication, and a more serious unrelated condition is reported on the certificate, reselect the underlying cause as if the trivial condition had not been reported.	**Rule B, Trivial conditions**: Where the selected cause is a trivial condition unlikely to cause death and a more serious condition is reported, reselect the underlying cause as if the trivial condition had not been reported. If the death was the result of an adverse reaction to treatment of the trivial condition, select the adverse reaction.
Rule 7, Linkage: Where the selected underlying cause is linked by a provision in the classification in the Notes for use in primary mortality coding on pages 713-721 with one or more of the other conditions on the certificate, code the combination. Where the linkage provision is only for the combination of one condition specified as due to another, code the combination only when the correct causal relationship is stated or can be inferred from application of the selection rules. Where a conflict in linkages occurs, link with the condition that would have been selected if the underlying cause initially selected had not been reported. Apply any further linkage that is applicable.	**Rule C, Linkage**: Where the selected cause is linked by a provision in the classification or in the notes for use in underlying cause mortality coding with one or more of the other conditions on the certificate, code the combination. Where the linkage provision is only for the combination of one condition specified as due to another, code the combination only when the correct causal relationship is stated or can be inferred from application of the selection rules. Where a conflict in linkages occurs, link with the condition that would have been selected if the cause initially selected had not been reported. Make any further linkage that is applicable.
Rule 8, Specificity: Where the selected underlying cause describes a condition in general terms and a term which provides more precise information about the site or nature of this condition is reported on the certificate, prefer the more informative term. This rule will often apply when the	**Rule D, Specificity**: Where the selected cause describes a condition in general terms and a term that provides more precise information about the site or nature of this condition is reported on the certificate, prefer the more informative term. This rule will often apply when the general term

Table 3. Comparison of ICD-9 and ICD-10 rules for selection of underlying cause of death

ICD-9	ICD-10
general term can be regarded as an adjective qualifying the more precise term.	becomes an adjective, qualifying the more precise term.
Rule 9, Early and late stages of disease: Where the selected underlying cause is an early stage of a disease and a more advanced stage of the same disease is reported on the certificate, code to the more advanced stage. This rule does not apply to a "chronic" form reported as due to an "acute" form unless the Classification gives special instructions to that effect.	**Rule E, Early and late stages of disease**: Where the selected cause is an early stage of a disease and a more advanced stage of the same disease is reported on the certificate, code to the more advanced stage. This rule does not apply to a "chronic" form reported as due to an "acute" form unless the classification gives special instructions to that effect.
Rule 10, Late effects: Where the selected underlying cause is an early form of a condition for which the Classification provides a separate late effects category and there is evidence that death occurred from residual effects of this condition rather than in its active phase, code to the appropriate late effects category. The following late effects categories, including those in the Supplementary E code, have been provided: 137, 138, 139, 268.1, 326, 438, 905-909, E929, E959, E969, E977, E989, and E999.	**Rule F, Sequelae**: Where the selected cause is an early form of a condition for which the classification provides a separate "Sequelae of …" category, and there is evidence that death occurred from residual effects of this condition rather than from those of its active phase, code to the appropriate "Sequelae of …" category. "Sequelae of …" categories are as follows: B90-B94, E64.-, E68, G09, I69, O97 and Y85-Y89.
Rule 11, Old pneumonia, influenza and maternal conditions: Where the selected underlying cause is pneumonia or influenza (480-487) and there is evidence that the date of onset was 1 year or more prior to death or a resultant chronic condition is reported, reselect the underlying cause as if the pneumonia or influenza had not been reported. Where the selected underlying cause is a maternal cause (630-678) and there is evidence that death occurred more than 42 days after termination of pregnancy or a resultant chronic condition is reported, reselect the underlying cause as if the maternal cause had not been reported. Take into account the pneumonia, influenza or maternal condition if it modifies the coding.	No corresponding rule.

Table 3. Comparison of ICD-9 and ICD-10 rules for selection of underlying cause of death

ICD-9	ICD-10
Rule 12, Errors and accidents in medical care: Where the selected underlying cause was subject to medical care and the reported sequence in Part I indicates explicitly that the death was the result of an error or accident occurring during medical care (conditions classifiable to categories E850-E858, E870-E876), regard the sequence of events leading to death as starting at the point at which the error or accident occurred. This does not apply to attempts at resuscitation.	No corresponding rule.

