

# An Assessment of the Validity of ICD Code 410 to Identify Hospital Admissions for Myocardial Infarction: The Corpus Christi Heart Project

M PLADEVALL,\* \*\* D C GOFF,\* M Z NICHAMAN,\* F CHAN,\* D RAMSEY,\* C ORTIZ\* AND D R LABARTHE\*

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**Background.** The identification of myocardial infarction (MI) is typically based on finding events designated by a nosologist with the appropriate International Classification of Diseases (ICD) code, currently code 410. These codes are applied based on review of medical records or death certificates. However, other factors, including reimbursement considerations, may influence the coding process, especially for hospitalizations. Thus, the validity of using ICD code 410 to identify MI must be assessed.

**Methods.** The Corpus Christi Heart Project (CCHP) is a population-based surveillance programme for hospitalized MI. Patients were identified using concurrent ascertainment in coronary care units and retrospective review of medical records. Events were validated as definite or possible MI using data regarding chest pain, electrocardiographic changes and cardiac enzymes. The validity of using ICD code 410 to identify cases of MI was assessed by calculating the sensitivity, specificity, predictive values and efficiency of ICD code 410 versus the CCHP 'gold standard'.

**Results.** Use of ICD code 410 identified 80.9% (401/496) of definite MI, but only 19.0% (243/1280) of possible MI. Only 12.3% (90/734) of discharges with an ICD 410 code received a 'no MI' designation based on the 'gold standard'. The efficiency of ICD code 410 for identifying MI was 92.0% for definite MI and 77.1% for definite and possible MI.

**Conclusions.** The use of ICD code 410 to identify hospitalized cases of MI results in a modestly biased overestimate of the number of definite MI hospitalizations; however, this approach warrants consideration due to the expense of validation procedures.

**Keywords:** surveillance, validity, myocardial infarction, ICD codes, sensitivity, predictive value

There have been striking changes in mortality and morbidity due to cardiovascular diseases during the last century.<sup>1,2</sup> The WHO MONICA project<sup>3</sup> (Multinational Monitoring of Trends and Determinants in Cardiovascular Diseases) is a surveillance project that was initiated to determine the extent to which those changes were related to changes in incidence and/or survival through the analysis of trends in cardiovascular mortality, morbidity and case fatality over 10 years in defined populations worldwide. The importance of an efficient system of comprehensive public health surveillance in the US has been stressed in a recent review.<sup>4</sup> This type of surveillance would imply an

ongoing systematic collection, analysis and interpretation of outcome-specific data, closely integrated with the timely dissemination of these data to those responsible for preventing and controlling disease or injury. Thus, the main purpose of surveillance is to control disease and injury. On the other hand, the US lacks a national surveillance system for chronic conditions. Surveillance of cardiovascular diseases (CVD) would allow among others: timely detection of changes in morbidity and mortality, monitoring trends in CVD, estimating the magnitude of the health problem including cost, setting research priorities, assessing control activities designed to impact CVD, monitoring changes in health practices, and facilitating planning.

The diagnostic criteria used for epidemiological surveillance of myocardial infarction (MI) were designed with the primary goal of minimizing the false positive rate (increased specificity); whereas, clinical diagnostic

\* The University of Texas-Houston School of Public Health, E-607 RAS, Houston, Texas 77225, USA.

\*\* Current address: Unitat d'Epidemiologia Clínica, Hospital General de Vic (Barcelona), Spain.

strategies are designed to minimize the false negative rate (increased sensitivity). Despite this dichotomy, the implementation of diagnostic criteria in epidemiological surveillance studies requires reliance on data sources that are the product of the clinical approach. This implementation may be difficult in many settings due to variations in the quality of hospital and vital records. The current use of International Classification of Diseases (ICD) codes for billing purposes by most hospitals may offer a means to design a simpler and less expensive surveillance programme if these ICD codes were shown to be valid. If high quality surveillance could be accomplished through use of discharge diagnostic ICD codes, state and local health agencies would be able to monitor trends in coronary heart disease more efficiently, and it would be easier to evaluate the effects of community interventions. We therefore assessed the validity of ICD codes through comparison with the epidemiological diagnostic criteria used in an ongoing surveillance study.

