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**The reliability of cause-of-death coding  
in  
The Netherlands**

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**Background:** Cause-of-death statistics are a major source of information for epidemiological research or policy decisions. Information on the reliability of these statistics is important for interpreting trends in time or differences between populations. Variations in coding the underlying cause of death could hinder the attribution of observed differences to determinants of health. Therefore we studied the reliability of cause-of-death statistics in the Netherlands.

**Methods:** We performed a double coding study. Death certificates from the month of May 2005 were coded again in 2007. Each death certificate was coded manually by four coders. Reliability was measured by calculating agreement between coders (intercoder agreement) and by calculating the consistency of each individual coder in time (intracoder agreement). Our analysis covered an amount of 10 833 death certificates.

**Results:** The intercoder agreement of four coders on the underlying cause of death was 78%. In 2.2% of the cases coders agreed on a change of the code assigned in 2005. The (mean) intracoder agreement of four coders was 89%. Agreement was associated with the specificity of the ICD-10 code (chapter, three digits, four digits), the age of the deceased, the number of coders and the number of diseases reported on the death certificate. The reliability of cause-of-death statistics turned out to be high (> 90%) for major causes of death such as cancers and acute myocardial infarction. For chronic diseases, such as diabetes and renal insufficiency, reliability was low (< 70%).

**Conclusions:** The reliability of cause-of-death statistics varies by ICD-10 code/chapter. A statistical office should provide coders with (additional) rules for coding diseases with a low reliability and evaluate these rules regularly. Users of cause-of-death statistics should exercise caution when interpreting causes of death with a low reliability. Studies of reliability should take into account the number of coders involved and the number of codes on a death certificate.

**Keywords:** Mortality statistics, cause of death, coding, reliability, intercoder agreement, intracoder agreement

**Number of words:** 3001

## Introduction

Statistics Netherlands has been reporting on mortality since 1901 by publishing underlying causes of death for deceased persons.<sup>1 2</sup> An underlying cause of death is defined as “the disease or injury that initiated the train of morbid events leading directly to death or the circumstances of the accident or violence which produced the fatal injury”.<sup>3</sup> The underlying cause of death is selected from a death certificate and coded according to the ICD-10. The coding of an underlying cause of death depends on (i) the information available on the death certificate, (ii) the interpretation of explicit coding or selection rules and (iii) individual deliberations of coders.<sup>4 5 6</sup> These factors vary in time and place, so the coding is apt to variations which could hinder the interpretation of trends in time or differences between populations.<sup>7 8 9</sup> Therefore we studied the reliability of coding. In general, reliability is measured by repeating an observation and calculating agreement between observers (this study: intercoder agreement) or calculating the consistency of the same observer in time (this study: intracoder agreement). Reliability differs from validity, e.g. the correspondence between the code for the cause of death and the clinical opinion, the medical record or the autopsy report.<sup>10 11</sup> We studied the reliability of coding an underlying cause of death in the Netherlands. In this article, we report on the intercoder and intracoder agreement; we discuss some explanations of our findings and we compare our results with the results of other studies of reliability.

## Methods

In the Netherlands, death certificates are issued by the attending physician or medical examiner. They are sent to Statistics Netherlands by the municipality where the death occurred. At Statistics Netherlands the death certificates are coded manually. Four coders are employed. Each coder handles about 30 000-40 000 death certificates a year. The 10th revision of the International Classification of Diseases (ICD-10) has been used for coding the underlying cause of death since 1996. In the Netherlands, a maximum of four diseases can be coded per deceased. We studied death certificates from the month of May 2005 (n = 11 266). This month was chosen, because (i) all four coders worked on it (no vacations), (ii) it is not too big as a burden (work load) for coding it a second time, and (iii) it can be considered representative for deceased persons in the Netherlands with regard to age, sex and frequency of the most important causes of death. Stillbirths and death certificates which (originally) needed additional information from the certifying physician in order to be coded were excluded (n = 393). After additional information is obtained, the code of the underlying cause of death is written on this kind of certificates; so they are not suitable for coding them a second time. For reasons of efficiency, cases with just one code per deceased (n = 5236) were sampled at random every one in two. These (easy) cases require no selection of an

underlying cause of death and are expected to exhibit less variation. The four coders of Statistics Netherlands coded all the remaining death certificates (n= 8 215), independently of each other during the second half of 2007, two years after the certificates had passed in the routine coding process. This time period is long enough to prevent direct recall of cases by coders and short enough to prevent a noticeable influence by a change in coding rules.

