

# Impact of misclassification on measures of cardiovascular disease mortality in the Islamic Republic of Iran: a cross-sectional study

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**Objective** To assess the extent and pattern of misclassification of death from non-specific diagnoses emanating from the Iranian death registration system, and to correct the data for health policy and planning.

**Methods** Detailed medical records for 1426 hospital deaths classified to seven ill-defined or vague causes of death were reviewed by trained physicians, who then completed standard death certificates. Underlying causes of death from the review were compared with the cause assigned in registration data.

**Findings** The probable underlying pattern of causes of death in the Islamic Republic of Iran is substantially different to that suggested by the death registration system. About 88% of 582 cases with non-specific diagnoses at ages 15–69 years were reassigned to various specific causes including ischaemic heart disease (33%), stroke (13%) and injuries (10%). A similar pattern of misclassification is apparent for 738 deaths at older ages (70 years and over), with 46% being reassigned to ischaemic heart disease and stroke.

**Conclusion** A significant proportion of deaths in the Iranian death registration system are being classified to cause groups of little relevance to epidemiological research or health policy. Reassignment of these deaths would increase the proportion of deaths from ischaemic heart disease and cerebrovascular diseases each by 32%, diabetes mellitus by 68% and chronic lower respiratory diseases by 73%. Substantial changes to procedures for diagnosing causes of death are urgently required if registration data are to effectively guide health policies and programmes in the Islamic Republic of Iran.

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Une traduction en français de ce résumé figure à la fin de l'article. Al final del artículo se facilita una traducción al español. الترجمة العربية لهذه الخلاصة في نهاية النص الكامل لهذه المقالة.

## Introduction

Measures of mortality, such as age-specific death rates, life expectancy, cause-specific death rates and years of life lost, are commonly used to measure the health status of a population and are essential for epidemiological research and priority setting for health development.<sup>1–4</sup>

In general, countries can be classified into two broad groups on the basis of availability of data on causes of death.<sup>3</sup> One group comprises countries that typically have complete vital registration with medical certification of the cause of death assigned by attending physicians. The other group includes countries that have death registration systems ranging from incomplete to virtually non-existent, where causes of deaths are often recorded inaccurately at registration, resulting in large propor-

tions of deaths assigned to ill-defined causes.<sup>1,3</sup> In some countries a history obtained from relatives or associates, known as “verbal autopsy” or “lay death recording”,<sup>5</sup> is available for some segments of the population. In China and India, for example, sample vital registration areas that collect information via the use of verbal autopsy provide useful and representative information on causes of death.<sup>6</sup>

Despite international efforts to facilitate and standardize processes for the collection and coding of data on causes of death, the quality of data from many countries remains poor.<sup>1–3</sup> Several factors influence cause of death ascertainment, such as the nature of the disease or circumstances of death, the qualifications and skills of the certifier, and the availability of diagnostic aids and medical evidence. Variations in these factors probably contribute to

significant misclassification of cause of death in many countries.<sup>7,8</sup>

Studies to assess the accuracy of data on causes of death from routine death registration systems have been implemented in several countries.<sup>4,7</sup> In general, these studies compare causes of death reported on death certificates with diagnoses from clinical records or autopsies. These studies can only be conducted in populations for which detailed clinical records (or autopsies) and data from death registration systems are available and useable, as in the Islamic Republic of Iran.

Death registration in the Islamic Republic of Iran was initiated by the National Organization for Civil Registration in 1918, and has evolved over the past few decades into a new comprehensive death registration system operated by the Ministry of Health and Medical Education (MOH&ME).<sup>9–14</sup>

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Table 1. Leading causes of death in the Islamic Republic of Iran as registered by MOH&amp;ME in 2004–2005

Cause of death <sup>a</sup>	Code <sup>b</sup>	Frequency	%	Rank
Ischaemic heart disease	I20–I25	46 907	19.5	1
Cerebrovascular disease	I60–I69	22 264	9.2	3
<b>Other cardiac disease</b>	<b>I27–I29, I44–I49, I51</b>	<b>9 005</b>	<b>3.7</b>	<b>6</b>
<b>Hypertensive disease</b>	<b>I11–I13</b>	<b>7 604</b>	<b>3.2</b>	<b>7</b>
<b>Other cardiovascular disease</b>	<b>I90–I99</b>	<b>3 105</b>	<b>1.3</b>	<b>11</b>
<b>Heart failure</b>	<b>I50</b>	<b>2 137</b>	<b>0.9</b>	<b>20</b>
Other specified cardiovascular and circulatory system diseases	<sup>c</sup>	3 246	1.3	–
<b>All deaths from diseases of circulatory system</b>	–	<b>94 267</b>	<b>39.1</b>	–
<b>Senility without mention of psychosis</b>	<b>R54</b>	<b>15 930</b>	<b>6.6</b>	<b>4</b>
<b>Unknown</b>	–	<b>10 457</b>	<b>4.3</b>	<b>5</b>
<b>Other respiratory diseases</b>	<b>J64–J84, J87–J99</b>	<b>2 853</b>	<b>1.2</b>	<b>14</b>
All other causes	–	117 386	48.8	–
<b>Total</b>	–	<b>240 704</b>	<b>100</b>	–

