

Validity of death certificates for coding coronary heart disease as the cause of death in Bahrain

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صلاحية شهادات الوفاة لرميز المرض القلبي التاجي كسبب للوفاة في البحرين فيصل المحروس

خلاصة: كان غرض هذه الدراسة بحث مدى دقة شهادات الوفاة في ترميز المرض القلبي التاجي كسبب أساسي للوفاة في البحرين. وقد تبين أنه من بين 1741 وفاة وقعت في البحرين عام 1993، تم تصنيف 371 على أنها نجمت عن مرض قلبي تاجي. وقد قمنا في هذه الدراسة بمراجعة تشخيص المستشفيات لمئة وتسع من الوفيات (منها 52 بسبب مرض القلب التاجي و 57 لأسباب أخرى). كذلك تمت مراجعة ترميز 459 شهادة وفاة من قبيل إدارة الصحة العامة (حيث عُزيت 151 شهادة إلى مرض القلب التاجي و 308 إلى أسباب أخرى). ولقد تبين أن حساسية ونوعية تشخيصات المستشفيات كانتا بنسبة 76% و 72% على التوالي. أما حساسية ونوعية تشخيصات إدارة الصحة العامة فقد كانتا 85% و 89% على التوالي. إن إحصاءات الوفيات الوطنية في البحرين، المعتمدة على بيانات شهادات الوفاة، ربما تُفُرط في تقدير تواتر حدوث مرض القلب التاجي. من أجل ذلك كان من الأهمية بمكان اتخاذ التدابير اللازمة لتحسين مستوى دقة الإشهاد.

ABSTRACT This study aimed to examine the accuracy of death certificates for coding coronary heart disease (CHD) as the underlying cause of death in Bahrain. Of the 1714 deaths occurring in Bahrain in 1993, 371 were classified as resulting from CHD. In this study the hospital diagnosis of 109 deaths (52 as CHD and 57 as other causes) were reviewed and re-diagnosed using hospital records. The coding of 459 death certificates (151 as CHD and 308 as other causes) by the Directorate of Public Health was similarly reviewed. The sensitivity and specificity of the hospital diagnosis were 76% and 72% respectively and those of the Directorate of Public Health were 85% and 89% respectively. National mortality statistics in Bahrain, which are based on death certificate data, may overestimate the frequency of CHD. Therefore, it is important that measures are taken to improve the accuracy of certification.

Validité des certificats de décès pour coder les cardiopathies coronariennes comme cause de décès à Bahreïn

RESUME Cette étude visait à examiner l'exactitude des certificats de décès pour coder les cardiopathies coronariennes (CPC) comme cause sous-jacente de décès à Bahreïn. Sur les 1714 décès survenus à Bahreïn en 1993, 371 ont été classifiés comme résultant de cardiopathies coronariennes. Dans cette étude, le diagnostic hospitalier de 109 décès (52 comme CPC et 57 comme autres causes) ont été examinés et ont fait l'objet d'un nouveau diagnostic à l'aide des registres hospitaliers. Le codage de 459 certificats (151 comme CPC et 308 comme autres causes) par la Direction de la Santé publique a été examiné de la même façon. La sensibilité et la spécificité du diagnostic hospitalier étaient de 76% et 72% respectivement et pour la Direction de la Santé publique de 85% et 89% respectivement. Il est possible que les statistiques nationales relatives à la mortalité à Bahreïn, qui sont basées sur les données des certificats de décès, surestiment la fréquence des cardiopathies coronariennes. Il est donc important que des mesures soient prises pour améliorer l'exactitude de la certification.

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Introduction

Mortality statistics derived from death certificates are the only continuously collected population-based, disease-related information available in most parts of the world [1,2].

Coronary heart disease (CHD) should be considered as a priority area when allocating resources for public health strategies in member states of the Gulf Cooperation Council because of its high prevalence [3-6]. Routine mortality statistics show that CHD death rates in both men and women have increased consistently in Bahrain since 1980 [7]. Associated with these high death rates, there has been a rise in CHD morbidity as indicated by admission rates for myocardial infarction and other types of CHD.

