Are examination findings important in screening for angina in the Malaysian patient?

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Abstract

Background. The objective of this study is to look at how well patient history and examination findings can be used in screening for angina.

Methods. A total of 887 records were extracted from the electronic medical record system (EMR) in Selayang Hospital, Malaysia. The data was cleaned; 69 possible variables were extracted, and univariate and multivariate analyses were performed.

Results. From the univariate analysis, it was found that 19 variables are significantly associated with a diagnosis of angina. However, multiple logistic regression reveals that only 11 of these 19 variables are significantly related to a diagnosis of angina. Chest pain aggravated by exertion, history of diabetes mellitus, and history of heart disease (regardless of whether on treatment or not) are significant predictors of angina. Sudden onset chest pain, pain that is persistent, pain relieved by other means, pain aggravated by inspiration, and findings of rhonchi are important predictors of a diagnosis other than angina. The degree of overall accuracy is high at 71.3%. There are eight factors which are significant in the univariate analysis but are not significant in the multivariate analysis. These are marital status, pain relieved by glyceryl trinitrate (GTN), pain relieved by rest, associated nausea, pain aggravated by posture, pain aggravated by cough, history of hypertension, and history of smoking.

Conclusions. These findings suggest that examination findings do not play a significant role in screening for angina.

Introduction

Angina pectoris is chest pain that is associated with transient episodes of myocardial ischemia. Because the ischemia is transient, the pain of angina pectoris is also transient, but episodes of prolonged angina may be the precursor to more serious myocardial injury. Acute chest pain in the adult is a frequently encountered symptom in all healthcare settings [1]. The diagnosis of angina is occasionally not as straightforward as it would appear, and in many cases, classical electrocardiogram findings (ECG) of angina may not be evident early on. However, there is broad consensus that lifestyle factors, including physical activity and diet, are fundamental determinants of heart disease risk [2]. The role of inflammatory markers such as C-reactive protein (CRP) in predicting ischemic heart disease especially acute myocardial infarction (AMI) [3–6] is increasingly being recognized, but a good clinical history, together with other patient-reportable factors such as age, history of diabetes, and previous history of ischemic heart disease and coronary surgery, is still an important predictor of angina, myocardial infarction, or cardiac death [7]. Gender differences exist for angina [8] with women more likely to have their initial manifestation of coronary artery disease as angina rather than AMI [9]. Racial factors are also thought to have some influence on cardiovascular risk with blacks more likely to suffer from angina than whites [10], but race differences in Southeast Asia are less well-studied. Yet, despite all that is known about cardiovascular risk factors and improvements in triage, up to 20% of patients are discharged from the coronary care unit with chest pain which defies diagnosis [11].
Chest pain may occasionally be vague but sometimes can be fairly localized and may have certain defining accompanying signs and symptoms. Localization of chest pain has been shown to have some limited value (although not that predictive) in the diagnosis of myocardial infarction [12], but data on this is lacking in angina. We do know that a focused history and physical examination followed by an ECG remain the key tools for the diagnosis of myocardial infarction [13], but there is little data on the role of these tools in diagnosing angina in the Malaysian population.

The aim of this study is to investigate patient-reportable and examination factors for angina with a view to using these factors for developing a decision support system for use by paramedics or the public. It may be possible to construct a tool or software to aid a paramedic or even the public in screening for angina without the benefit of an ECG with a high degree of probability.

Materials and methods

Source of data

The data set was obtained from Selayang Hospital, a tertiary level hospital in Malaysia. Malaysia is a multi-ethnic and multicultural country and has a total population of 24 million comprising of 50% Malays, 33% Chinese, and 9% Indians with the rest being made up of other indigenous races. Heart diseases and diseases of the pulmonary circulation were the second most common cause of death, accounting for 15.12% of all public hospital deaths in Malaysia in 2002. Diseases of the circulatory system also form 7.34% of all causes of admission to public hospitals in Malaysia and are the third most common cause of admission (after normal delivery is excluded).