Analysis was performed on weighted data in order to compensate for the sampling of cases with (originally) just one code per deceased (n= 2618). These cases were weighted by counting them for 2, resulting in a weighted number of 10 833 death certificates. For analysis we used SPSS 14.0. First, we calculated the *intercoder* agreement by comparing the four coders on underlying cause of death per deceased. Second, we calculated the *intracoder* agreement for each coder by comparing the code for the selected underlying cause of death during the routine coding process in 2005 with the code assigned when coding the same death certificate again in 2007. The number of death certificates differs per coder now from 1500 to 2700, according to the initial number of certificates coded by each coder in 2005. For identifying significant differences between intracoder agreements, we calculated 95% confidence intervals.

In our study, the strongest measure of agreement seems to be four coders agreeing on a code for the underlying cause of death while this code also corresponds with the code assigned in 2005. This measurement is shown in the tables 4 and 5 according to the European-65 short list for causes of death (Eurostat, August 1998). This list contains 65 causes of death agreed on as being important for health policy purposes in Europe. Twenty causes of death were omitted, because of low frequencies (n < 20). For the remaining causes of death, the agreement on underlying cause of death by ICD-10 chapter can be found in table 4. Table 4 presents agreement on different levels of specification of the ICD code in order to enable a comparison between coding on chapter level (one digit) and the specification of a code within a chapter (three of four digit codes). The agreement on ICD-10 codes representing specific diseases as a cause of death can be found in table 5 on a four digit code level (maximum level of specification). We added some causes of death not on the European-65 short list in order to make our results more specific.

For comparing our results with other studies of reliability, we calculated the intercoder agreement for each combination of three or two coders. We did not use a (Fleisch) kappa measure for inter-rater reliability, as the chance on expected agreement among the four coders in our study is very small due to the large number of ICD-10 categories (about 8000 code entries).<sup>12</sup>

We present our results by specificity of an ICD-10 code. The ICD-10 has twenty-two chapters, representing disease entities and external causes of death. Letters from the alphabet – usually called digits - are used to identify the chapters. The chapters or disease entities are divided into groups, representing pathological entities or manifestations of diseases. Two digits are used for coding these entities. Pathological entities or manifestations are further divided into specific subgroups by different principles. Sometimes location is used (neoplasms), sometimes causal mechanisms (infections), and external causes of death are further divided by place of injury. The fourth or fifth position of an ICD-10 code is used for this. In this way a disease can be coded by a 4-digit code (for example: acute transmural myocardial infarction of anterior wall = I21.1), a 3-digit code (for example: acute myocardial infarction = I21) or a one-digit or chapter code (for example: disease of the circulatory system = I). In our study, all cases were coded at a 4-digit level. For diseases with just a 3-digit code (for example stroke: I64) a zero is added by default.

## **Results**

Our study included 10 833 death certificates. Eighty percent of the deceased was 65 or older. There was a slightly higher proportion of women (51.1%) than men (48.9%). There is an increase in the number of diseases reported on the death certificate by age of the deceased. The relatively high proportion of people aged 0-49 years with more than one code is explained by the high proportion of external causes of death in this age category. For external causes of death the ICD-10 always requires two codes. The first code represents the circumstances of the accident or violence which produced the fatal injury and the second code represents the injury itself - see table 1.

(Table 1 here)

Table 2 shows the intercoder agreement on underlying cause of death for sex and age of the deceased and for the number of codes reported on the death certificate per deceased. There is a relationship between intercoder agreement and the number of coders participating in the study: in 78.0% of the cases four, in 81.5% three and in 86.9% two coders agree on the underlying cause of death. Intercoder agreement increases with a decrease in specification level of ICD-10 code. It is 78.0% at a 4-digit level, 81.8% at a 3-digit level and 90.5% at chapter (one digit) level. There is no significant difference in agreement for coding the underlying cause of death of men or women ( $p > 0.05$ ). Intercoder agreement first increases and then decreases with an increase in age of the deceased. Intercoder agreement increases with a decrease in the number of diseases (codes) reported on the death certificate - see table 2.

(Table 2 here)

Table 3 shows the intracoder agreement. The (weighted) mean intracoder agreement of four coders was 89.0% at a 4-digit, 89.4% at a 3-digit and 95.3% at ICD-10 chapter level. Coder D appeared to be more consistent than coders A or B at a three or 4-digit ICD code level. There was no significant difference of intracoder agreements at ICD-10 chapter level - see table 3.