A study on the reliability of death certificate diagnosis in Kuwait has shown that there is a need to improve the quality of death certificate diagnosis [8]. Examination of the validity of death certification is required to assess how much of the increase in CHD mortality in Bahrain is due to coding differences and how much is real. There are many diagnostic problems when dealing with death certificates, even in countries where autopsies are carried out. In Bahrain, the problem is even greater because autopsy is discouraged unless there is a crime involved. For medicolegal reasons, the doctor who sees the patient at death is required to fill in the death certificate.

Death certificate surveillance in Bahrain

A completed death certificate is sent to the Death Registry Office in the Directorate of Public Health (PHD), with a copy sent to the Department of Vital and Health Statistics to update the mortality database. Another copy is filed in the clinical record of the deceased. To facilitate swift delivery of

the deceased's body, the death certificate is customarily completed within 2 hours of death.

Certifiers may encounter problems in assigning an underlying cause of death in cases of multiple causes. When the death takes place at home, the relatives report to their local health centre where usually the certifiers are not medically qualified, which is an added source of difficulty. One of the shortcomings of the mortality data in Bahrain is that 10% of deaths are recorded as ill-defined causes by the Bahrain Health Information Directorate. This is because information on the cause of death is absent in many cases where, for example, police medical officers issue the death certificate or deaths occur in hospital. However, the recording of ill-defined cause of death in Bahrain declined from 1974 to 1992.

Bahrain has a coroner's system and all deaths from unnatural, violent, accidental, sudden or unknown causes must be reported to the coroner. Non-Bahraini cases are usually subjected to postmortem examination after which a pathologist will sign the certificate for cause of death. Thus, certifying unnatural causes of death is permitted only if the coroner has been involved. Other categories of personnel are allowed to certify natural causes only.

The objective of this study was to examine the accuracy of death certificates for coding CHD as the underlying cause of death in Bahrain.

Materials and methods

The study was a retrospective cohort study using medical records supplied by the Ministry of Health and government death records. The settings were in the PHD and the Salmaniya Medical Centre (SMC), the main public hospital in Bahrain. Permis-

sion for the study was obtained from the PHD and the Chief of Staff of SMC. The information from death certificates issued in the hospitals was recorded on a specially designed form.

All death certificates in Bahrain for the year 1993 were reviewed to identify the cases in which CHD was indicated to be the underlying cause of death. Out of the total of 371 deaths identified as resulting from CHD, one-third were certified in hospital, while police department medical doctors certified the rest outside of hospital. From those who died in SMC in the age range 30–69 years, 52 death certificates in which CHD was given as the cause of death and 57 death certificates in which CHD was not the cause of death were drawn by simple random procedure. The data were then examined to decide whether there was clinical or laboratory evidence to support CHD diagnosis. The certainty of the diagnosis was graded as CHD-related or non-CHD-related based on World Health Organization (WHO) criteria [9] for acute myocardial infarction or any type of CHD and according to the quality of the data supporting the diagnosis. The final diagnosis was coded and a comparison of the original and the revised death certificates was made.

All 151 death certificates with a diagnosis of CHD in those aged 30–69 years old from all hospitals in Bahrain and 308 death certificates with a diagnosis other than CHD coded by the PHD coder were re-coded by the reviewer to estimate the sensitivity and specificity of the coding system of death certificates. The re-coding followed the standard instructions given in the international form for medical certificates of causes of death [9] to seek the “disease or condition directly leading or underlying or contributing to death”.

The *Stata 5.0* package (Stata Co, Texas) was used for all statistical analyses. Propor-

tions, odds ratios, sensitivity, specificity, test bias, predictive values and likelihood ratios were used in the analysis of the data.

Results

The total number of deaths occurring in all regions of Bahrain in 1993 was 1714, of which 371 were certified as resulting from CHD. Police medical officers certified most deaths due to CHD, particularly when the death took place outside of hospital. In all, 75% of the total deaths occurred in hospital, 20% occurred outside hospital, and the rest (5%) outside Bahrain (Table 1). The data obtained from PHD in Bahrain were coded according to whether the routine death certificate data were produced by hospital physicians in-house or doctors working with the Public Security Department outside of hospital. During 1993, 496 (28.9%) deaths were classified as being a result of diseases of the circulatory system, 371 of which were classified as due to ischaemic heart disease (ICD 410–414), according to the ninth revision of the *International classification of diseases* (ICD-9) (Table 2) [10]. The 371 deaths included those occurring both in and out of hospital; 220 occurred outside hospital and 151 in hospital, mainly at SMC.

