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Abstract

The structural deficits and problems associated with application of the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) were investigated. For this purpose, mortality statistics in Japan were examined for bias in the proportions of death causes classified using the ICD-10 four-character subcategory system, particularly the large distribution of cases classified under the .9 (unspecified) codes. The results showed that most deaths due to the 3 major causes were coded into the .9 subcategories. For example, 97.6% of the 607,065 deaths between 1995 and 2007 classified as I21 (acute myocardial infarction) were coded as I21.9 (acute myocardial infarction, unspecified). This suggests that the quality of the data recorded on many death certificates is poor. Thus, to ensure that the fourth-digit-level subcategories of the ICD-10 code system are effectively used to represent mortality data and actual causes of death in Japan, future studies should address the following objectives:(1) to minimize the discrepancy between the ICD classification terms and the names of diseases actually used in clinical practice, and (2) to actively raise awareness among physicians about the need to accurately record death causes on death certificates, since these records form the basis for determining mortality statistics in Japan.

KEYWORDS: ICD-10, four-character subcategories, death certificate, mortality statistics

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Original Article

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The structural deficits and problems associated with application of the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) were investigated. For this purpose, mortality statistics in Japan were examined for bias in the proportions of death causes classified using the ICD-10 four-character subcategory system, particularly the large distribution of cases classified under the .9 (unspecified) codes. The results showed that most deaths due to the 3 major causes were coded into the .9 subcategories. For example, 97.6% of the 607,065 deaths between 1995 and 2007 classified as I21 (acute myocardial infarction) were coded as I21.9 (acute myocardial infarction, unspecified). This suggests that the quality of the data recorded on many death certificates is poor. Thus, to ensure that the fourth-digit-level subcategories of the ICD-10 code system are effectively used to represent mortality data and actual causes of death in Japan, future studies should address the following objectives: (1) to minimize the discrepancy between the ICD classification terms and the names of diseases actually used in clinical practice, and (2) to actively raise awareness among physicians about the need to accurately record death causes on death certificates, since these records form the basis for determining mortality statistics in Japan.

Key words: ICD-10, four-character subcategories, death certificate, mortality statistics

The International Statistical Classification of Diseases and Related Health Problems (ICD) was developed to provide statistical classifications for the systematic recording, analysis, interpretation, and comparison of mortality and morbidity data collected in different countries or areas and during different periods [1, 2]. In Japan, the ICD has been used to classify causes of death for more than a century. Its tenth revision (ICD-10), recommended by the World Health Organization (WHO) in 1990, was adopted in Japan in 1995 [2, 3].

In the ICD-10, each code consists of 4 characters: an initial alphabetical letter followed by 2 numerals represents a block (three-character category), and the third numeral after a decimal point represents the subcategory for each block [1]. For example, C16 denotes malignant neoplasm of the stomach, which is further subdivided on the basis of location: C16.0 for the cardia, C16.1 for the fundus of stomach, C16.2 for the body of stomach, C16.3 for the pyloric antrum, and so on.

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With regard to gastrointestinal diseases, Nagoshi pointed out the discrepancy between the anatomical classification terms used in clinical practice and those used in the ICD-10 [4]. Kawai compared discharge summaries on medical records with the descriptions provided on death certificates, and reported that the granularity of death certificates was low and that omission of the lesion sites, in particular, made coding of the fourth digit difficult [5]. In the ICD-10, .9 refers to the four-character subcategories in unspecified cases for which no additional information is available, denoting that the lesion site or details are unknown [1]. Therefore, if, for example, only 'stomach cancer' is entered and no lesion site is specified on the death certificate, then the death is coded as C16.9 (stomach, unspecified).

On the basis of the results of a questionnaire-based survey of hospital physicians, Yamamoto argued that physicians failed to make efforts to ensure accuracy during practical application of the ICD-10 codes, and that this resulted in incorrect use of the .9 codes in many cases where the actual causes of death were known [6]. However, no study has quantitatively examined the application of the .9 code in mortality statistics. The aim of the present study was to examine the structural deficits and problems associated with the application of the ICD-10. For this, we examined mortality statistics to determine the degree of bias in the proportion of death causes classified according to the ICD-10 four-character subcategories, particularly the extremely large proportion of .9 (unspecified) cases.