ICD-10 rule revisions	
Selection Rule 3	
As originally published by WHO in 1993	**As revised, effective 2003**
Assumed direct consequences of another condition: Pneumonia and bronchopneumonia may be accepted as complications of any disease. In particular, bronchopneumonia should be assumed to be an obvious consequence of wasting diseases (such as malignant neoplasm and malnutrition) and diseases causing paralysis (such as brain or spinal cord injuries, cerebral haemorrhage or thrombosis, and poliomyelitis), as well as communicable diseases and non-trivial injuries.	*Assumed direct consequences of another condition:* Any pneumonia in J12-J18 should be considered an obvious consequence of conditions that impair the immune system. Pneumonia in J18.0 and J18.2-J18.9 should be considered an obvious consequence of wasting diseases (such as malignant neoplasm and malnutrition) and diseases causing paralysis (such as cerebral haemorrhage or thrombosis), as well as serious respiratory conditions, communicable diseases, and serious injuries. Pneumonia in J18.0 and J18.2-J18.9, J69.0, and J69.8 should also be considered an obvious consequence of conditions that affect the process of swallowing.
Modification Rule A	
As originally published by WHO in 1993	**As revised, effective 2001**
Where the selected cause is classifiable to Chapter XVIII (Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified) except for R95 (Sudden infant death syndrome), and a	Where the selected cause is ill-defined and a condition classified elsewhere is reported on the certificate, reselect the cause of death as if the ill-defined condition had not been reported, except to take account of

Table 3. Comparison of ICD-9 and ICD-10 rules for selection of underlying cause of death

ICD-10 rule revisions	
condition classified elsewhere than to R00-R94 or R96-R99 is reported on the certificate, reselect the cause of death as if the condition classified to Chapter XVIII had not been reported, except to take account of that condition if it modifies the coding.	that condition if it modifies the coding. The following conditions are regarded as ill-defined: I46.9 (Cardiac arrest, unspecified); I95.9 (Hypotension, unspecified); I99 (Other and unspecified disorders of circulatory system); J96.0 (Acute respiratory failure); J96.9 (Respiratory failure, unspecified); P28.5 (Respiratory failure of newborn); R00-R94 or R96-R99 (Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified). Note that R95 (Sudden infant death syndrome) is not regarded as ill-defined.