MOH&ME, Iranian Ministry of Health and Medical Education.

<sup>a</sup> Causes of death selected for this study are shown in bold.

<sup>b</sup> These codes are based on the Iranian MOH&ME's Death Registration Coding System.

<sup>c</sup> Codes for this category include: I26, I30–I43, I70–I79.

Starting in one province (Bushehr) as a pilot study in 1997, the new system was progressively implemented to cover 29 out of 30 Iranian provinces by 2006.<sup>10,15–17</sup> In urban areas, attending physicians complete a medical certificate of cause of death in accordance with the principles of the International Classification of Diseases (ICD). In rural areas, causes of death are determined by physicians from the local rural health centre, based on “verbal autopsy” interviews conducted by health-centre staff.<sup>15</sup> Each month, urban and rural health facilities submit summary information on age, sex and up to three causes for each death to the district health centre, where the data are matched against other sources (e.g. cemetery, hospital or medico-legal records) to improve the level and quality of death registration, and to remove duplication. Next, trained personnel select and code the underlying cause for each death according to ICD rules. These data are then computerized and submitted to the provincial health department, where data are cross-checked with information from the National Organization for Civil Registration to further reconcile missed deaths or duplications. A final dataset is submitted to the MOH&ME where deaths are tabulated according to an abbreviated list of 321 causes based on ICD-10, but adapted to represent the epidemiological profile of the Islamic Republic of Iran.<sup>15</sup>

A perusal of leading causes of death from registration data (Table 1) raises considerable concerns about their utility, with five being nonspecific or vague cause categories such as “senility without mention of psychosis”, “unknown”, “other cardiac diseases”, “other unspecified disorders of the circulatory system” and “other respiratory diseases”. Further, although “heart failure” and “hypertensive diseases” are recognized causes of death, the number of deaths classified to these two categories appears disproportionately large in comparison with other countries with good-quality data.<sup>18</sup> The validity of reported data for these two specified causes should therefore be assessed to ascertain whether these proportions are true, or are an artefact of death-certification practices. Similarly, an assessment of the “true” causes of those deaths classified to the five nonspecific or vague categories could help identify the principal patterns of misclassification to these categories. This study addresses these two specific issues by comparing registration diagnoses with reference diagnoses derived from medical records for a sample of deaths that occurred in health facilities in the Islamic Republic of Iran during 2005.

## Methods

### Study design

For the purpose of measuring validity of registered causes of death, a reference

diagnosis for each death in the study sample is required for comparison. In view of the limited availability of pathological autopsies as “gold standard” reference diagnoses in the Islamic Republic of Iran, medical records might serve as a suitable alternative.<sup>8,19</sup> Analysis of death registration data from 2003 and 2004 indicated that about 45% of deaths in the Islamic Republic of Iran occurred in hospitals, suggesting that hospital medical records might constitute the best source for reference causes of death for this study.<sup>15,20</sup> To assess the feasibility of using this information, a pilot study was conducted on a random sample of 100 deaths from one hospital in each of two provinces (Kermanshah and Yazd) in 2005. The aims of the pilot study were to review the availability of medical records in each hospital, assess their suitability to establish reference diagnoses, and estimate the resources required to do so. Based on the pilot study, it was apparent that the quality of medical records might well vary substantially between provinces. Furthermore, the quality of medical records for some deceased persons who died at an advanced age, or who had a short length of stay in hospital, was generally very poor.

### Sampling plan and study population

Sensitivity and positive predicted value are commonly used to summarize the validity of registered causes of death.<sup>19,21</sup>

Table 2. Geographic distribution of cases by recorded cause in death registration, the Islamic Republic of Iran, 2005–2006

Region	Cause of death in death registration system						Total
	Heart failure	Hypertension	Other cardiac diseases	Other and unspecified disorders of the circulatory system	Other respiratory diseases	Senility and unknown	
Region 1 <sup>a</sup>	45	170	159	215	135	76	800
Region 2 <sup>b</sup>	86	121	203	56	91	69	626
<b>Total</b>	<b>131</b>	<b>291</b>	<b>362</b>	<b>271</b>	<b>226</b>	<b>145</b>	<b>1426</b>

<sup>a</sup> Region 1 includes East Azerbaijan, West Azerbaijan, Kurdistan and Zanjan provinces.