Materials and Methods

In this study, we used mortality data, a component of the vital statistics data (prepared by the Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare), covering a 13-year period (from 1995, when the ICD-10 was adopted in Japan, to 2007, the latest year for which such data were available). We analyzed the data to determine the third-digit-level death causes with the highest mortality in each of the 3 major death-cause categories—malignant neoplasms, cardiac diseases, and cerebrovascular diseases [7]. We then calculated the yearly proportions of the deaths classified into the .9 subcategories of each of the three-character categories and determined the mean values of these proportions over the 13-year-period. The selected causes of death were as follows. For malignant neoplasms, C34 (malignant neoplasm of bronchus and lung), C16 (malignant neoplasm of stomach), and C22 (malignant neoplasm of liver and intrahepatic bile ducts) for men and C16, C34, and C18 (malignant neoplasm of colon) for women. For cardiac diseases, the selected causes of death were I50 (heart failure) and I21 (acute myocardial infarction) for both men and women. For cerebrovascular diseases, they were I63 (cerebral infarction) and I61 (intracerebral haemorrhage) for both men and women.

Among the analyzed three-digit codes, certain death causes had relatively small proportions of cases classified under the respective .9 subcategories. For these death causes, we also calculated the proportions of cases classified under other subcategories and determined the mean values of these proportions over the 13-year-period. To this end, we considered the following additional subcategories: with regard to malignant neoplasms, C22.0 (liver cell carcinoma) for men, C18.2 (ascending colon) and C18.7 (sigmoid colon) for women; with regard to cardiac and cerebrovascular diseases, I50.0 (congestive heart failure), I61.3 (intracerebral haemorrhage in brain stem), and I61.4 (intracerebral haemorrhage in cerebellum) for both men and women.

Since the present study only used published government data, approval from the ethics committee was not required.

Results

Table 1 shows the proportions of deaths due to malignant neoplasms coded as .9. Considering the mean values for C34 over the 13-year-period between 1995 and 2007, we found that 91.7% of male deaths and 92.8% of female deaths were subcategorized as C34.9 (bronchus or lung, unspecified). Among the cases classified under C22, C22.9 (liver, unspecified) accounted for 0.7% of the male deaths. Among the female deaths classified under C18, C18.9 (colon, unspecified) accounted for 47.3% of the cases (average value; range, 41.7% [2007] to 50.1% [2002]). The proportion of deaths classified as C16.9 in the C16 block for men and women increased gradually, from 73.0% and 75.2%, respectively, in 1995 to

86.9% and 88.7%, respectively, in 2006.

Table 2 shows the proportions of deaths from cardiac and cerebrovascular diseases coded as .9. Among the deaths from acute myocardial infarction (I21) over the 13-year-period between 1995 and 2007, 97.6% were categorized as I21.9 (acute myocardial infarction, unspecified), and the proportion of deaths categorized as I21.9 increased slightly, from 94.9% in 1995 to 98.5% in 2006. Among the cases classified under I63, an average of 90.0% of the deaths was categorized under I63.9 (cerebral infarction, unspecified). Similarly, an average of 83.0% of cases classified as I50 were categorized under I50.9 (heart failure, unspecified), while an average of 78.2% of the cases classified as I61 were categorized under I61.9 (intracerebral haemorrhage, unspecified).

With regard to the codes of concern with four-character subcategories other than .9, among the deaths classified under the respective three-digit codes, the mean value (calculated from the values obtained in the course of the 13-year-period from 1995 to 2007) of the proportions of deaths classified as C22.0 among those classified as C22 was 93.6% in men and those of deaths classified as C18.2 and C18.7 were 16.1% and 18.0%, respectively, in women. The mean values (from 1995 to 2007) of the proportions of deaths classified as I50.0, I61.3, and I61.4 among those classified as the respective three-character categories for both men and women were 15.2%, 8.1%, and 4.6%, respectively.

Discussion

Official mortality registers are of fundamental importance in epidemiologic research because they contain information on causes of death, on the circumstances of death, and on the characteristics of decedents—all derived from information reported on official death certificates [8]. However, in the present study, we found that most of the major death causes recorded in death certificates in Japan were categorized as the .9 (unspecified) fourth-digit subcategories of the corresponding three-digit codes. This finding signifies that the fourth-level subcategories of the

Table 1 The proportions of deaths due to malignant neoplasms coded as .9 from 1995 to 2007

	Year					Deaths coded as .9 (%)									
ICD-10 code	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean	N[e]
Men															
C34[a]	91.3	92.5	92.4	92.3	92.7	92.6	92.5	92.7	93.2	92.9	89.2	89.5	89.5	91.7	523,167
C16[b]	73.0	78.3	80.8	81.2	82.3	82.8	83.6	84.5	85.1	85.7	86.3	86.9	86.9	82.9	422,640
C22[c]	0.8	0.7	0.8	0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.8	0.8	0.9	0.7	301,548
Women															
C16[b]	75.2	79.8	82.8	83.3	84.5	84.8	85.6	86.2	86.5	86.7	87.7	88.7	88.4	84.6	229,937
C34[a]	92.3	93.6	93.8	93.6	93.5	93.7	93.6	93.8	94.7	94.1	90.1	90.3	90.6	92.8	195,045
C18[d]	46.5	48.1	49.3	49.3	49.2	49.9	48.9	50.1	50.0	48.5	42.9	42.6	41.7	47.3	156,206

[a]Malignant neoplasm of bronchus and lung, [b]Malignant neoplasm of stomach, [c]Malignant neoplasm of liver and intrahepatic bile ducts, [d]Malignant neoplasm of colon, [e]The number of deaths from 1995 to 2007.