The Corpus Christi Heart Project (CCHP) is a surveillance programme for hospitalized cases of coronary heart disease in a biethnic community of Mexican Americans and non-Hispanic whites in Nueces County, Texas. Detailed aspects of the study design and characteristics of the study population have been reported elsewhere.<sup>5</sup> The CCHP is an affiliated centre in the international MONICA project. The objective of this report is to assess the validity of ICD codes 410 (acute myocardial infarction) and 411 (other acute and sub-acute forms of ischaemic heart disease) for surveillance of hospitalized cases of MI.

## PARTICIPANTS, MATERIALS, AND METHODS

### *Study Population*

According to the 1990 census,<sup>6</sup> Nueces County has a total population of 291 145, with 88% of the county population residing in the city of Corpus Christi. Of the total population, 42% were whites of non-Hispanic origin, 52% were of Hispanic origin and of these, 95% were Mexican Americans.

### *Case Ascertainment and Case Definition*

Residents of Nueces County, aged 25–74 years, who were hospitalized for an MI in special care units at any of the seven study area hospitals between 1 May 1988 through 30 April 1990 were identified and interviewed in-hospital by specially trained interviewers. To identify MI patients hospitalized outside the special care units, lists of discharges with selected coronary heart disease related diagnoses (ICD-9 codes 410–414, 427, 429, 440, 786.5 and procedure codes 36.01–36.09,

36.10–36.19 and 99) were periodically obtained from each hospital, and the relevant hospital records were reviewed. This report includes information on both fatal and non-fatal cases of hospitalized MI.

Diagnostic classification of definite and possible MI cases was made in accordance with criteria recommended by Gillum *et al.*<sup>7</sup> as modified in the Cardiovascular Community Surveillance Project.<sup>8</sup> This classification was based on data from electrocardiograms (ECG), cardiac enzymes and cardiac pain, obtained from medical records. Data on cardiac enzymes, reported within 72 h after arrival or after in-hospital event, were recorded. Electrocardiograms, taken within 72 h after arrival at hospital or after in-hospital event, were classified according to the Minnesota Code.<sup>9</sup> Staff members of the project were trained and certified by The University of Minnesota ECG coding laboratory and selected ECG were sent periodically to the Minnesota laboratory for independent recoding.

### *Validation Process*

ICD-9 codes 410 and 411 were validated using the standardized diagnostic criteria of the CCHP as the 'gold standard'. ICD code 410 was validated against the standardized diagnosis of definite MI and against definite and possible MI combined. The combination of ICD codes 410 and 411 was also validated in relation to definite MI and the combination of definite and possible MI. Sensitivity, specificity, positive and negative predictive values, and efficiency were calculated for ICD code 410 and codes 410 and 411 combined. Efficiency was assessed as the sum of the true positive and true negative divided by the total number of admissions (per cent of agreement).

## RESULTS

Between 1 May 1988 and 30 April 1990, 5329 hospitalizations of interest were identified and classified in the CCHP. The percentage of hospitalizations that met criteria for definite MI, possible MI, and non-MI respectively by ICD-9 discharge code are presented in Table 1. For hospitalizations with multiple discharge codes, a single code was selected according to a hierarchical list of ICD codes as seen in this Table. Of the 734 hospitalizations with ICD code 410, 401 (54.6%) met criteria for definite MI and only 90 (12.3%) did not meet criteria for either definite or possible MI. Of the 650 hospitalizations with ICD code 411, 431 (66.3%) met criteria for no MI, 191 (29.4%) met criteria for possible MI and only 28 (4.3%) met criteria for definite MI. Overall, hospitalizations with codes 412–414 met

TABLE 1 Proportion of hospitalizations classified by ICD code<sup>a</sup> having definite, possible or no myocardial infarction (MI) by CCHP criteria: The Corpus Christi Heart Project, 1 May 1988 through 30 April 1990