Table 4. Bridge-coding of 1999 deaths: ICD-10/ICD-9 comparability ratios

ICD codes		Cause of death (ICD-10 titles)	Number of deaths allocated with		Estimated comparability ratio	Standard error	95% confidence limits	
ICD-9	ICD-10		ICD-9	ICD-10			Lower	Upper
001-799, E800-E999	A00-R99, V01-Y89	All causes	157,158	157,158	1.0000	…	…	…
001-139	**A00-B99**	**Chapter I. Certain infectious and parasitic diseases**	**1,941**	**2,110**	**1.0871**	**0.0099**	**1.0676**	**1.1065**
002-003	A01-A02	Salmonella infections	F	F	F	F	F	F
004, 006	A03, A06	Shigellosis and amoebiasis	0	0	…	…	…	…
007-009	A04, A07-A09	Certain other intestinal infections	108	100	0.9237	0.0496	0.8265	1.0208
010-018	A16-A19	Tuberculosis	76	67	0.8772	0.0088	0.8600	0.8944
010-012	A16	Respiratory tuberculosis	54	47	0.8704	0.0000	…	…
013-018	A17-A19	Other tuberculosis	22	20	0.8939	0.0303	0.8345	0.9533
033	A37	Whooping cough	F	F	F	F	F	F
034.1-035	A38, A46	Scarlet fever and erysipelas	F	F	F	F	F	F
036	A39	Meningococcal infection	F	F	F	F	F	F
038	A40-A41	Septicaemia	876	1,087	1.2413	0.0194	1.2033	1.2792
090-097	A50-A53	Syphilis	F	F	F	F	F	F
045	A80	Acute poliomyelitis	0	0	…	…	…	…
062-064	A83-A84, A85.2	Arthropod-borne viral encephalitis	F	F	F	F	F	F
055	B05	Measles	0	0	…	…	…	…
070	B15-B19	Viral hepatitis	219	191	0.8733	0.0244	0.8256	0.9211
042-044	B20-B24	Human immunodeficiency virus (HIV) disease	286	315	1.1013	0.0199	1.0624	1.1402
084	B50-B54	Malaria	0	0	…	…	…	…
001, 005, 020-032, 037, 039-041, 046-054, 056-061, 065-066, 071-083, 085-088, 098-134, 136-139, 771.3	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	Other and unspecified infectious and parasitic diseases and their sequelae	312	326	1.0448	0.0233	0.9991	1.0906
140-239	**C00-D48**	**Chapter II. Neoplasms**	**44,777**	**45,564**	**1.0176**	**0.0016**	**1.0144**	**1.0207**
140-208	C00-C97	Malignant neoplasms	43,984	44,529	1.0124	0.0017	1.0090	1.0157
140-149	C00-C14	Malignant neoplasms of lip, oral cavity and pharynx	695	683	0.9828	0.0115	0.9602	1.0054
150	C15	Malignant neoplasm of esophagus	1,005	980	0.9750	0.0245	0.9269	1.0231
151	C16	Malignant neoplasm of stomach	1,361	1,391	1.0223	0.0183	0.9865	1.0581
153-154	C18-C21	Malignant neoplasms of colon, rectum and anus	4,386	4,366	0.9955	0.0132	0.9696	1.0214
155	C22	Malignant neoplasms of liver and intrahepatic bile ducts	913	900	0.9856	0.0049	0.9761	0.9951
157	C25	Malignant neoplasm of pancreas	2,188	2,199	1.0050	0.0031	0.9988	1.0111
161	C32	Malignant neoplasm of larynx	286	282	0.9861	0.0263	0.9346	1.0376
162	C33-C34	Malignant neoplasms of trachea, bronchus and lung	11,478	11,260	0.9810	0.0014	0.9782	0.9838
172	C43	Malignant melanoma of skin	576	534	0.9274	0.0231	0.8822	0.9726
174-175	C50	Malignant neoplasm of breast	3,481	3,528	1.0134	0.0031	1.0073	1.0194
180	C53	Malignant neoplasm of cervix uteri	320	310	0.9686	0.0183	0.9328	1.0045
179, 182	C54-C55	Malignant neoplasms of corpus uteri and uterus, part unspecified	450	458	1.0174	0.0102	0.9973	1.0374
183.0	C56	Malignant neoplasm of ovary	1,034	989	0.9560	0.0245	0.9080	1.0040
185	C61	Malignant neoplasm of prostate	2,746	2,834	1.0319	0.0142	1.0040	1.0598
189.0-189.1	C64-C65	Malignant neoplasms of kidney and renal pelvis	905	906	1.0007	0.0069	0.9871	1.0143
188	C67	Malignant neoplasm of bladder	1,076	1,065	0.9899	0.0070	0.9761	1.0037
191-192	C70-C72	Malignant neoplasms of meninges, brain and other parts of central nervous system	1,050	1,051	1.0006	0.0045	0.9918	1.0093
200-208	C81-C96	Malignant neoplasms of lymphoid, haematopoietic and related tissue	4,209	4,228	1.0045	0.0093	0.9863	1.0228
201	C81	Hodgkin's disease	100	95	0.9511	0.0189	0.9141	0.9881
200, 202	C82-C85	Non-Hodgkin's lymphoma	1,783	1,733	0.9718	0.0193	0.9339	1.0097
204-208	C91-C95	Leukaemia	1,536	1,549	1.0085	0.0072	0.9944	1.0227