<sup>b</sup> Region 2 includes Bushehr, Hormozgan, Isfahan, Kermanshah, Kuzestan and Yazd provinces.

We therefore estimated the sample size based on expected values for these variables. Since there was no prior information on these measures in the Islamic Republic of Iran, we based our sample size calculations on expected sensitivity values of 50%, which suggested that about 200 deaths from a particular cause were required to adequately assess sensitivity at this level (95% confidence interval, CI: 42.5–57.5), or a sample size of 1400 deaths for the seven causes of interest. We initially selected 1800 cases into the study, in the expectation of some losses (25–30%) based on pilot study findings. We chose to conduct the study in district and provincial hospitals located in 10 out of 30 provinces in two regions of the Islamic Republic of Iran, based on willingness to participate in the research. Region 1 includes provinces in the north and north-west (East Azerbaijan, West Azerbaijan, Kurdistan and Zanjan provinces) and Region 2 includes provinces in the south, south-west and central parts (Bushehr, Hormozgan, Kuzestan, Kermanshah, Isfahan and Yazd provinces). We did not include eastern provinces owing to logistic considerations and the low probability of obtaining adequate medical records from hospitals located there. Hospitals were chosen on the basis of cases selected in chronological order from March 2005. This resulted in a total of 117 hospitals being selected from the 10 provinces.

Table 2 shows the distribution of study sample deaths from each region. Interestingly, the relative frequency for some causes varies considerably across the two regions. Thus, almost 80% of cases coded to “other and unspecified disorders of the circulatory system” were from Region 1. On the other hand, deaths in the sample coded to “heart failure” and “other cardiac diseases”

appear to be much more common in Region 2. This suggests that physicians in different parts of the country assign different vague diagnoses for cardiovascular disease deaths. Overall, the study sample includes adequate numbers from each of these selected categories.

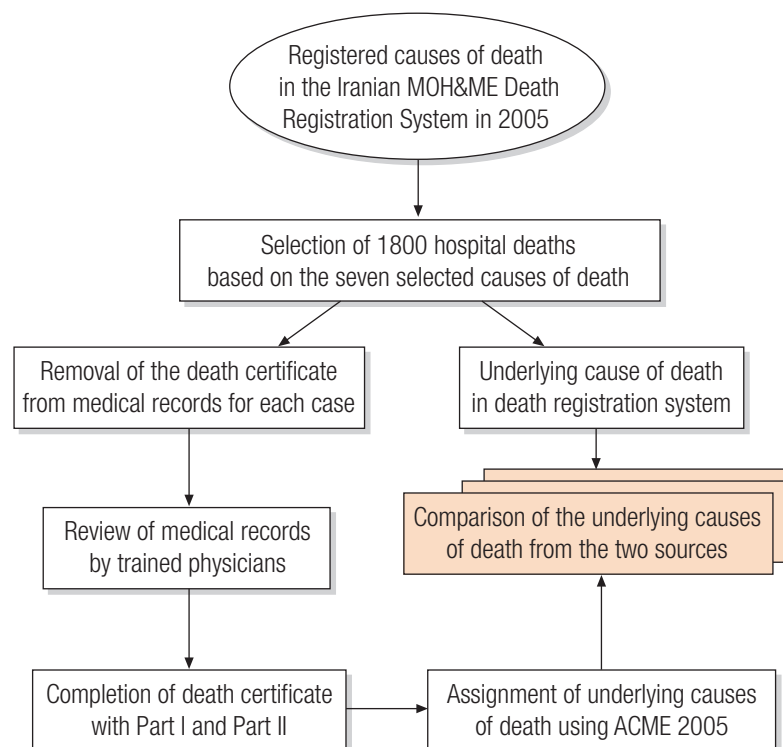
### Data collection and processing

The reference period for the study was March 2005 to March 2006. The process of data collection and the design of the study are illustrated in Fig. 1. First, target cases for each province out of the total of 1800 deaths were

calculated proportionally according to cause, based on data from the Iranian MOH&ME's Death Registration System for 2005. For each selected death, data from this system, including date of death, hospital and registered underlying cause of death, were entered into the study database. From this database, personal identification details were used to trace medical records in health facilities.