The sample hospital cases which were reviewed consisted of 52 of 151 (34%) patients for whom CHD was given as the underlying cause of death and 57 of 1135 (5%) patients for whom CHD was not given as the underlying cause of death.

Of the total number of deaths in 1993 (1714), 920 (54%) were males and 794 (46%) females and 1385 (81%) were Bahraini citizens. Of the deaths certified to be as a result of CHD, 61% of the deceased were aged 60–69 years. The age distribution and other characteristics of those who died in

Table 1 Reported deaths by sex, nationality and place of death, Bahrain 1993

Place of death	Bahraini				Non-Bahraini				Total	
	Male		Female		Male		Female		No.	%
	No.	%	No.	%	No.	%	No.	%		
Hospital	561	33	488	28	164	10	73	4	1286	75
Outside hospital	128	7	120	7	84	5	8	1	340	20
Abroad	61	4	27	2	-	-	-	-	88	5
Total	760	44	655	38	248	14	81	5	1714	100

Source: Public Health Directorate, Ministry of Health, Bahrain

Table 2 Cause of death as listed on death certificates for all ages by sex and ICD code, Bahrain 1993

Cause of death	ICD-9 code	Total		Male		Female	
		No.	%	No.	%	No.	%
Diseases of the circulatory system ^a	390-459	496	28.9	311	33.8	185	23.3
Neoplasms	140-239	212	12.4	121	13.2	91	11.5
Certain conditions originating in the perinatal period	760-779	130	11.2	0	0	130	16.4
Endocrine, nutritional and metabolic diseases and immunity disorders	240-279	155	9.0	66	7.2	89	11.2
Injury and poisoning	800-999	141	8.2	116	12.6	25	3.1
Symptoms, signs, and ill-defined conditions	780-799	121	7.1	55	6.0	66	8.3
Diseases of the respiratory system	460-519	118	6.9	70	7.6	48	6.0
Diseases of the digestive system	520-579	79	4.6	49	5.3	30	3.8
Congenital anomalies	740-779	78	4.6	38	4.1	40	5.0
Diseases of the genitourinary system	580-629	46	2.7	21	2.3	25	3.1
Diseases of the nervous system and sense organs	320-389	45	2.6	25	2.7	20	2.5
Infectious and parasitic diseases	001-139	32	1.9	21	2.3	11	1.4
Diseases of the skin and subcutaneous tissue	680-709	21	1.2	8	0.9	13	1.6
Diseases of the blood and blood-forming organs	280-289	25	1.5	10	1.1	15	1.9
Diseases of the musculoskeletal system and connective tissue	710-739	15	0.9	9	1.0	6	0.8
Total		1714		920		794	

^aCirculatory system include: acute myocardial infarction (ICD 410), ischaemic heart disease (ICD 410-414), heart failure (ICD 428), cardiac dysrhythmias (ICD 427), angina pectoris (ICD 413), acute but ill-defined cerebrovascular disease (ICD 436)

Source: Public Health Directorate, Ministry of Health, Bahrain

Table 3 Characteristics of hospital patients who died from CHD or other causes as included in the death certificates

Characteristic	Certificates listing CHD ^a		Certificates listing other causes	
	No.	%	No.	%
Sex				
Male	27	52	31	54
Female	25	48	26	46
Nationality				
Bahraini	46	88	48	84
Non-Bahraini	6	12	9	16
Age group (years)				
30-39	2	4	4	7
40-49	4	8	8	14
50-59	15	29	15	26
60-69	31	60	30	53
Length of hospital stay (days)				
< 10	46	88	27	47
> 10	6	12	30	53
Certificate certifier				
Intern	7	14	14	25
Resident	10	19	16	28
Senior resident	35	67	27	47

^aCondition specified as underlying cause of death or contributory cause of death

1993 from CHD or other causes are given in Table 3. The average length of hospital stay for those patients who died from CHD was < 10 days, while patients who died from other causes had a longer length of stay.