Permission was granted by the Ministry of Health, Malaysia, to use this data for this research. This hospital is unique in that it is the first hospital in Malaysia to use an electronic medical record (EMR) system and thus is able to record and store accurate and comprehensive details about a patient’s illness in an electronic database right from the point of entry until discharge. All records of adult patients (18 years or older) seen in the emergency department for nontraumatic chest pain from August 20, 1999 (when the hospital opened), to August 9, 2002, and clerked using the chest pain clerking form were extracted for this study. Because this form was used for chest pain suspected to be of cardiac origin, the number of patients clerked using this form was low, and the proportion of angina patients clerked using this form is high.

Selayang Hospital has a specific form for patients with chest pain, and the database is a rich source of data on which many studies can be done. All data from this form were extracted for records that fitted the criteria above. No identification data other than the medical record number (MRN) and financial number were required to identify the record. This ensured that confidentiality was preserved.

To extract the data set from the hospital, a specialized data-mining tool called Speedminer was used as the database was constructed for flexibility rather than for easy data mining. After processing the information using Speedminer, a total of 887 records were extracted, which was exported into an MS Excel spreadsheet and subsequently exported to MS Access.

Data cleaning and preprocessing

Data cleaning and preprocessing were performed before any analysis was carried out. This involved accuracy checking, treatment of missing values, recategorization, and recoding of fields and feature construction. The data was then analyzed using various statistical techniques. A total of 77 variables were analyzed with respect to angina. The diagnosis on discharge was used as the definitive diagnosis. This is the diagnosis as confirmed by specialist physicians after taking into consideration ECG readings and other laboratory investigations.

Missing value analysis and treatment

Some data were missing, probably because the attending doctor did not see any need to fill in such data. The range of missing data was variable and depended on the variable but ranged between 0% and 10%. Missing values in numeric fields were analyzed and treated.

Statistical tests

The $t$ test and the Mann-Whitney $U$ test (where the variances were not homogenous) were performed to compare the means of angina and nonangina patients for these variables—age, pulse rate, and systolic and diastolic blood pressure (BP) [14]. Before the $t$ test was used, normality assumptions were assessed using the Kolmogorov-Smirnov test, and homogeneity of variances was tested using the Levene’s test. The $\chi^2$ test (with continuity correction for $2 \times 2$ tables) and odds ratios (ORs) were performed to look for relationships between categorical variables [15]. These variables are divided into various groups—demographic factors, nature of chest pain, radiation of chest pain, relieving factors, associated factors, aggravating factors, cardiac risk factors, and examination factors. Multiple logistic regression was carried out for all categorical variables with respect to angina as the dependent variable [16]. Interaction was carefully examined, and likely interaction terms were tested before the final model was produced. All univariate statistical tests were carried out using a significance level of 0.05. Multiple logistic
regression models were built using $P = 0.05$ for entry and $P = 0.10$ for removal.

**Biases and limitations**

There are some limitations to this analysis. As the data is from a hospital, it does not include those who suffered from angina but did not seek treatment in that particular hospital or sought treatment elsewhere. It is however, difficult to obtain data from such patients in Malaysia, and there is no way of determining what proportion of patients has been missed in this way. It is also not possible to analyze stable and unstable angina separately as there were too few patients diagnosed as stable angina. Most patients were just diagnosed as angina with some as unstable angina so it was decided to combine them all as angina. It is not possible to provide information about the number of subjects in the sample who had not been appropriately treated in the emergency department or had been misdiagnosed as such information was not available.

**Results**

A total of 887 records were analyzed. The mean age of patients was 53.84 years (SD 13.09). There were 649 males (73.2%) and 238 females (26.8%). Malays formed the biggest proportion of patients (43.4%), followed by Chinese (27.1%), Indians (25.7%), and other races (3.8%). Indians are overrepresented in this sample, and the Malays and Chinese are slightly underrepresented. Almost all the patients were Malaysians (98.5%).