For inclusion into the study, the medical records of the deceased needed to contain a fully reported clinical history, medical examination report and/or one of the following clinical aids for

Fig. 1. Study design for assessing misclassification of the seven ill-defined causes of death, the Islamic Republic of Iran, 2005–2006



ACME, Automatic Classification of Medical Entry; MOH&ME, Ministry of Health and Medical Education.

diagnosis: electrocardiograph, radiology, computerized tomography (CT) scan or laboratory reports. A team of 15 physicians drawn from the 10 provinces was specifically trained to review and certify each death from the hospital records. A full-day workshop about the significance, aims and objectives of the research was held for reviewers (physicians) and other provincial staff involved in the study. Standard forms for collection of data and guidelines for reviewing medical records were prepared in Farsi and described in detail during the training workshop. Training was also provided in the principles and procedures for completing the international medical certificate of causes of death. During the training workshop, an assessment of inter-rater reliability was conducted to ensure consistency in death certification.

The medical records for each case were reviewed by one of the physicians on the study team (blind to the cause of death recorded at registration), who then specified the sequence of conditions on the death certificate.<sup>22</sup> Reviewers also assessed the quality of clinical and paraclinical evidence from the medical records, which was categorized as: clinical history; electrocardiograph; X-ray and/or imaging; blood test; pathology; or other (specified).

The data for each case (in Farsi) were entered into a customized computer questionnaire in Epi Info™ version 3.3.2 (Centers for Disease Control and Prevention, Atlanta, GA, United States of America).<sup>23</sup> All medical terms and conditions collected from the medical record review were translated from Farsi to English by a physician. The underlying cause of death was assigned by using ACME (Automatic Classification of Medical Entry) software, based on ICD-10 rules.<sup>24–26</sup> In about one-fifth of cases, the cause of death needed to be coded manually. This was done by Ardeshir Khosravi following a formal training course.

Staff at the Australian National Centre for Classification in Health in Brisbane, a WHO Collaborating Centre for the International Classification of Diseases, manually recoded a random sample of 150 cases (10%), to assess the quality of coding in assigning the underlying cause of death. There was 96% agreement between the two sources concerning the underlying

Table 3. Strength of evidence distributions for the selected specific cause of death, the Islamic Republic of Iran, 2005–2006

Specific causes of death	Criteria			
	Confirmatory <sup>a</sup> (%)	Suggestive (%)	Weak <sup>b</sup> (%)	
Ischaemic heart disease (I20–I25)	0	Electrocardiograph	78	22
Cerebrovascular disease (I60–I69)	0	X-ray and CT	71	29
Neoplasms (C00–D48)	27	X-ray and CT	30	42
Injuries (V01–Y98)	0	X-ray and CT	33	67
Diabetes (E10–E14)	0	Blood test	86	14
Chronic obstructive pulmonary diseases (J44)	0	X-ray and CT	54	45

CT, computerized tomography.

<sup>a</sup> Includes autopsy, histopathology, microbiology and operative findings.

<sup>b</sup> Includes clinical diagnosis based on history/physical examination.

cause of death, suggesting that our procedures for coding causes of death were valid and did not introduce serious bias.

Ethical approval for the study was obtained from the School of Population Health Research Ethics Committee (University of Queensland, Australia). The study was carried out with the full cooperation and support of the Iranian MOH&ME and the 11 Universities of Medical Sciences in the selected provinces.

### Data analysis

Underlying causes of death from the two sources (death registration and medical records review) were aggregated according to the Iranian MOH&ME ICD Mortality Tabulation List.<sup>15</sup> The few remaining deaths that were still classified to “senility without mention of psychosis” and “unknown” were aggregated into one group. Patterns of misclassification of causes of death were analysed for two broad age groups: 15–69 years, and 70 years and over. The causes of death selected for the study are relatively uncommon at younger ages, where mortality in the Islamic Republic of Iran is already comparatively low.<sup>27</sup>

### Results

Adequate medical records were not available for 374 deaths in the target sample (21%), of which 147 cases were at ages 15–69 years. Of the remaining 1426 deaths, 655 (46%) were females and 771 (54%) were males. In the final study sample, only 106 (7%) deaths

were at ages 0–14 years. The remaining deaths were roughly evenly divided across the two age groups: 15–69 years (582 deaths; 41%) and 70 years and over (738 deaths; 52%).