ICD Code	Definite MI		Possible MI		No MI		Total	Per cent
	No.	Per cent	No.	Per cent	No.	Per cent		
410	401	54.6	243	33.1	90	12.3	734	100.0
36	7	4.8	29	19.3	114	76	150	100.0
99	1	100	0	0	0	0	1	100.0
411	28	4.3	191	29.4	431	66.3	650	100.0
412	7	3.2	56	25.5	157	71.4	220	100.0
413	13	1.9	183	26.7	489	71.4	685	100.0
414	25	2	244	19.3	993	78.7	1262	100.0
427	8	1.1	181	23.8	572	75.2	761	100.0
429	2	0.8	43	17.1	207	82.1	252	100.0
440	0	0	8	13.1	53	86.9	61	100.0
786	4	0.7	102	18.4	447	80.8	553	100.0
Total	496		1280		3553		5329	

<sup>a</sup> International Classification of Disease code. 410 = Acute MI, 36 = Operation on vessels of the heart, 99 = Injection or infusion of other therapeutic or prophylactic sclerosing agent, 411 = Other acute and subacute forms of ischaemic heart disease, 412 = Old MI, 413 = Angina pectoris, 414 = Other forms of chronic ischaemic heart disease, 427 = Cardiac dysrhythmias, 429 = Ill-defined descriptions and complications of heart disease, 440 = Atherosclerosis, 786 = Chest pain.

TABLE 2 Sensitivity and specificity of ICD<sup>a</sup> code 410 and 410 or 411 in identifying cases of definite or possible MI by CCHP criteria: The Corpus Christi Heart Project, 1 May 1988 through 30 April 1990

	ICD Code 410				ICD Code 410 or 411			
	Definite MI	95% confidence interval	Definite or possible MI	95% confidence interval	Definite MI	95% confidence interval	Definite or possible MI	95% confidence interval
Sensitivity	80.9	77.4-84.4	36.3	34.1-38.5	86.5	83.5-89.5	48.6	46.3-50.9
Specificity	93.1	92.4-93.8	97.5	97.0-98.0	80.2	79.3-81.3	85.3	84.1-86.5
Negative predictive value	97.9	96.7-99.2	75.4	73.4-77.4	98.3	97.2-99.4	76.9	74.9-78.8
Positive predictive value	54.6	53.2-56.0	87.7	86.6-88.8	31.0	29.7-32.3	62.4	60.8-64.0
Efficiency	92.0	91.2-92.7	77.1	76.0-78.2	80.8	79.7-81.9	73.1	71.9-74.3

<sup>a</sup> International Classification of Diseases.

criteria for no MI approximately 70-80% of the time; for possible MI 20-25% of the time and only met criteria for definite MI 1-3% of the time. Hospitalizations for cardiac revascularization procedures and those with the codes 427, 429, 440, or 786.5 were rarely classified as definite MI and, for the most part, were classified as no MI (75-87%).

The sensitivity, specificity, positive and negative predictive value, and efficiency of using ICD code 410

alone as a screening code for definite MI, and for definite and possible MI combined are shown in Table 2. ICD code 410 has high specificity (93%) and acceptable sensitivity (81%) for detecting definite MI. The specificity increases marginally for detecting the combination of definite and possible MI (98%); however, the sensitivity is much lower (36%). The positive predictive value of ICD code 410 is higher (88%) for the combination of definite and possible MI than for

TABLE 3 Summary of published studies examining the validity of the use of International Classification of Disease (ICD) codes to detect definite myocardial infarction (MI)

Ref.	Year of publication	MI screening ICD Code(s)	Method of identifying false negatives	Non-MI ICD Codes	Gold standard	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Current	Current	410	Discharge ICD Code screening/validation	36, 99 411–414 427, 429 440, 786	CCHP criteria	81	93	55	98
10	1993	410	Discharge ICD Code screening/validation	411	Physician review	99	65	96	92
11	1988	410	Discharge ICD Code screening/validation	411–414	MONICA criteria	93	84	82	94
12	1988	410	Discharge ICD Code screening/validation	411–414	MONICA criteria	85	88	70	94
13	1989	410–411	Discharge ICD Code screening/validation	412–414	Physician review	87	95	60	99
14	1984	410	Cardiology surveillance	All others <sup>a</sup>	Physician review	94	99	61	99

<sup>a</sup> These discharges were not reviewed and validated.

definite MI alone (55%). On the other hand, the negative predictive value is lower (75%) for the combination of definite and possible MI than for definite MI alone (98%). Overall, the efficiency is better when screening for definite MI alone (92% versus 77%).