Table 2 The proportions of deaths from cardiac and cerebrovascular diseases coded as .9 from 1995 to 2007

	Year					Deaths coded as .9 (%)									
ICD-10 code	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean	N[e]
Cardiac diseases															
I50[a]	82.9	83.8	83.7	83.8	83.7	82.8	82.7	83.4	82.8	82.5	82.6	82.8	82.6	83.0	627,687
I21[b]	94.9	96.8	97.3	97.5	97.7	97.7	97.9	98.0	98.1	98.1	98.4	98.5	98.3	97.6	607,065
Cerebrovascular diseases															
I63[c]	90.3	90.6	90.4	90.4	90.1	90.0	89.8	89.9	89.7	89.9	89.5	89.7	90.0	90.0	628,410
I61[d]	80.9	80.3	79.4	79.4	78.8	77.8	77.7	76.9	77.4	76.6	77.4	77.1	76.9	78.2	344,290

[a]Heart failure, [b]Acute myocardial infarction, [c]Cerebral infarction, [d]Intracerebral haemorrhage, [e]The number of deaths for both men and women from 1995 to 2007.

ICD-10 codes, which form the basis for evaluating mortality statistics in Japan, have not been used effectively.

To our knowledge, the literature contains no Japanese or foreign studies focusing on the .9 codes. However, Müssigbrodt *et al.* analyzed cases of mental and behavioural disorders (F codes) from eight countries (Russian Federation, Egypt, Italy, UK, Denmark, Germany, Mexico, and India) and identified 20 frequently used ICD-10 codes for describing the primary diseases in inpatients (N = 22,492). In that report, F29 (unspecified nonorganic psychosis), F20.9 (schizophrenia, unspecified), F32.9 (depressive episode, unspecified), and F03 (unspecified dementia) were included in the 20 frequently used codes [9]. Interestingly, among the cases of major mental disorders (schizophrenia and depression), a large number of cases were classified into the .9 codes.

Deaths due to malignant neoplasms. With regard to C34 (malignant neoplasm of bronchus and lung), more than 90% of deaths among men and women were classified as C34.9. Other subcategories of this block are C34.0 (main bronchus), C34.1 (upper lobe, bronchus or lung), C34.2 (middle lobe, bronchus or lung), C34.3 (lower lobe, bronchus or lung), and C34.8 (overlapping lesion of a bronchus and lung). As indicated by Nagoshi [4] with regard to gastrointestinal diseases, there may be considerable discrepancies between the anatomic classification terms used in the ICD-10 and the disease names actually used in clinical practice. The adequacy of the definition of C34.2 seems doubtful because the left lung does not have a middle lobe.

With regard to C16 (malignant neoplasm of stomach), although the percentage of deaths classified as C16.9 was nearly 10 points lower than that of deaths classified as C34.9, the figure gradually increased from 1995 to 2006 for both men and women. This trend is of concern. When the format for the preparation of death certificates was revised after the adoption of the ICD-10 in 1995, the Statistics and Information Department, the Minister's Secretariat of what was then called the Ministry of Health and Welfare conducted seminars in all the prefectures to disseminate this information to concerned organizations and people such as physicians [10]. However, the awareness generated by the seminars seems to have gradually diminished over the years.

With regard to C18 (malignant neoplasm of colon), the percentage distributions of the subcategories obtained from this study—16.1% for C18.2 (ascending colon) and 18.0% for C18.7 (sigmoid colon)—may suggest that the ascending colon and sigmoid colon are distinguishable to a certain extent as common sites of colon cancer observed in clinical practice. However, the average proportion of deaths categorized into C18.9 was as high as approximately 50%, and there were almost 10-point differences between the proportions for each year. Therefore, the validity of these results is uncertain.

The percentage of deaths classified as C22.9 among those classified into the C22 group (malignant neoplasm of liver and intrahepatic bile ducts) was very low, at 0.7%. In contrast, more than 90% of the cases were categorized as C22.0. Unlike C34, C16, and C18, which are subclassified on the basis of anatomy, C22 is subcategorized on the basis of histopathology [4]. Therefore, in death certificates, both "liver cell carcinoma" and "hepatoma" would have been categorized into C22.0, regardless of the presence or absence of anatomic-site data. In other words, for the C22 codes, C22.0 may have been used in the same manner as the .9 subcategory in the other categories.