Table 3 shows the distribution of deaths reassigned to specific causes according to the strength of evidence contained in the medical records, summarized in three broad categories: confirmatory, suggestive or weak. Confirmatory evidence was available for one-quarter of cases of neoplasms; most cases of diabetes (86%), ischaemic heart disease (78%) and cerebrovascular disease (71%) were assigned on the basis of suggestive evidence. About 50% of the diagnoses of chronic obstructive pulmonary disease (COPD) and neoplasms were based on weak evidence from medical records.

### Misclassification patterns by age groups

Accurate cause of death data for young and middle-aged adults is particularly important if public health policies and programmes to reduce premature mortality are to be appropriately informed. As Table 4 indicates, the probable underlying pattern of causes of death at these ages is considerably different to what the routine death registration system suggests. Of the 582 cases of ill-defined or vague diagnoses at these ages, less than 12% (69) were still classified as such after medical records review. The remainder were primarily reassigned to ischaemic heart disease (194, or 33%), cerebrovascular disease (75, or 13%) and, interestingly, injuries (56, or 10%). This undercoding

Table 4. Misclassification matrix for six leading ill-defined causes of death, ages 15–69 years, the Islamic Republic of Iran, 2005–2006

Medical record diagnosis	IDC-10 code	Death registration diagnosis						Total
		Other cardiac diseases	Other and unspecified disorders of the circulatory system	Heart failure	Hypertensive disease	Other respiratory diseases	Senility and unknown <sup>b</sup>	
Other cardiac diseases	I27–I29, I44–I49, I51	1	0	3	1	6	2	13
Other and unspecified disorders of the circulatory system	I90–I99	0	0	0	1	0	0	1
Heart failure	I50	4	1	5	1	5	1	17
Hypertensive disease	I10–I13	4	5	5	1	3	3	21
Ischaemic heart disease	I20–I25	23	27	60	14	63	7	194
Cerebrovascular disease	I60–I69	2	46	12	5	9	1	75
Other specified cardiovascular diseases	<sup>a</sup>	1	2	4	2	15	0	24
Influenza and pneumonia	J12–J18	0	0	1	3	0	0	4
Chronic lower respiratory diseases	J40–J44	1	4	4	8	3	1	21
Other respiratory diseases	J64–J84, J87–J99	1	0	0	10	0	0	11
Diabetes	E10–E14	2	13	4	7	8	0	34
Neoplasms	C00–D48	0	3	6	10	5	4	28
Digestive diseases	K00–K93	1	0	2	1	2	3	9
Genitourinary diseases	N17–N98	1	5	2	6	5	4	23
Infectious diseases	A00–B99	2	3	1	4	3	0	13
Injuries	V01–Y98	4	5	6	12	5	24	56
Other causes	–	4	4	10	8	9	3	38
<b>Total</b>	–	<b>51</b>	<b>118</b>	<b>125</b>	<b>94</b>	<b>141</b>	<b>53</b>	<b>582</b>

<sup>a</sup> Codes for this category include: I26, I30–I43, I70–I79.

<sup>b</sup> Because of the relatively small number of deaths assigned to the two component causes, they have been aggregated for analytical purposes.

of injury deaths in vital statistics has been observed in other countries of the region.<sup>28–30</sup> Half of these injury deaths had been assigned to the category “senility and unknown” in the death registration system. Other causes of death that were commonly misdiagnosed include diabetes, neoplasms and genitourinary diseases. While there is evidence of serious undercount of specific vascular disease deaths in registration data, the statistics for the broad category of cardiovascular diseases seem reliable: of the 388 cases of ill-defined vascular disease in the study sample, 345 or 90% were reassigned within the cardiovascular disease category upon medical records review.

A similar pattern of misclassification is apparent for deaths at older ages

(70 years and over) as well (Table 5). Almost half of the 738 cases of ill-defined deaths were reassigned to ischaemic heart disease (219) and stroke (121), upon review. COPD (51) and digestive diseases (37) were also commonly misdiagnosed at these ages. Neoplasms and injuries, on the other hand, were less commonly misdiagnosed than at ages 15–69 years. Interestingly, the number of deaths from all ill-defined forms of cardiovascular disease in the routine registration system at these ages (460) was almost identical to the number of deaths reassigned to some form of cardiovascular disease (464) upon medical records review, confirming that mortality rates from the broad category of cardiovascular disease may not be that unreliable in registration data.

## Discussion

Assessments of quality and reliability of data from routine death registration are critical.<sup>1–3</sup> In the new Iranian MOH&ME's Death Registration System (Deputy of Health), data on causes of death are collected from various sources and have been assessed to be about 80% complete.<sup>27</sup> This study estimates misclassification patterns of seven ill-defined or vague diagnoses that were among the leading causes of death over the period 2000–2004.