(Table 3 here)

Table 4 presents the agreement on the underlying cause of death by ICD-10 chapter as the percentage of cases on which all four coders agree while the code is also in agreement with the code assigned in 2005. The agreement varies by chapter and by specification level of a code. At chapter level, agreement is high for cancers, diseases of the circulatory system and for external causes of death such as transport accidents and suicide; it is low for diseases of the bloodforming organs or skin. These findings indicate how easy or difficult it is to assign a case to an ICD-10 chapter. The difference in agreement between a code at chapter level and a code at 3-digit level is relatively large ( $> 15\%$ ) for diseases of the bloodforming organs, the perinatal period, congenital malformations and transport accidents, indicating difficulties in specifying a code within a chapter. The difference in agreement on a 3-digit and a 4-digit code is relatively large ( $> 15\%$ ) for endocrine diseases, diseases of the musculoskeletal system and for external causes of death such as suicide, indicating difficulties in specifying complications of diabetes, the site of musculoskeletal involvement, or the circumstances of a suicide respectively - see table 4.

(Table 4 here)

Table 5 shows the reliability of codes for underlying causes-of-death at the 4-digit level. All four coders agree on a code *and* this code is in agreement with the original one assigned to a case in 2005. For major causes of death, such as cancers and acute myocardial infarction, the reliability appeared high ( $>90\%$ ). The reliability was low ( $< 70\%$ ) for chronic diseases such as diabetes, atrial fibrillation and flutter, cardiac arrhythmias, gastrointestinal ulcers, chronic liver diseases, renal failure, and for congenital malformations of the nervous system - see table 5.

(Table 5 here)

## Discussion

Information on reliability can be used for interpreting cause-of-death statistics.<sup>13 14</sup> First of all, we identified causes of death with a low reliability, notably chronic diseases (table 5). This low reliability is caused by difficulties in coding (for example specifying diabetes mellitus on a 4-digit level) on the one hand and difficulties in selecting a chronic disease (such as renal failure) as underlying cause of death on the other. There are several reasons for this. First of all, for many chronic diseases it is hard to assess their contribution in the process of dying, even with a full medical record at hand. For example, diabetes mellitus may or may not be the cause of an acute myocardial infarction. Moreover, all chronic diseases that severely restrict mobility may or may not cause infections of bladder or lung. As chronic diseases are, by definition, not very lethal and may well start 20 years or more before death, it is hard to draw the line where they are considered the starting point of a causal chain of events leading to death. The ICD provides rules for this, but as Lu et al. discovered, these rules leave room for individual interpretations.<sup>15</sup> For example, according to the ICD-10 selection rule 3 a coder can select a disease as a cause of death *disregarding* any causal connection reported on the death certificate when death is obviously a direct consequence of this disease.<sup>16</sup> Interpretation of “obviously” is left to the discretion of the coders, forming a source of variations in coding. A second reason lies in the coding process itself. Table 2 shows the agreement decreases with age and with the number of diseases coded on a death certificate. Chronic diseases tend to become more common with age, so the number of codes on a death certificate increases with age (see: table 1). The number of diseases on a death certificate has a direct influence on agreement. If there is only one coded disease present, only coding variation and no variation in selecting the underlying cause of death can occur. With two, three or four codes present, there are increasingly more ways to interpret their causal ranking. Therefore the number of coded diseases per death certificate determines for a large part the differences in reliability.

Our results fit in with several other studies of reliability. Studies of reliability were published in the USA,<sup>17</sup> Austria,<sup>18</sup> Germany,<sup>19 20</sup> Sweden,<sup>21</sup> Switzerland,<sup>22</sup> and Taiwan<sup>23</sup> - see table 6.