Table 4. Bridge-coding of 1999 deaths: ICD-10/ICD-9 comparability ratios

ICD codes		Cause of death (ICD-10 titles)	Number of deaths allocated with		Estimated comparability ratio	Standard error	95% confidence limits	
ICD-9	ICD-10		ICD-9	ICD-10			Lower	Upper
203	C88, C90	Multiple myeloma and immunoproliferative neoplasms	790	835	1.0573	0.0205	1.0172	1.0974
…	C96	Other and unspecified malignant neoplasms of lymphoid, haematopoietic and related tissue	…	F	…	…	…	…
152, 156, 158-160, 163-171, 173, 181, 183.2-184, 186-187, 189.2-190, 193-199	C17, C23-C24, C26-C31, C37-C41, C44-C49, C51-C52, C57-C60, C62-C63, C66, C68-C69, C73-C80, C97	All other and unspecified malignant neoplasms	5,825	6,566	1.1273	0.0097	1.1083	1.1463
210-239	D00-D48	In situ neoplasms, benign neoplasms and neoplasms of uncertain or unknown behaviour	793	1,035	1.3050	0.0352	1.2359	1.3741
280-289	**D50-D89**	**Chapter III. Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism**	**544**	**497**	**0.9144**	**0.0170**	**0.8810**	**0.9478**
280-285	D50-D64	Anaemias	306	296	0.9675	0.0283	0.9121	1.0230
240-279	**E00-E90**	**Chapter IV. Endocrine, nutritional and metabolic diseases**	**5,591**	**5,792**	**1.0360**	**0.0039**	**1.0282**	**1.0437**
250	E10-E14	Diabetes mellitus	4,431	4,610	1.0404	0.0046	1.0314	1.0494
260-269	E40-E64	Nutritional deficiencies	141	158	1.1186	0.0672	0.9868	1.2503
260-263	E40-E46	Malnutrition	125	129	1.0287	0.0746	0.8825	1.1748
264-269	E50-E64	Other nutritional deficiencies	F	F	F	F	F	F
290-319	**F00-F99**	**Chapter V. Mental and behavioural disorders**	**4,317**	**3,626**	**0.8398**	**0.0071**	**0.8259**	**0.8538**
320-389	**G00-H95**	**Chapters VI-VIII. Diseases of the nervous system and the sense organs**	**4,686**	**6,213**	**1.3258**	**0.0191**	**1.2884**	**1.3633**
320, 322	G00, G03	Meningitis	39	37	0.9551	0.0294	0.8976	1.0127
332	G20-G21	Parkinson's disease	995	1,050	1.0551	0.0092	1.0371	1.0731
331.0	G30	Alzheimer's disease	2,074	3,286	1.5845	0.0056	1.5735	1.5955
390-459	**I00-I99**	**Chapter IX. Diseases of the circulatory system**	**58,462**	**58,309**	**0.9974**	**0.0026**	**0.9922**	**1.0026**
390-434, 436-448	I00-I78	Major cardiovascular diseases	58,038	58,056	1.0003	0.0027	0.9951	1.0055
390-398, 402, 404, 410-429	I00-I09, I11, I13, I20-I51	Diseases of heart	42,028	41,246	0.9814	0.0032	0.9751	0.9877
390-398	I00-I09	Acute rheumatic fever and chronic rheumatic heart diseases	283	233	0.8217	0.0370	0.7492	0.8943
402	I11	Hypertensive heart disease	458	417	0.9109	0.0162	0.8792	0.9426
404	I13	Hypertensive heart and renal disease	59	62	1.0510	0.0649	0.9237	1.1783
410-414	I20-I25	Ischaemic heart diseases	31,229	32,222	1.0318	0.0007	1.0304	1.0332
410-414, 429.2 (Alt)	I20-I25	Ischaemic heart diseases	32,262	32,222	0.9988	0.0007	0.9974	1.0001
410	I21-I22	Acute myocardial infarction	14,511	14,132	0.9739	0.0016	0.9708	0.9769
411	I24	Other acute ischaemic heart diseases	222	348	1.5683	0.1024	1.3677	1.7689
412-414, 429.2	I20, I25	Other forms of chronic ischaemic heart disease	17,529	17,742	1.0121	0.0018	1.0085	1.0158
429.2	I25.0	Atherosclerotic cardiovascular disease, so described	1,033	935	0.9052	0.0095	0.8865	0.9238
412-414	I20, I25.1-I25.9	All other forms of chronic ischaemic heart disease	16,496	16,807	1.0188	0.0019	1.0151	1.0225
415-429.1, 429.3-429.9	I26-I51	Other heart diseases	8,966	8,313	0.9271	0.0149	0.8979	0.9564
421	I33	Acute and subacute endocarditis	49	54	1.1080	0.0545	1.0012	1.2148
420, 422-423	I30-I31, I40	Diseases of pericardium and acute myocarditis	50	56	1.1248	0.0678	0.9920	1.2577
428	I50	Heart failure	3,429	3,549	1.0349	0.0358	0.9647	1.1051
415-417, 424-427, 429.0-429.1, 429.3-429.9	I26-I28, I34-I38, I42-I49, I51	All other forms of heart disease	5,438	4,653	0.8557	0.0112	0.8338	0.8777