Medical records review suggests that a substantial proportion (56%) of these vague and/or ill-defined causes of death can be reclassified to diseases of the circulatory system, primarily

Table 5. Misclassification matrix for six leading ill-defined causes of death, ages 70 years and over, the Islamic Republic of Iran, 2005–2006

Medical record diagnosis	IDC-10 code	Death registration diagnosis						Total
		Other cardiac diseases	Other and unspecified disorders of the circulatory system	Heart failure	Hypertensive disease	Other respiratory diseases	Senility and unknown <sup>b</sup>	
Other cardiac diseases	I27–I29, I44–I49, I51	1	5	3	4	8	3	24
Other and unspecified disorders of the circulatory system	I90–I99	1	1	1	0	1	0	4
Heart failure	I50	14	0	7	1	15	3	40
Hypertensive disease	I10–I13	5	16	1	4	8	3	37
Ischaemic heart disease	I20–I25	24	43	65	15	56	16	219
Cerebrovascular disease	I60–I69	3	60	15	11	23	9	121
Other specified cardiovascular diseases	<sup>a</sup>	2	5	5	0	5	2	19
Influenza and pneumonia	J12–J18	0	2	0	4	2	4	12
Chronic lower respiratory diseases	J40–J44	1	7	6	17	17	3	51
Other respiratory diseases	J64–J84, J87–J99	2	0	1	7	6	0	16
Diabetes	E10–E14	0	12	1	3	19	4	39
Neoplasms	C0–0D48	0	1	0	5	6	0	12
Digestive diseases	K00–K93	4	2	9	5	10	7	37
Genitourinary diseases	N17–N98	2	4	4	6	8	1	25
Infectious diseases	A00–B99	2	5	2	1	3	5	18
Injuries	V01–Y98	4	4	3	7	13	4	35
Other causes		0	6	6	3	9	5	29
<b>Total</b>	–	<b>65</b>	<b>173</b>	<b>129</b>	<b>93</b>	<b>209</b>	<b>69</b>	<b>738</b>

<sup>a</sup> Codes for this category include: I26, I30–I43, I70–I79.

<sup>b</sup> Because of the relatively small number of deaths assigned to the two component causes, they have been aggregated for analytical purposes.

ischaemic heart disease (29%) and cerebrovascular disease (14%). These findings suggest that ischaemic heart disease probably causes about one-third more deaths, and stroke about 15% more, than recorded at routine death registration. Several other causes, including diabetes, injuries and COPD, are also likely to cause substantially more mortality than the official data suggest. These findings have important implications for epidemiological assessments and health planning in the Islamic Republic of Iran.

It is important to note that these correction factors are based solely on the redistribution of the seven selected ill-defined causes of death for this study. Death rates for leading causes of death may be even higher if there

were to be systematic miscoding across specific well-defined diseases and injuries, as observed in other studies.<sup>8</sup>

Although traffic accidents are the third leading cause of death in registration data,<sup>15,31,32</sup> our results suggest that mortality from external causes may be even higher than reported. A possible explanation might be the tendency to code injury deaths of undetermined intent to “unknown causes”, pending investigation by the Iranian Legal Medicine Organization, without subsequent correction based upon investigation results.

The hypothesis that deaths coded to “heart failure” and “hypertension” actually are due to more specific forms of vascular disease, particularly ischaemic heart disease and stroke, is con-

firmed by our investigation. Two-thirds of these vague diagnoses were re-assigned to more specific causes within the cardiovascular disease category.

Our findings suggest a substantial undercount of major vascular diseases in the Islamic Republic of Iran, confirming findings from a smaller study carried out in Isfahan.<sup>33</sup> In this study, a panel of physicians from the Isfahan Cardiovascular Research Center reviewed medical records of 571 deaths. They reported a positive predicted value of 0.82 for cardiovascular diseases, confirming substantially higher death rates from ischaemic heart disease and stroke than reported from the official records. According to the authors, the main reasons for this undercount were lack of experience in death

certification and coding of the underlying causes of death.<sup>33</sup>

The Iranian death certificate<sup>15</sup> has only one part with three lines for recording the sequence of events and conditions leading to death. This differs from the WHO standard death certificate,<sup>34</sup> which provides space (Part II) for recording contributory causes of death. The absence of Part II in the Iranian death certificate results in contributory causes being mentioned in Part I of the certificate, which could affect the selection of the underlying cause of death. The MOH&ME would be well advised to adopt the international death certificate to reduce this potential source of error.