(Table 6 here)

In comparison to other countries we seem to perform well. However, comparing different studies of reliability is difficult as a variety of study protocols and measures have been applied. Some countries, like Sweden and Taiwan, report an intercoder agreement much lower than found in our study. The aim of these studies differs from ours. They compare a coder with an expert, e.g. one coder is a standard for the other based on his or her



knowledge and experience. This looks more like a study of the validity of *coding*. We found a difference between the agreement of four coders as such (table 2) and the agreement of four coders on a code for the underlying cause of death while this code corresponds with the code of 2005 (table 4): 78.0 versus 75.8% at a 4-digit ICD-10 code level, e.g. in looking back, coders seem to agree on a change of code in 2.2% of the cases. This seems to be a general measure for the validity of coding in the Netherlands. In Germany and Switzerland, samples of death certificates were exchanged among coders of different countries and recoded manually. These studies look more like studies of reliability, e.g. the consistency of coding. However, the second coding took place apart from the routine coding process and could thus be influenced by context (coders correcting other coders from different countries). The intercoder agreement in these studies is also (much) lower than in our study. A recent German study of reliability showed low agreement when comparing two coding offices.<sup>20</sup> This study is restricted to the mortality of ethnic German migrants from the former Soviet Union and includes 372 death certificates. Studies differ in study population and the number of death certificates. This might explain the difference in findings. However, the number of coders involved seems to be the most important explanation for the different findings of the different studies of reliability. Agreement decreases with an increasing number of coders on all levels of specificity of ICD codes. Moreover, in our study, the intracoder agreement (table 3: 88-90% at a 4- or 3-digit level and 95-96% at chapter level) was more or less the same in magnitude as the intercoder agreement for pairs of coders (table 2: 87% at a 4-digit, 89% at a 3-digit and 94% at chapter level). This is an important finding. If intracoder and intercoder agreement are about the same, this means that the coding process in itself has limited reproducibility and is not bound by individual preferences of coders. Therefore, reporting on reliability should include the number of coders.

In contrast to most other studies of reliability (see: table 6), we found that both intercoder and intracoder agreement did not differ significantly between the third or fourth digit of codes: 78% versus 81.5% and 89.0% versus 89.4% respectively. This finding could be explained by the structure of the ICD-10. The ICD-10 has about 8 000 code entries. Some of them do not have a fourth digit at all, such as stroke (I64), unspecified dementia (F03) or Parkinson's disease (G20). This kind of codes - in our study 20% - has no variation at a 4-digit level (table 4). Furthermore, we noticed that in 53% of the cases an 8 ("other") or 9 ("unspecified") is assigned as a fourth digit. The death certificate did not provide the information for a more accurate classification in these cases. Approximately 73% of the cases have no *informative* fourth digit and a limited variation at a 4-digit level of the ICD-10 code. This is an important finding as it indicates the upper level of detail that can be expected from a cause-of-death statistics.

From a user perspective, the results of our study can be used as an estimate of possible bias when studying trends in time or comparing causes of death between places or populations. For major causes of death, such as cancers or acute myocardial infarction, this bias is low. Observed differences can be attributed to underlying causal factors such as unhealthy behaviour, smoking, food or environment. For chronic diseases, such as diabetes or renal failure, the bias is high. Observed differences could be caused by the coding practice as such. Bias can be reduced by using software for coding and selecting the cause of death, like ACME or IRIS, as the reliability study of Sweden shows (table 6).<sup>24 25</sup> The impact of these automatic coding systems on reliability is large.<sup>26</sup> However, automatic coding systems reject 15-20% of the death certificates, because the system does not recognise medical terms on the death certificate, encounters ambiguous causal relationships or cannot handle external causes of death or complications of surgery.<sup>27</sup> These rejected death certificates have to be coded manually. They are still exposed to intercoder or intracoder variations. Therefore, information on the reliability of manual coding is important for understanding cause-of-death statistics now and in the near future.

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We would like to thank the four coders of Statistics Netherlands for their participation in this study. We thank Onno van Hilten and the staff members of Health Statistics for their critical comments on earlier drafts of this paper.

**Table 1** The study population, according to sex and age of the deceased by the number of diseases reported on the death certificate\* (percentages, n = 10 833)

		number of diseases per deceased *				Total
		1	2	3	4	
Sex of deceased						
	Male	47.5	33.5	13.5	5.6	48.9
	Female	49.1	31.8	13.7	5.4	51.1
Age of deceased (years)						
	0-49	46.9	37.1	13.3	2.7	6.1
	50-64	61.2	27.0	7.2	4.5	13.0
	65-74	51.4	30.6	13.4	4.7	17.8
	75+	45.0	33.8	15.0	6.2	63.1

\* In the Netherlands, a maximum of four diseases can be coded per deceased

**Table 2** Inter-coder agreement on underlying cause of death by specification of the ICD-10 code for age of the deceased and the number of codes (diseases) per deceased (percentages, n = 10 833)