Comparison between the hospital medical records for underlying cause of death and the reviewer's diagnosis of cause of death for 109 patients is shown in Table 4. The differences between the diagnosis of hospital physician and the reviewer's diagnosis indicated a sensitivity of 76%, specificity of 72% and test bias of 1.2. Comparison between the coding of the

Table 4 Comparison between hospital physicians' diagnosis of death and the reviewer's diagnosis of death of those aged 30-69 years who died in Salmaniya Medical Centre, Bahrain 1993

Hospital physicians' diagnosis	Reviewer's diagnosis		
	Coronary heart disease	Other	Total
Coronary heart disease	34	18	52
Other	11	46	57
Total	45	64	109

Sensitivity = 76%

Specificity = 72%

Test bias = 1.2

Positive predictive value = 65%

Negative predictive value = 89%

Likelihood ratio for a positive test result = 2.7

Likelihood ratio for a negative test result = 0.34

PHD coder and the reviewer's coding for 459 deaths is shown in Table 5. There was little difference between the reviewer's coding and the coding of the PHD coder, which showed a specificity of 89% and a sensitivity of 85% (Table 5).

Table 6 illustrates differences in sensitivity and specificity between the review of PHD coding and the review of hospital diagnosis. The level of agreement between underlying cause of death due to CHD and any other diagnosis in hospital medical records showed lower sensitivity and specificity than review of PHD coding and a higher bias rate.

Discussion

Exploration of the validity of death certificate information for classifying underlying causes of death has historically focused on "natural" or disease-related causes of death. An important question of public

Table 5 Comparison between coding of underlying cause of death by the Directorate of Public Health coder and the re-coding by the reviewer of death certificates of those aged 30-69 years, Bahrain 1993

Directorate of Public Health coding	Reviewer's coding		Total
	Coronary heart disease	Other	
Coronary heart disease	116	35	151
Other	21	287	308
Total	137	322	459

Sensitivity = 85% Specificity = 89%
Test bias = 1.1
Positive predictive value = 77%
Negative predictive value = 96%
Likelihood ratio for a positive test result = 7.7
Likelihood ratio for a negative test result = 0.17

Table 6 Comparison between the reviewer's analysis of Public Health Department coding and hospital diagnosis of CHD as the underlying cause of death

Test	Directorate of Public Health coding	Hospital diagnosis
Sensitivity	85%	76%
Specificity	89%	72%
Likelihood ratio positive	7.7	2.7
Likelihood ratio negative	0.2	0.3
Test bias	1.1	1.2

health interest in Bahrain is whether the high rate of CHD mortality in Bahrain is due to an actual increase in the incidence of CHD or due to overestimation by certifying physicians or miscoding by coding clerks. To answer this question, one has to exam-

ine the accuracy of certification and coding and to determine what measures are necessary to rectify any problem. Epidemiological studies of CHD are heavily dependent on national mortality rates [11]. The diagnostic error for CHD is substantial but unquantifiable; however, it is conservatively estimated to be at least $\pm 30\%$ [12]. When this error is superimposed on innumerable errors and omissions in the compilation of mortality rates, the lack of reliability of such vital statistics precludes their use for scientific purposes [12].

In the present study, 75% of total deaths occurred in hospital, 20% outside hospital and 5% outside Bahrain, most of which were certified in hospital. Hospital death certificates are probably more accurate than police death certificates because of the availability of hospital charts and past medical history of the deceased, which might help physicians assign an accurate underlying cause of death. On the other hand, most deaths with a diagnosis of CHD occurred out of hospital and were certified by the police department in Bahrain. A biased diagnosis of CHD might be a factor in the high CHD rates in Bahrain. Comparison of the coding of the death certificates with hospital records for 109 patients who died in hospital showed discrepancies in 25% of cases (positive likelihood ratio 2.7) (Table 4). The association of a substantial rate of discrepancies with indefinite diagnosis, prolonged stay in hospital and with certain hospitals and specialties suggests that the discrepancies are not a random occurrence. In addition, the errors in the entries for both hospital diagnosis and death certificates detected in the study sample do not appear to be random, although the number of case records examined was small. Information on death certificates and hospital records are amongst the most important sources of information on the nation's health [11].

Statistics in the hospital reports are based on the coding about 75% of death certificates and health information, including hospital discharge summary sheets and provisional diagnosis. Our study indicated that these clinical data require interpreting with caution since, in a sample of hospital records, apparently major errors in the completion of the death certificate were detected in 25% of the cases. The coding of death certificates by public health staff showed a 15% error, which indicates that this coding is more reliable than hospital diagnosis on the death certificates. Thus coding and data entry on the death certificate often does not accurately reflect the clinician's true opinion of the underlying cause of death and may frequently be erroneous.