Table 4. Bridge-coding of 1999 deaths: ICD-10/ICD-9 comparability ratios

ICD codes		Cause of death (ICD-10 titles)	Number of deaths allocated with		Estimated comparability ratio	Standard error	95% confidence limits	
ICD-9	ICD-10		ICD-9	ICD-10			Lower	Upper
401, 403	I10, I12	Essential (primary) hypertension and hypertensive renal disease	629	737	1.1717	0.0871	1.0009	1.3425
430-438	I60-I69	Cerebrovascular diseases	11,902	12,628	1.0610	0.0079	1.0454	1.0766
430-434, 436-438 (Alt)	I60-I69	Cerebrovascular diseases	11,815	12,628	1.0688	0.0080	1.0531	1.0845
440	I70	Atherosclerosis	1,116	1,146	1.0265	0.0068	1.0132	1.0398
441-448	I71-I78	Other diseases of circulatory system	2,450	2,299	0.9385	0.0068	0.9252	0.9518
441	I71	Aortic aneurysm and dissection	1,506	1,509	1.0017	0.0036	0.9945	1.0088
442-448	I72-I78	Other diseases of arteries, arterioles and capillaries	944	791	0.8377	0.0167	0.8051	0.8704
451-459	I80-I99	Other disorders of circulatory system	337	253	0.7507	0.0000	…	…
460-519	**J00-J99**	**Chapter X. Diseases of the respiratory system**	**15,988**	**13,680**	**0.8556**	**0.0038**	**0.8481**	**0.8631**
480-487	J10-J18	Influenza and pneumonia	7,116	4,002	0.5623	0.0285	0.5064	0.6183
487	J10-J11	Influenza	509	489	0.9606	0.0198	0.9218	0.9994
480-486	J12-J18	Pneumonia	6,607	3,513	0.5317	0.0307	0.4715	0.5918
466	J20-J22	Other acute lower respiratory infections	38	66	1.7247	0.1759	1.3800	2.0694
466	J20-J21	Acute bronchitis and bronchiolitis	38	25	0.6579	0.0815	0.4981	0.8177
…	J22	Unspecified acute lower respiratory infection	…	41	…	…	…	…
490-494, 496	J40-J47	Chronic lower respiratory diseases	6,890	7,484	1.0862	0.0285	1.0302	1.1422
490-491	J40-J42	Bronchitis, chronic and unspecified	245	136	0.5571	0.0171	0.5235	0.5907
492	J43	Emphysema	686	601	0.8756	0.0183	0.8397	0.9114
493	J45-J46	Asthma	317	247	0.7799	0.0380	0.7055	0.8543
494, 496	J44, J47	Other chronic lower respiratory diseases	5,642	6,500	1.1520	0.0350	1.0835	1.2205
500-506	J60-J66, J68	Pneumoconioses and chemical effects	37	44	1.1819	0.0587	1.0668	1.2970
507	J69	Pneumonitis due to solids and liquids	529	694	1.3120	0.0287	1.2558	1.3682