		4-digits	3-digits	ICD-10 chapter (one digit)
Four coders		78.0	81.8	90.5
Three coders*		81.5	84.9	91.8
Two coders*		86.9	89.4	94.3
Age of deceased				
	< 28 days	48.3	56.9	82.8
	28 days-44 years	64.7	73.9	93.0
	45-54 years	76.1	80.8	90.7
	55-64 years	81.0	85.3	93.7
	65-74 years	80.2	84.1	91.7
	75-84 years	78.4	81.9	90.1
	> 85 years	77.6	80.7	88.9
Number of codes (diseases) per deceased				
	1	85.6	88.2	95.3
	2	74.1	78.7	88.7
	3	66.9	72.6	83.3
	4	61.8	66.8	77.1

\*Every possible combination of three or two out of four coders

**Table 3** Intra-coder agreement on underlying cause of death (percentages with 95% CI between brackets, n = 10 833)

	Coder A	Coder B	Coder C	Coder D	Mean*
4-digit level	87.6 (86.2-89.0)	87.9 (86.8-89.0)	90.0 (88.9-91.1)	91.1 (89.8-92.4)	89.0 (88.4-89.6)
3-digit level	88.1 (86.7-89.5)	88.3 (87.2-89.4)	90.3 (89.3-91.3)	91.3 (90.0-92.6)	89.4 (88.8-90.0)
ICD-10 chapter	95.7 (94.1-95.9)	94.8 (94.1-95.5)	95.4 (94.7-96.1)	95.7 (94.8-96.6)	95.3 (94.9-95.7)

\* weighted mean, CI: mean  $\pm$  1,96 x (1/ $\sum w_i$ )

**Table 4** Agreement on underlying cause of death by ICD-10 chapter \* (percentages, n = number of death certificates with corresponding code in 2005, e.g. 100% in row)

<i>ICD-10 chapter</i>	<i>Intercoder agreement*</i>			<i>n</i>
	<i>4-digit level</i>	<i>3-digit level</i>	<i>Chapter level (one digit)</i>	
<i>Number on European-65 short list, cause of death (chapter code)</i>				
01 Infectious diseases (A00-B99)	61.3	62.7	67.3	150
06 Neoplasms (C00-D48)	87.6	90.1	95.0	3290
07 Malignant neoplasms (C00-C97)	88.2	90.6	95.5	3222
25 Bloodforming organs (D50-D89)	31.6	31.6	55.3	38
26 Endocrine diseases (E00-E90)	49.6	64.2	68.8	397
28 Mental disorders (F00-F99)	80.0	81.1	85.2	466
31 Nervous system & sense organs (G00-H95)	75.4	77.7	82.6	264
33 Circulatory system (I00-I99)	74.6	78.2	91.5	3522
37 Respiratory system (J00-J99)	81.2	84.4	88.0	1145
42 Digestive system (K00-K93)	53.8	66.8	82.0	416
45 Diseases of skin (L00-L99)	58.8	58.8	58.8	34
46 Musculoskeletal system (M00-M99)	46.9	62.5	76.6	64
48 Genitourinary system (N00-N99)	65.8	67.9	78.9	237
51 Perinatal period (P00-P96)	44.4	48.9	82.2	45
52 Congenital malformations (Q00-Q99)	43.6	53.8	71.8	39
55 Symptoms and signs (R00-R99)	65.9	65.9	79.8	287
60 Transport accidents (V01-V99)**	61.9	66.7	93.7	63
++ Falls & accidents (W00-W19, X59) **	61.5	73.9	85.7	161
63 Suicide (X60-X84)**	60.0	78.1	92.3	155
<i>ICD-10 3-digit codes</i>	<i>79.6</i>	<i>79.6</i>	<i>88.8</i>	<i>2188</i>
<i>All ICD-10 causes of death</i>	<i>75.8</i>	<i>79.9</i>	<i>88.8</i>	<i>10 833</i>

\* Agreement of four coders on ICD-10 code in 2007 and correspondence of this code with the code in 2005

\*\* For external causes of death, reliability is also influenced by adjustments made after May 2005 based on information concerning the circumstances of death from other sources (police, courts).

++ not on European-65 short list of causes of death (August 1998)

**Table 5** Agreement on underlying cause of death by ICD-10 code \* (percentage, n = number of death certificates with corresponding code in 2005 e.g. 100% in the row).