### Limitations of the study

The validity of our study findings could be affected by the quality of documentation in medical records, which are subject to information bias since more than one person might collect information in the records and also different definitions might be used.<sup>35</sup> Also, variation in the quality of medical records among hospitals in the different provinces could affect our findings.

The generalizability of our results to the entire population of the Islamic Republic of Iran depends on several factors, the most important being the selection of study deaths from hospitals. While nearly half of all deaths occur in hospitals, differences between the cause distribution of hospital deaths and deaths that occurred at home are likely; e.g. deaths that occur in hospital tend to be due to multiple end-stage conditions. Also, differential access to health-facility and

in-patient services might result in disparities between hospital and non-hospital deaths. Generalizability might also be affected by the choice of provinces, which were selected on the basis of interest in the study, costs and the availability of other resources.

Our study has provided an audit of the quality of medical records in health facilities in the Islamic Republic of Iran. About one-quarter of records in the original sample were judged to be unusable, and this suggests an urgent need for training and procedural changes to improve hospital information systems. However, about half of these cases were deaths among elderly people who were referred to emergency units without complete medical records. This is an issue for medical records development in all countries, not only in the Islamic Republic of Iran. Nevertheless, 44% of rejected cases were deaths in young and middle-aged adults for which better health records ought to be available.

In this study, we used ACME software to assign the underlying cause of death. ACME is considered to be the de facto international standard for assigning causes of death.<sup>25,26</sup> However, the software has some limitations.<sup>25</sup> For some sequences, the causal relationship cannot be determined unequivocally from the ICD decision tables that are used for selecting the underlying cause of death, requiring the cause to be assigned manually. Additionally, the software strictly adheres to the selection rules and consequently there might well be overcoding of deaths based on “physiological derangement” at the expense of causes of death that are “etiologically specific”.<sup>25</sup>

We conclude that a significant proportion of deaths in the Islamic Republic of Iran classified to vague causes can be reclassified to more specific causes of death, primarily ischaemic heart diseases and stroke. There is an urgent need to improve the quality of medical records and cause of death certification. As a minimum, the standard international certificate of causes of death should be adopted, with appropriate training of physicians in its use. Until these changes are implemented, considerable caution should be exercised when using death registration data in the Islamic Republic of Iran for epidemiological research and planning. ■

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**Competing interests:** None declared.

## Résumé

### Impact des erreurs de classification des décès sur la mesure de la mortalité cardiovasculaire en République islamique d'Iran : étude transversale

**Objectif** Évaluer l'ampleur et la structure des erreurs de classification des décès résultant de diagnostics non spécifiques dans le système d'enregistrement des décès iranien et corriger les données en vue de la planification et de l'élaboration de politiques dans le domaine sanitaire.

**Méthodes** Les dossiers médicaux détaillés de 1426 décès hospitaliers, attribués à sept causes mal définies ou vagues de décès, ont été examinés par des médecins expérimentés, qui ont ensuite rempli des certificats de décès standards. Les causes sous-jacentes de la mort d'après cet examen ont été comparées aux causes enregistrées dans le système.

**Résultats** Il est probable que la structure des causes sous-jacentes de décès en République islamique d'Iran diffère substantiellement de celle suggérée par le système d'enregistrement des décès. Environ 88 % des 582 cas de diagnostic non spécifique, dont l'âge se situait entre 15 et 69 ans, ont été réaffectés à diverses causes spécifiques, dont les cardiopathies ischémiques (33 %), les accidents vasculaires cérébraux (13 %) et les traumatismes (10 %). Une structure similaire des erreurs de classification se dégage de l'examen de 738 décès à des âges plus avancés (70 ans et plus), parmi lesquels 46 % ont été réaffectés dans les catégories cardiopathies ischémiques et AVC.

**Conclusion** Une proportion importante des décès recensés dans le système iranien d'enregistrement est classée dans des groupes de causes peu pertinents pour la recherche épidémiologique ou pour l'élaboration de politiques sanitaires. La réaffectation de ces décès augmenterait les proportions de décès par cardiopathie ischémique et par maladie cérébrovasculaire l'une et l'autre de 32 %, celle des décès par diabète de 68 % et celle des décès

par maladies respiratoires chroniques des voies inférieures de 73 %. Il est urgent d'apporter des modifications substantielles aux procédures de diagnostic des causes de décès si l'on veut que les données d'enregistrement puissent guider de manière efficace les politiques et les programmes sanitaires de la République islamique d'Iran.