**Quantitative variables**

Table 1 looks at the difference in certain quantitative variables between angina and nonangina patients. Seven quantitative variables were analyzed—age, pulse rate, and systolic and diastolic blood pressure (BP), creatinine phosphokinase (CPK), aspartate transaminase (AST), and lactate dehydrogenase (LDH). All of them except for pulse rate and LDH are significantly different in both groups. Angina patients are on average older than nonangina and have a higher systolic and diastolic BP and lower CPK and AST levels.

**Demographic factors and nature of chest pain**

Table 2 looks at demographic factors and nature of chest pain. Five demographic factors were examined—Malaysian citizenship, marital status, race, and sex. Of these, only marital status shows a definite relationship with angina. Single patients are less likely to be diagnosed with angina than married patients (OR 0.37; 95% CI 0.12, 0.95). Four factors related to the nature of chest pain were examined here—location, onset, pattern, and quality. Neither location, onset of pain, nor quality of pain is associated with angina. Persistent pain is less likely to be diagnosed as angina compared to other types of pain (OR 0.62; 95% CI 0.47, 0.82).

**Radiation of chest pain and angina (not shown)**

Six factors related to radiation of chest pain were examined—radiation to jaw, radiation to left arm, radiation laterally, radiation to neck, radiation locally, and radiation to other parts. None of these factors are significantly associated with angina.

**Relieving and associated factors and angina**

Table 3 shows results for relieving and associated factors for angina. Five ways whereby chest pain could be relieved were analyzed—leaning forward, sitting up, GTN (glyceryl trinitrate), rest, and other means. Pain that is relieved by GTN is more likely to be diagnosed as angina (OR 2.13; 95% CI 1.57, 2.90). Pain that is relieved by rest is also more likely to be diagnosed as angina (OR 1.69; 95% CI 1.24, 2.32). However, pain that is relieved by other means is less likely to be diagnosed as angina (OR 0.51; 95% CI 0.38, 0.69).

Five cardiac/respiratory-associated factors were analyzed in this category—cough, dyspnea, edema, orthopnea, and palpitations. None of these factors are associated with a higher chance of being diagnosed with angina. Other than cardiac/respiratory factors, nine other factors were examined—collapse, headache, dizziness, fever, nausea, numbness, vomiting, and fainting. Of these, patients complaining of nausea (OR 1.37; 95% CI 1.02, 1.86) are more likely to be diagnosed with angina.

**Aggravating factors**

Table 4 looks at aggravating factors for chest pain. Five aggravating factors of chest pain were examined here—posture, meals, cough, inspiration, and exertion. Patients complaining that their chest pain was aggravated by posture (OR 0.31; 95% CI 0.12, 0.74) or cough (OR 0.23; 95% CI 0.04, 0.77) or inspiration (OR 0.19; 95% CI 0.07, 0.46)
are less likely to be diagnosed with angina. However, patients complaining of chest pain being aggravated by exertion are more likely to be diagnosed with angina (OR 2.36; 95% CI 1.75, 3.18).

Cardiac risk factors and angina

Table 5 looks at cardiac risk factors. Ten cardiac risk factors were examined—age more than 40, diabetes mellitus, family history of heart disease, hypertension, physical inactivity, obesity, smoking, known case of heart disease defaulted treatment, known case of heart disease still on treatment, and high cholesterol levels. Patients with diabetes mellitus are more likely to be diagnosed with angina (OR 1.73; 95% CI 1.22, 2.45). Hypertensives are also more likely to be diagnosed with angina (OR 1.55; 95% CI 1.15, 2.09). Oddly, smokers are less likely to be diagnosed with angina (OR 0.72; 95% CI 0.53, 0.97), but patients who are known heart cases still on treatment are more likely to be diagnosed with angina (OR 3.61; 95% CI 2.64, 4.94). Half (50.3%) of the cases of angina in this sample are new cases.