Underlying Cause of Death	%	n
<i>Number on European-65 short list, Underlying Cause of death (ICD-10 code)</i>		
++ septicæmia (A41.0, A41.9)	78.9	71
08 malignant neoplasm of lip, oral cavity and pharynx (C00.0-C14.9)	77.5	40
09 malignant neoplasm of oesophagus (C15.0-C15.9)	93.0	129
10 malignant neoplasm of stomach (C16.0-C16.9)	88.5	130
11 malignant neoplasm of colon (C18.0-C18.9)	91.9	272
12 malignant neoplasm of rectum and anus (C19.0-C21.9)	92.8	97
++ malignant neoplasm of rectum (C20) **	94.0	84
13 malignant neoplasm of liver and intrahepatic bile ducts (C22.0-C22.9)	71.2	52
14 malignant neoplasm of pancreas (C25.0-C25.9)	94.1	185
15 malignant neoplasm of larynx, bronchus and lung (C32.0-C34.9)	91.8	803
16 malignant melanoma of skin (C43.0-C43.9)	90.5	63
17 malignant neoplasm of breast (C50.0-C50.9)	95.1	266
18 malignant neoplasm of cervix uteri (C53.0-C53.9)	95.2	21
19 malignant neoplasm of other parts of the uterus (C54.0-C55.9)	78.4	37
20 malignant neoplasm of ovary (C56) **	97.8	89
21 malignant neoplasm of prostate (C61) **	86.5	178
22 malignant neoplasm of kidney (C64) **	89.9	69
23 malignant neoplasm of bladder (C67.0-C67.9)	94.2	69
24 malignant neoplasm of blood and blood forming organs (C81.0-C96.9)	78.6	285
27 unspecified diabetes mellitus (E14.0-E14.9)	53.4	262
++ dementia, unspecified (F03) **	87.5	391
++ Parkinson's disease (G20) **	81.0	63
++ Alzheimer's disease (G30.1)	86.8	68
++ Essential (primary) hypertension (I10) **	70.7	58
34 ischemic heart disease (I20.0-I25.9)	81.6	1065
++ acute myocardial infarction (I21.0-I21.9)	89.1	760
++ cardiac arrest (I46.0-I46.9)	77.1	236
++ atrial fibrillation and flutter (I48) ** + cardiac arrhythmias (I49.0-I49.9)	59.2	147
++ heart failure (I50.0-I50.9)	75.6	483
36 cerebrovascular disease (I60.0-I69.9)	78.5	817
++ Stroke, not specified as haemorrhage or infarction (I64) **	84.6	475
39 pneumonia (J12.0-J18.9)	85.5	441
40 COPD (J40.0-J47)	85.2	539
43 ulcer of stomach, duodenum and jejunum (K25.0-K28.9)	20.7	29
44 chronic liver disease (K70.0, K73.0-K74.6)	62.9	35
++ GI haemorrhage (K92.2)	70.1	87
49 diseases of kidney and ureter (N00.0-N29.8)	52.3	111
++ renal failure (N17.0-N19)	59.3	86
++ Urinary Tract Infection (N39.0)	82.9	105
53 congenital malformations of the nervous system (Q00.0-Q07.9)	43.6	39
++ Senility (R54) **	66.7	105
57 sudden death, cause unknown or unattended death (R96-R99)	72.1	111
<i>All ICD-10 causes of death</i>	<i>75.8</i>	<i>10 833</i>

\* Agreement of four coders on ICD-10 code in 2007 and correspondence of this code with the code in 2005 at a 4-digit code level \*\* ICD-10 code with (just) three digits ++ Not on European-65 short list for causes of death (August 1998)

**Table 6** Inter-coder agreement in studies of reliability

ICD code	Germany 2009	<b>Netherlands 2007 **</b>	Austria 2006 **	Sweden 2002 *	Taiwan 2000	Germany 1989	Switzerland 1981 **	USA 1980
4-digit level	46.0%	81.9%	70%	94.6%		61.5%		90.3%
3-digit level	56.0%	84.4%	74%	96.7%	80.9%	67.7%	75.4%	90.2%
1-digit level (chapter)	78.2%	91.8%	87%	98.7%	83.9%	86.9%		
	n = 372 (ICD-10)	n = 10 833 (ICD-10)	n = 3066 (ICD-10)	n = 2400 (ICD-10)	n = 5621 (ICD-9)	n = 1136 (ICD-9)	n = 665 (ICD-8)	n = 766 (ICD-8)

\*automated coding system used \*\* Agreement of three coders

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