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Effect of patient sex on triage for ischaemic heart disease and treatment onset times: A retrospective analysis of Australian emergency department data

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ABSTRACT

Time between emergency department (ED) presentation and treatment onset is an important, but little-researched phase within the revascularization process for ischaemic heart disease (IHD).

Objective: To determine if sex influences triage score allocation and treatment onset for patients with IHD in the ED.

Methods: Retrospective data for patients 18–85 years presenting to EDs from 2005 to 2010 for acute myocardial infarction (AMI), unstable and stable angina, and chest pain were analysed collectively and separately for AMI.

Results: Proportionately more men (61% of males) were triaged correctly for AMI than women (51.4% of females; $P < 0.001$). Across all triage categories, average treatment time was faster for men than women with AMI ($P < 0.001$). When incorrectly triaged for AMI, treatment time for men was faster than for women ($P = 0.04$). When correctly triaged for AMI, there was no difference in mean treatment time between men and women ($P = 0.538$).

Conclusions: Substantial undertriage of AMI occurred for both sexes, but was worse in women. Incorrect triage led to prolonged treatment times for AMI, with women's treatment delays longer than men's. When triaged correctly, both sexes were treated early for AMI, emphasising the need for all patients to be accurately triaged for this time-sensitive disease.

Introduction

Mortality rates from acute myocardial infarction (AMI) have improved considerably in Australia and most other westernized countries over recent decades (Mackay and Mensah, 2004; AIHW, 2013). Slower improvements in outcomes associated with women's AMI, when compared to men's have previously been attributed to under-assessment, under-diagnosis and under-treatment of women for AMI in the emergency department (ED) (Arslanian-Engoren, 2000; Jneid et al., 2008). No research regarding the effect of ED nurse triage on treatment times for ischaemic heart disease (IHD), including AMI, stable and unstable angina and chest pain likely to be of cardiac origin was located, prompting us to test our hypotheses that women are more often undertriaged than men for IHD and undifferentiated chest pain, resulting in delays in women's treatment.

Published Australian research for triage of women's heart disease is lacking however a recent literature review has identified pervasive sex related influences working against women from triage through to early ED treatment in North American EDs (Kuhn et al., 2011). This may be partly attributable to differences in symptoms reported by women experiencing AMIs (Arslanian-Engoren et al., 2006; DeVon et al., 2008; Canto et al., 2012). However, other research has shown women with new onset of chest pain received different treatment to men in EDs, even

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when their symptoms were similar (Lehmann et al., 1996). Triage nurse biases and use of stereotypes have been found to negatively influence triage of women with AMI in North America (Arslanian-Engoren, 2009). One study concluded nurses' inabilities to "associate middle-aged women's presenting symptoms with MI (myocardial infarction) may contribute to the increased morbidity and mortality experienced by this population" (Arslanian-Engoren, 2000: p. 117).

One of the most important developments in AMI therapy over recent decades has been the early revascularisation of affected coronary arteries by pharmacologic or mechanical means. There has been considerable interest in establishing the superiority of one method over the other, yet time delay between symptom onset to commencement of treatment is considered an important obstacle to positive results (Boersma, 2006; Gibson et al., 2008; Rathore et al., 2009). According to current Australian and New Zealand guidelines, revascularisation therapy for AMI is ideally undertaken in less than 90 min from the point of contact with health carers (Aroney et al., 2006). These narrow time-frames are consistent with the latest American Heart Association (O'Gara et al., 2013) and European Society of Cardiology (Steg et al., 2012) guidelines. They are generally more important for patients with ST segment elevation myocardial infarction (STEMI) than non-ST segment elevation myocardial infarction (NSTEMI) (Aroney et al., 2006; O'Gara et al., 2013). Differentiation of STEMI from NSTEMI is not possible at the point of triage unless the patient presents with an ECG with confirmed changes, so all suspected patients with AMI should be treated with haste until the provisional diagnosis is determined and the patient stabilised. The time-dependent nature of AMI requires expeditious patient triage upon arrival and immediate transfer through to the ED treatment area for rapid application of evidence-based therapy. Australian EDs employ the Australasian Triage Scale (ATS) to assess all presenting patients on arrival.

The ATS is a 5-tiered scale designed to enable the "sorting" of patients arriving at EDs according to level of physiologic urgency (Australasian College for Emergency Medicine, *ACEM*, 1993; Department of Human Services, *DHS*, 2001). Urgency is defined as the need for time-critical intervention, rather than disease severity or likelihood of patient admission (ACEM, 2000). Patients with STEMI represent a time-critical cohort where delay of even a few minutes may be clinically consequential (De Luca et al., 2004; Rathore et al., 2009). All patients with AMI require early treatment until stable. Unless in cardiopulmonary arrest or shocked (such affected patients require ATS Category 1), patients with AMI, ongoing angina or chest pain likely to be of cardiac origin should receive ATS Category 2 on the basis of the illness potentially being a life-threatening, time-critical and generally a painful condition (DHS, 2001; ACEM, 2006). Patients allocated ATS Category 2 should have treatment commenced within 10 min (ACEM, 2006). 'Treatment' within this context includes procuring and evaluating an ECG.