Examination factors

Fifteen examination factors were examined here—abdomen, air entry, breath sounds, central nervous system (CNS), chest expansion, chest wall, lung crepitations, eye,
Multiple logistic regression of angina

Results of the multiple logistic regression analysis are shown in Table 6. The overall percentage of correctness is 71.3%. The backward stepwise (likelihood ratio) method shows that 11 variables (not including the constant) are significantly related to a diagnosis of angina. The variables are sudden onset of pain, pattern of pain (persistent), pain that is relieved by other means, pain that is aggravated by exertion, history of diabetes mellitus, history of physical inactivity, history of smoking, history of heart disease but defaulted treatment, history of heart disease still on treatment, and presence of rhonchi on examination. However, of these variables, only history of heart disease still on treatment, and presence of rhonchi (not shown in any table).

None of the heart/lung examination factors are significantly related to a diagnosis of angina. The same is true for examination of other systems where none of the factors are significantly related to the diagnosis of angina.

Table 6
Multiple logistic regression of angina (backward stepwise)

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>β (SE)</th>
<th>P value</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-1.699 (0.572)</td>
<td>0.003</td>
<td>2.94 (0.99, 8.69)</td>
</tr>
<tr>
<td>Marital status (single)</td>
<td>1.077 (0.554)</td>
<td>0.052</td>
<td>2.87 (1.28, 6.44)</td>
</tr>
<tr>
<td>Race (Indian)</td>
<td>0.354 (0.182)</td>
<td>0.052</td>
<td>1.43 (1.00, 2.04)</td>
</tr>
<tr>
<td>Onset (sudden)</td>
<td>-0.363 (0.171)</td>
<td>0.034</td>
<td>0.70 (0.50, 0.97)</td>
</tr>
<tr>
<td>Pattern (persistent)</td>
<td>-0.584 (0.177)</td>
<td>0.001</td>
<td>0.56 (0.40, 0.79)</td>
</tr>
<tr>
<td>Relieved by other means</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collapse</td>
<td>-6.303 (13.844)</td>
<td>0.649</td>
<td>0.002 (0, 1.11 * 10^6)</td>
</tr>
<tr>
<td>Orthopnea</td>
<td>8.488 (36.658)</td>
<td>0.817</td>
<td>4855.41 (0, 7.76 * 10^14)</td>
</tr>
<tr>
<td>Nausea</td>
<td>0.329 (0.181)</td>
<td>0.069</td>
<td>1.39 (0.98, 1.98)</td>
</tr>
<tr>
<td>Numbness</td>
<td>9.069 (24.978)</td>
<td>0.717</td>
<td>8680.98 (0, 1.58 * 10^25)</td>
</tr>
<tr>
<td>Aggravated by cough</td>
<td>-1.271 (0.698)</td>
<td>0.069</td>
<td>0.28 (0.07, 1.10)</td>
</tr>
<tr>
<td>Aggravated by inspiration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggravated by exertion</td>
<td>-1.561 (0.561)</td>
<td>0.005</td>
<td>0.21 (0.07, 0.63)</td>
</tr>
<tr>
<td>Aggravated by inspiration</td>
<td>0.774 (0.173)</td>
<td>&lt;0.001</td>
<td>2.17 (1.55, 3.04)</td>
</tr>
<tr>
<td>Age&lt;40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>0.284 (0.168)</td>
<td>0.092</td>
<td>1.33 (0.96, 1.85)</td>
</tr>
<tr>
<td>Physical inactivity</td>
<td>0.645 (0.329)</td>
<td>0.050</td>
<td>1.91 (1.00, 3.63)</td>
</tr>
<tr>
<td>Smoking</td>
<td>-0.375 (0.176)</td>
<td>0.033</td>
<td>0.69 (0.49, 0.97)</td>
</tr>
<tr>
<td>Heart disease defaulted treatment</td>
<td>1.053 (0.413)</td>
<td>0.011</td>
<td>2.87 (1.28, 6.44)</td>
</tr>
<tr>
<td>Heart disease on treatment</td>
<td>1.429 (0.182)</td>
<td>&lt;0.001</td>
<td>4.17 (2.92, 5.96)</td>
</tr>
<tr>
<td>Percussion</td>
<td>-7.084 (17.937)</td>
<td>0.693</td>
<td>0.001 (0, 1.55 * 10^15)</td>
</tr>
<tr>
<td>Rhonchi</td>
<td>-0.864 (0.398)</td>
<td>0.030</td>
<td>0.42 (0.19, 0.92)</td>
</tr>
</tbody>
</table>