034.0, 460-465, 470-478, 495, 508-519	J00-J06, J30-J39, J67, J70-J98	Other diseases of respiratory system	1,378	1,391	1.0093	0.0199	0.9704	1.0482
520-579	**K00-K93**	**Chapter XI. Diseases of the digestive system**	**5,456**	**5,561**	**1.0192**	**0.0043**	**1.0107**	**1.0277**
531-534	K25-K28	Peptic ulcer	374	361	0.9639	0.0090	0.9462	0.9816
540-543	K35-K38	Diseases of appendix	26[E]	21[E]	0.7949[E]	0.1462[E]	0.5084[E]	1.0814[E]
550-553	K40-K46	Hernia	98	108	1.1061	0.0309	1.0454	1.1667
571	K70, K73-K74	Chronic liver disease and cirrhosis	1,439	1,530	1.0632	0.0120	1.0397	1.0868
571.0-571.3	K70	Alcoholic liver disease	711	779	1.0951	0.0155	1.0646	1.1255
571.4-571.9	K73-K74	Other chronic liver disease and cirrhosis	728	751	1.0322	0.0198	0.9934	1.0710
574-575	K80-K82	Cholelithiasis and other disorders of gallbladder	211	211	1.0011	0.0078	0.9857	1.0165
680-709	**L00-L99**	**Chapter XII. Diseases of the skin and subcutaneous tissue**	**186**	**196**	**1.0517**	**0.0263**	**1.0001**	**1.1032**
710-739	**M00-M99**	**Chapter XIII. Diseases of the musculoskeletal system and connective tissue**	**711**	**964**	**1.3552**	**0.0166**	**1.3227**	**1.3877**
580-629	**N00-N99**	**Chapter XIV. Diseases of the genitourinary system**	**2,906**	**2,937**	**1.0106**	**0.0071**	**0.9966**	**1.0246**
580-589	N00-N07, N17-N19, N25-N27	Nephritis, nephrotic syndrome and nephrosis	2,120	2,223	1.0487	0.0101	1.0289	1.0684
580-581	N00-N01, N04	Acute and rapidly progressive nephritic and nephrotic syndrome	F	F	F	F	F	F
582-583, 587	N02-N03, N05-N07, N26	Chronic glomerulonephritis, nephritis and nephropathy not specified as acute or chronic, and renal sclerosis unspecified	53	31	0.5755	0.0589	0.4600	0.6909
584-586	N17-N19	Renal failure	2,050	2,186	1.0663	0.0106	1.0456	1.0871
588-589	N25, N27	Other disorders of kidney	F	F	F	F	F	F
590	N10-N12, N13.6, N15.1	Infections of kidney	71	71	0.9967	0.0233	0.9510	1.0425
600	N40	Hyperplasia of prostate	32	40	1.2422	0.0590	1.1266	1.3578
614-616	N70-N76	Inflammatory diseases of female pelvic organs	F	F	F	F	F	F
630-676	**O00-O99**	**Chapter XV. Pregnancy, childbirth and the puerperium**	**F**	**F**	**F**	**F**	**F**	**F**