The sensitivity, specificity, positive and negative predictive values, and efficiency of using the combination of 410 and 411 to screen for definite MI and for the combination of definite and possible MI are also shown in Table 2. For detecting definite MI, the combination of ICD codes 410 and 411 had high specificity and sensitivity (80% and 86%) while for detecting the combination of definite and possible MI, the use of both codes maintains high specificity (85%), but the sensitivity decreases considerably (49%). The positive predictive value is not as high for definite MI (31%) as for the combination of definite and possible MI (62%). Conversely, the negative predictive value is very high for definite MI (98%) but decreases (77%) when combining definite and possible MI. The efficiency is also better when screening for definite MI alone

than for the combination of definite and possible MI (80.8% versus 73%). To summarize, the use of ICD code 410 alone or ICD codes 410 and 411 were not adequate for detecting the majority of possible MI hospitalizations. The use of ICD code 410 alone was more efficient than the combined use of ICD codes 410 and 411 to identify definite MI hospitalizations.

#### DISCUSSION

Few studies have been published in which the validity of using ICD codes to detect MI are examined. The reported studies are summarized in Table 3.<sup>10–14</sup> In these studies the sensitivity of using ICD code 410 to detect definite MI has been consistently greater than 80%. The wide range in estimates of sensitivity is due in part to the use of differing sets of negative ICD codes (those used as indicators of non-MI discharges). The specificity has also varied from a low of 65% in a study that used ICD 411 as the negative code to 99% in a study that used all ICD codes other than ICD code

410 as negative codes. The positive predictive value of using ICD code 410 to detect definite MI has varied greatly as a result, but has been consistently greater than 50%. In those reports where the data were presented, and in this report, the majority of ICD 410 discharges that failed to satisfy criteria for definite MI met criteria for possible MI. The implication of these findings are that (i) most patients hospitalized for definite MI can be identified by screening discharges using the ICD code 410 and thus, passive ascertainment, or cold pursuit, can be utilized as the surveillance strategy; (ii) a variable number of false positive discharges will be included among the discharges that receive a 410 code; and (iii) that most of these false positives will meet criteria for possible MI. The only effective way to eliminate these discharges currently is to abstract the medical record for data regarding chest pain, changes in ECG, and changes in cardiac enzymes. Future research should examine the possibility of validating discharges through linkages to computerized laboratory and ECG databases.

From our data and the review of the literature it might be concluded that the combined use of ICD codes 410–411 as a screening test is not sufficiently valid for surveillance of definite and possible MI when compared to the reference algorithms in use in most epidemiological studies and in the CCHP. The use of ICD code 410 for the purpose of surveillance of definite MI has acceptable validity but still yields a slightly biased overestimate of the number of definite MI hospitalizations.

Our findings are based on data from one community over a 2-year period. It is possible that geographical variation and temporal trends in the practice of ICD coding might limit the generalizability of these findings. However, the consistency of results reported in the literature from widely separated centres over the past decades serves to minimize these concerns. Nevertheless, the validity of the 410 code may differ importantly between subgroups in the population. And, of course, this surveillance strategy would not enable detection of silent MI or out-of-hospital deaths due to MI. Further work is needed to validate death certificate diagnoses. Despite these concerns, the current findings, when synthesized with previous work, support the contention that state and local health agencies should focus on the use of discharge diagnoses (ICD code 410) as an inexpensive tool for surveillance of MI. Since the conditions of use of specific discharge diagnostic codes is subject to change, the validity of these codes should be examined periodically in surveillance programmes.

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