Deaths due to cardiac and cerebrovascular diseases. With regard to ICD-10 [1], death certificates in Japan contain a note to avoid attributing a death to heart failure or respiratory failure, since such failures occur during the terminal stages of all diseases. In addition, to disseminate information on the points to be considered while preparing death certificates, the Ministry of Health, Labour and Welfare published a manual on the procedures for completing a death certificate [11]. However, the total number of deaths (men and women) for the period 1995–2007 attributable to heart failure (I50) was 627,687, which was greater than that (607,065) attributable to acute myocardial infarction (I21). Moreover, among the cases classified as I50, I50.0 (congestive heart failure) accounted for 15.2% of the cases. This finding suggested that in clinical practice, heart failure and right ventricular failure (as an example of I50.0) can be distinguished to a certain extent and recorded accordingly. However, I50.9 accounted for a high proportion of cases, 83.0%. This suggests the need for a substantial increase in physicians' awareness of the note published on the death certificate regarding certificate preparation [11].

With regard to I21 (acute myocardial infarction), I21.9 accounted for an overwhelming 97.6% of cases and tended to increase slightly over time. Although the classification of I21.3 (acute transmural myocardial infarction of unspecified site) includes the term 'unspecified site', physicians who are unfamiliar with the word 'transmural' may not have selected it. In some cases of acute myocardial infarction in which the "anterior wall" or the "inferior wall" was recorded as the site of infarction on the death certificate, the cause of death may have been classified as I21.9 during processing for mortality statistics because of the absence of the term "transmural". In such cases, data loss would have occurred during the processing of mortality statistics from the death-certificate data.

Kawai pointed out from a neurosurgery perspective that the term 'precerebral artery' included in I63.0 (cerebral infarction due to thrombosis of precerebral arteries), I63.1 (cerebral infarction due to embolism of precerebral arteries), and I63.2 (cerebral infarction due to unspecified occlusion or stenosis of precerebral arteries) was specific to the ICD system. He noted that this term was not used in any field of clinical or basic medicine, including neurosurgery, clinical neurology, and neuroanatomy, or in any of the leading medical dictionaries, and that its definition was unclear [5]. A significant proportion (90.0%) of the cases classified as I63 (cerebral infarction) were categorized under I63.9. Similar to the case with I21, a fundamental review of the classification terms used for these fourth-level codes of the ICD-10 is required, with emphasis on the actual disease names used in clinical practice.

Among the cases classified as I61 (intracerebral haemorrhage), 8.1% and 4.6% were classified as I61.3 (intracerebral haemorrhage in brain stem) and I61.4 (intracerebral haemorrhage in cerebellum), respectively. It is inferred that, among cases of haemorrhage in the brain stem and cerebellum, only a small percentage list the cause of death as 'intracerebral haemorrhage' on the death certificate. However, the fact that I61.9 accounted for 78.2% of cases seems to suggest that clinicians do not well recognize the existence of the I61.0 (intracerebral haemorrhage in hemisphere, subcortical) and I61.1 (intracerebral haemorrhage in hemisphere, cortical) subcategories.

Limitations, conclusion and further examinations. In the present study, we did not examine the contents of the death certificates *per se*. Nor did we obtain information on the actual diseases cited or any recorded data other than the underlying causes of death [1] named in the certificates. However, since the percentages of cases classified under the .9 subcategories were substantially high, it can be concluded that the quality of data recorded in the death certificates was poor. This can be attributed to the following factors: (1) a structural problem with the ICD-10, *i.e.*, the terms used in the four-character subcategories of the ICD-10 are different from those used in actual clinical practice, and (2) a problem associated with the application of the ICD-10, such as a lack of awareness among physicians regarding the fourth-digit-level codes of the ICD-10 or the points to consider while preparing death certificates.

According to a study by Kawai, there was 81% concordance up to the three-digit code level of the underlying causes of death inferred from the discharge summaries of medical records and those described in the death certificates [5]. It is expected that further studies will be based on the methods used in similar overseas studies [8, 12, 13]. These studies will focus on the quantity of information recorded in the death certificates and the accuracy or loss of these data, which can be determined by comparing the data recorded in death certificates with those in the medical records [5, 6]. Importantly, the findings of these studies should not only be presented as recommendations when the ICD-10 is updated or revised to the ICD-11 [2, 5], but they should also be shared with practicing physicians. This approach may enable the use of death certificates in Japan for their primary purpose [11], *i.e.*, recording data for the preparation of mortality statistics, thereby facilitating the effective use of such statistics for preventing and treating diseases among Japanese.

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