Postmortem is not carried out routinely in Bahrain, unless there is criminal suspicion associated with death, because traditionally the relatives of the deceased usually refuse postmortem investigation. Since postmortem investigation has been established in the industrialized countries, the quality of mortality statistics has been improved [13].

The validity of death certificates has been studied extensively [14-16]. The results of these studies are similar to the present study, showing inaccurate death certification in 10%-30% of cases. In positive terms, the level of correspondence between the official death certificates and those based upon the WHO diagnostic criteria was a little over 80%. This was true for all groups studied and nationalities and for both sexes. Comparison between diagnosis of CHD in the hospital records and the reviewer's diagnosis showed that the sensitivity was greater than the predictive value of a positive result (confirmation rate). In addition, there were more CHD false-positives than CHD false-negatives,

which suggests that physicians tend to overestimate CHD diagnosis. On the other hand in Kuwait, the CHD diagnosis on death certificates was found to be underestimated [8].

The problems of death certification in hospital deaths may be a consequence of inadequate training of physicians. The medical information on the death certificates is often incomplete, which increases the rate of ill-defined cause of death. The percentage of ill-defined cause of death in Bahrain has fallen from 22% in 1974 to 7% in 1990 [17]. In our survey, the physicians who certified most of the hospital deaths were senior residents, but in some studies certification is usually carried out by junior doctors [18]. Certifiers are not always familiar with the ICD-9 indexing or the guidelines and instructions [10] for filling out death certificates and do not realize how the order of entry of the terms they record ultimately determines the selection of the underlying cause of death by the coders.

A gradual increase in the rate death for cardiovascular disease has been found in Bahrain [20]. It is difficult to say whether this trend is due to an actual increase in the incidence of CHD or to overestimated diagnoses by hospital physicians or police medical officers.

When the coding by the PHD coder of CHD-related deaths was compared with the re-coding by the reviewer, the false positives were greater than the false negatives, which means that the ICD-code diagnosis of CHD-related deaths (410-414) was overestimated. Age, sex, socioprofessional category, family situation and place of death and doctor who signed the certificate did not modify the agreement rate between death certificate and complementary inquiry. This observation might mean that CHD mortality rates are overestimated in Bahrain. This

may be due to a lack of training of coding clerks in medical terminology and WHO criteria of coding and classification of diseases and/or might be because of incomplete medical information on the death certificates. In Australia, a similar reliability and validity study of the coding system was carried out [21]. If physicians and coders understand how the reporting affects the classification of the underlying cause of death, they are likely to complete the death certificate more accurately. The vital statistics department can and must play a role in monitoring and encouraging accurate certification. Ensuring that postmortem diagnosis is reflected on death certificates would be a step in the right direction. The quality of data on cardiovascular deaths will continue to be an important issue for epidemiologists and health policy-makers if mortality data are used in studies for control and prevention of cardiovascular diseases. It is crucial therefore that they not only acknowledge this issue but also address it.

Comparison of the coding of the PHD coder with the reviewer's coding showed discrepancies in 15% of cases (positive likelihood ratio 5.7) (Table 5). The coding of the PHD coder had better validity than the validity of hospital diagnosis on death

certificates when compared with hospital clinical records. It is remarkable that the specificity (89%) of the coding system in the PHD was much higher than the results reported earlier in some countries [8]. The essential element relates to the predictive values of CHD codes in coding death certificates by the PHD coder when compared with the reviewer's codes. Predictive values, however, are not constant and change with the prevalence (or pretest probability) of the target disorder in dead patients. The predictive values of CHD codes in coding death certificates in some studies [22] have been reported to be 95%, which is much higher than the present study. If predictive values are so variable, how can the results of studies investigating death certificate validity be better presented? One solution is to use likelihood ratios, stratified by levels of test results when possible. Because likelihood ratios do not change with the underlying prevalence of the target disorder, they give a much more stable assessment of an investigation's usefulness in all situations. Further work is needed on the accuracy of certification. It would be particularly worthwhile to investigate sources of error in patients discharged from and not dying in hospital.

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