## Resumen

### Estudio transversal sobre el impacto de los errores de clasificación en la medición de la mortalidad cardiovascular en la República Islámica del Irán

**Objetivo** Determinar la magnitud y el tipo de errores de clasificación de las defunciones por causas no especificadas en los registros de mortalidad en Irán, y corregir los datos con miras a la política y planificación sanitarias.

**Métodos** Las historias clínicas detalladas correspondientes a 1426 muertes hospitalarias atribuidas a siete causas mal definidas o vagas de defunción fueron examinadas por médicos bien preparados al efecto, que procedieron a continuación a cumplimentar los certificados de defunción ordinarios. Las causas de defunción deducidas a partir del examen realizado se compararon con las causas asignadas en los registros.

**Resultados** La distribución probable de las causas de defunción en la República Islámica del Irán difiere sustancialmente de la que se desprende de los registros de mortalidad. Alrededor de un 88% de los 582 casos con diagnóstico inespecífico a edades de entre 15 y 69 años se reasignaron a diversas causas específicas, entre ellas cardiopatía isquémica (33%), accidente

cerebrovascular (13%) y traumatismos (10%). Se observó una pauta similar de errores de clasificación al analizar 738 defunciones de personas de edad más avanzada ( $\geq 70$  años), el 46% de las cuales se reasignaron a cardiopatía isquémica y accidente cerebrovascular.

**Conclusión** Un porcentaje importante de las defunciones reflejadas en los registros de mortalidad de Irán se clasifican de manera que dan lugar a grupos de escaso interés para las investigaciones epidemiológicas o las políticas sanitarias. La reasignación de esas muertes aumentaría el porcentaje de defunciones por cardiopatía isquémica y por enfermedades cerebrovasculares, un 32% en cada caso; por diabetes mellitus, un 68%; y por enfermedades crónicas de las vías respiratorias inferiores, un 73%. Es preciso introducir cambios sustanciales en los procedimientos de diagnóstico de las causas de defunción para poder orientar eficazmente las políticas y los programas de salud en la República Islámica del Irán.

## ملخص

### أثر سوء التصنيف على قياس نسبة الوفيات الناجمة عن مرض القلب الوعائي في جمهورية إيران الإسلامية: دراسة مستعرضة

الإقفاري (33%)، والسكتة (13%)، والإصابات (10%). ولوحظ نمط مماثل لسوء التصنيف في حالة 738 وفاة في أعمار متقدمة (70 عاماً فأكثر)، مع تعديل تشخيص 46% منها إلى مرض القلب الإقفاري والسكتة.

**الاستنتاج:** هناك نسبة لا يُستهان بها من الوفيات في نظام تسجيل الوفيات الإيراني تصنف في فئات سببية ذات علاقة قليلة بالبحوث الوبائية أو السياسات الصحية. ومن شأن تعديل تشخيص أسباب هذه الوفيات أن يزيد نسبة الوفيات الناجمة عن مرض القلب الإقفاري والأمراض القلبية الوعائية بنسبة 32% لكل منهما، ولمرض السكري بنسبة 68%، ولأمراض الجهاز التنفسي السفلي المزمنة بنسبة 73%. وتمس الحاجة إلى تغييرات جوهرية في إجراءات تشخيص أسباب الوفاة إذا أردنا لمعطيات التسجيل أن توجّه السياسات والبرامج الصحية بفعالية في جمهورية إيران الإسلامية.

الغرض: تقييم مدى وتمط التصنيف غير الدقيق للوفيات، بسبب التشخيصات غير المحددة المستمدة من نظام تسجيل الوفيات الإيراني، وكذلك تصحيح المعطيات اللازمة للسياسات الصحية والتخطيط الصحي.

**الطريقة:** قام أطباء مدرّبون بمراجعة السجلات الطبية المفصلة لـ 1426 وفاة مستشفوية مصنفة إلى سبعة أسباب غير معروفة بدقة أو غامضة، ثم قاموا بعد ذلك باستكمال شهادات وفاة موحدة. وتمت مقارنة الأسباب الأساسية للوفاة، الناتجة عن المراجعة، مع السبب المدوّن في معطيات التسجيل.

**الموجودات:** يختلف النمط الأساسي المحتمل لأسباب الوفاة في جمهورية إيران الإسلامية اختلافاً جوهرياً عن النمط المقترح في نظام تسجيل الوفيات. فقد تم تعديل نحو 88% من 582 حالة غير مشخصة تشخيصاً محدداً، لمن هم في عمر 15 – 69 عاماً، إلى أسباب محددة مختلفة، تشمل مرض القلب

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