Discussion

It is not surprising to find a difference in systolic and diastolic BP between angina and nonangina patients, but the difference is larger with systolic BP than for diastolic BP. The mean systolic BP of the angina group is in the hypertensive zone, while the mean of the nonangina group is not. It is well known that hypertension remains one of the more important risk factors for ischemic heart disease [17–19]. However, in this sample, although the diastolic means of angina and nonangina patients differ statistically, the difference is not clinically significant, and both means are in fact lower than 90 mm Hg. This is probably due to the hypertension having been treated in these patients who had hypertension before being diagnosed with angina, thus not showing up in the analysis. The higher systolic blood pressure of the angina group is probably attributable to autonomic reaction to angina pain as this is not resting blood pressure but blood pressure taken in the emergency department. On the other hand, the difference in cardiac enzymes is probably due to AMI patients in the nonangina group, resulting in higher mean levels of cardiac enzymes in this group.

It is not quite clear why single (marital status) patients are less likely to be diagnosed with angina as this difference cannot be easily explained. A social factor like type of job has been associated with coronary heart disease [20], but marital status has been less well-studied. However, marital status is probably confounded by age (they are likely to be younger) as it fails to stand up to multivariate analysis.

Indians have been said to have a greater risk for acute myocardial infarction (AMI) as suggested by literature from neighboring Singapore [21,22], and thus one might expect to extrapolate these findings to angina. However, neither univariate nor multivariate analysis in this research has managed to demonstrate this. The overrepresentation of Indians in the sample could be due to the area being served by Selayang Hospital having a higher proportion of Indians in its catchment area.

There is no relationship between nature of chest pain and angina. Localization of chest pain may have some limited value (although not that predictive) in the diagnosis of myocardial infarction [23], but it does not appear to be of any use in angina. Neither does radiation of chest pain. It is not surprising to find that pain that is relieved by GTN or rest, and pain that is aggravated by exertion are more likely to be diagnosed as angina as these are probably among the criteria used for diagnosing angina anyway.

face, heart sounds, jugular venous pressure (JVP), chest percussion, presence of pleural rub, appearance of precordium, and presence of rhonchi (not shown in any table). None of the heart/lung examination factors are significantly related to a diagnosis of angina. The same is true for examination of other systems where none of the factors are significantly related to the diagnosis of angina.
Diabetic as well as hypertensive patients are more likely to be diagnosed with angina. This is in keeping with known risk factors [18,24]. The lack of significance of smoking as a risk factor for angina (in both univariate and multivariate analyses) is, however, puzzling, although this may be attributed to insufficient power of the test. Gender does not appear to be a risk factor for angina in this study, although the prevalence of Rose angina has been shown to be higher in women [9].

The multivariate analysis reveals that only pain aggravated by exertion, history of diabetes, physical inactivity, and history of heart disease (regardless of whether on treatment or not) are predictive of angina after controlling for all other factors. While these factors are well known to be predictors, the lack of significance of age is surprising.

The factors studied in this paper confirm the value of a good history in diagnosing angina. Examination factors, on the other hand, are less useful. The importance of this cannot be overemphasized as the fairly high predictive value based on only a few important history points raises the possibility of angina diagnosis based on history alone.

There are some limitations to this analysis. The possibility of some bias occurring because the sample has been limited to hospital patients cannot be excluded. However, the main aim was to obtain some predictive signs and symptoms to enable the development of a decision support system relevant to the Malaysian population, so this is possibly the best way one can go about accomplishing this. The author believes that these findings can have important applications in the design of an intelligent decision support system for use by the public or paramedics as the predictive capability can be further refined with the use of intelligent computational techniques.

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References