Table 4. Bridge-coding of 1999 deaths: ICD-10/ICD-9 comparability ratios

ICD codes		Cause of death (ICD-10 titles)	Number of deaths allocated with		Estimated comparability ratio	Standard error	95% confidence limits	
ICD-9	ICD-10		ICD-9	ICD-10			Lower	Upper
630-639	O00-O07	Pregnancy with abortive outcome	0	0	…	…	…	…
640-676	O10-O99	Other complications of pregnancy, childbirth and the puerperium	F	F	F	F	F	F
760-771.2, 771.4-779	**P00-P96**	**Chapter XVI. Certain conditions originating in the perinatal period**	**599**	**612**	**1.0225**	**0.0115**	**1.0001**	**1.0450**
740-759	**Q00-Q99**	**Chapter XVII. Congenital malformations, deformations and chromosomal abnormalities**	**658**	**601**	**0.9128**	**0.0139**	**0.8856**	**0.9400**
780-799	**R00-R99**	**Chapter XVIII. Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified**	**2,609**	**2,626**	**1.0067**	**0.0064**	**0.9941**	**1.0192**
798.0	R95	Sudden infant death syndrome	97	97	1.0000	0.0000	…	…
780-797, 798.1-799	R00-R94, R96-R99	Other symptoms, signs and abnormal clinical and laboratory findings	2,512	2,529	1.0069	0.0067	0.9939	1.0200
Residual	Residual	All other diseases	12,157	11,771	0.9682	0.0079	0.9528	0.9837
E800-E999	**V01-Y98**	**Chapter XX. External causes of morbidity and mortality**	**7,726**	**7,870**	**1.0186**	**0.0146**	**0.9900**	**1.0471**
E800-E869, E880-E929	V01-X59, Y85-Y86	Accidents (unintentional injuries)	5,416	5,593	1.0327	0.0207	0.9922	1.0731
E800-E848, E929.0, E929.1	V01-V99, Y85	Transport accidents	2,102	2,105	1.0016	0.0035	0.9947	1.0085
E810-E825	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	Motor vehicle accidents	1,930	1,894	0.9813	0.0055	0.9705	0.9922
E800-E807, E826-E829	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	Other land transport accidents	29	67	2.3161	0.1492	2.0236	2.6086
E830-E848, E929.0, E929.1	V90-V99, Y85	Water, air and space, and other and unspecified transport accidents and their sequelae	143	144	1.0091	0.0502	0.9107	1.1074
E850-E869, E880-E928, E929.2-E929.9	W00-X59, Y86	Nontransport accidents	3,314	3,488	1.0524	0.0338	0.9862	1.1185
E880-E888	W00-W19	Falls	2,089	1,048	0.5018	0.0087	0.4848	0.5187
E922	W32-W34	Accidental discharge of firearms	24	20	0.8333	0.0000	…	…
E910	W65-W74	Accidental drowning and submersion	222	231	1.0405	0.0191	1.0031	1.0780
E890-E899	X00-X09	Accidental exposure to smoke, fire and flames	166	165	0.9940	0.0000	…	…
E850-E869, E924.1	X40-X49	Accidental poisoning and exposure to noxious substances	177	163	0.9181	0.0281	0.8630	0.9732

Table 4. Bridge-coding of 1999 deaths: ICD-10/ICD-9 comparability ratios

ICD codes		Cause of death (ICD-10 titles)	Number of deaths allocated with		Estimated comparability ratio	Standard error	95% confidence limits	
ICD-9	ICD-10		ICD-9	ICD-10			Lower	Upper
E900-E909, E911-E921, E923-E924.0, E924.8-E928, E929.2-E929.9	W20-W31, W35-W64, W75-W99, X10-X39, X50-X59, Y86	Other and unspecified nontransport accidents and their sequelae	636	1,861	2.9258	0.1751	2.5827	3.2690
E950-E959	X60-X84, Y87.0	Intentional self-harm (suicide)	1,787	1,787	1.0000	0.0000	…	…
E955.0-E955.4	X72-X74	Intentional self-harm (suicide) by discharge of firearms	513	498	0.9714	0.0178	0.9364	1.0064
E950-E954, E955.5-E959	X60-X71, X75-X84, Y87.0	Intentional self-harm (suicide) by other and unspecified means and their sequelae	1,274	1,289	1.0115	0.0072	0.9974	1.0256
E960-E969	X85-Y09, Y87.1	Assault (homicide)	245	255	1.0416	0.0191	1.0042	1.0790
E965.0-E965.4	X93-X95	Assault (homicide) by discharge of firearms	65	60	0.9231	0.0000	…	…
E960-E964, E965.5-E969	X85-X92, X96-Y09, Y87.1	Assault (homicide) by other and unspecified means and their sequelae	180	195	1.0844	0.0260	1.0336	1.1353
E970-E978	Y35, Y89.0	Legal intervention	F	F	F	F	F	F
E980-E989	Y10-Y34, Y87.2, Y89.9	Events of undetermined intent	175	150	0.8557	0.0306	0.7956	0.9158
E985.0-E985.4	Y22-Y24	Discharge of firearms, undetermined intent	F	F	F	F	F	F
E980-E984, E985.5-E989	Y10-Y21, Y25-Y34, Y87.2, Y89.9	Other and unspecified events of undetermined intent and their sequelae	170	145	0.8515	0.0315	0.7896	0.9133
E990-E999	Y36, Y89.1	Operations of war and their sequelae	0	0	…	…	…	…
E870-E879, E930-E949	Y40-Y84, Y88	Complications of medical and surgical care	101[E]	83[E]	0.8185[E]	0.1337[E]	0.5564[E]	1.0806[E]

... Not applicable
[E]Use with caution
[F]Too unreliable to be published