Patients with AMI or other conditions not readily differentiated from AMI triaged to lower acuity than ATS Category 2 (3, 4 or 5) are considered to be 'undertriaged', whereas those who receive the recommended triage category for AMI receive 'expected' or 'correct' triage (Hollis and Sprivulis, 1996). Undertriage may lead to longer waiting times and increased risk of adverse patient outcomes (Considine et al., 2001).

This paper will present findings from a retrospective audit of five consecutive years of contemporary State Government of Victoria, Australia administrative health data to establish if patients with AMI, unstable or stable angina or undifferentiated chest pain are triaged differently according to their sex and if so, whether this influences time to treatment.

Methods

Design and setting

A retrospective analysis of non-identifiable Victorian Emergency Minimum Dataset (VEMD) data on adult patient presentations for the diagnoses; AMI, unstable angina pectoris (UAP), stable angina pectoris (SAP) and chest pain (CP) reporting to Victorian public hospital EDs between 1 July 2005 and 30 June 2010 was conducted. We sought to establish the number and proportion of men and women receiving correct triage for these diagnoses, to compare equity in triage score allocation and evaluate mean times to onset of ED treatment for patients grouped by triage score and sex.

Selection criteria

In Victoria, the State Government Department of Health (DoH) routinely collects data for all ED patient presentations regarding patient sex, triage score allocation, time to treatment and principal diagnosis in the VEMD. Data for patient presentations to all non-specialist regional and metropolitan Victorian public hospital EDs ($n = 34$) were collected for five years (2005–2010). Specialty hospital EDs, whose staff do not routinely triage patients for AMI were excluded from data collection. Private hospital ED presentations were excluded because not all were reporting complete data to DoH for the entire study period.

Presentations classified as alive on arrival, and aged between 18 and 85 years were obtained using the International Classification of Diseases, 10th Revision Australian Modifications (ICD-10 AM) for the principal diagnoses: AMI (I21.9); UAP (I20.0); SAP (I20.9); and with complaint of chest pain (R07.4). All were selected to obtain an overview of triage patterns for presentations which may have prompted triage nurses to consider patients potentially experiencing AMI at the time of triage. The data were then filtered for I21.9 specifically to evaluate equity in triage score allocation for patients diagnosed with AMI. The VEMD does not differentiate between STEMI and NSTEMI, which would have been our preferred option, had it been available.

Data collection

Data were requested from the custodians of the VEMD for variables including age, time to treatment, ICD-10 AM code (hereafter, ICD), patient sex and ATS score allocation, and provided to the researchers in non-identifiable digital datasets.

Statistical analysis

All data were transferred to SPSS Statistics Version 18.0 (SPSS Inc., an IBM Company, Chicago, Ill, USA) software, where string data fields were allocated numerical codes, examined for missing values, outliers and accuracy of data entry. Distributions were checked for normality with the Lilliefors test.

Frequency tables were used to provide descriptive statistics for independent variables (patient sex and triage score allocation) and dependent variables (triage score allocation and time to treatment), for all diagnoses combined, followed by selection for AMI separately. Independent-samples *t*-tests were conducted to compare times to treatment for men and women for all selected diagnoses and also for AMI singly. AMI, as the most time-critical of the identifiable cardiac event presentations, was analysed and reported separately.

To determine interaction effects when patient sex and triage score allocation were added to the investigation, we applied oneway analysis of variance (ANOVA) and two-way between-groups ANOVA, allowing the examination of individual and joint effects of the two independent variables on the dependent variable.

Main outcome measures were triage score allocation proportions and mean times to reported onset of treatment for males and females. All tests of statistical significance were 2-tailed, with a P value < 0.05 considered to be statistically significant.

Ethics approval

The Australian Catholic University Human Research Ethics Committee approved the study (HREC V2009 83). The Victorian Department of Human Services 'Conditions of Release of Patient Level Data Sets' were also met.

Results

Demographic and diagnostic characteristics

A total of 261,628 patients presented to Victorian EDs between 1 July 2005 and 30 June 2010 with AMI, UAP, SAP or CP (Table 1). The mean age for all male (n = 146,603) presentations was 53.29 years (SD 16.04) and 57.63 years (SD 16.69) for females (n = 115,025). As shown in Table 1, chest pain was the most common principal diagnosis assigned to women and men.

A total of 21,080 patient presentations were assigned a principal diagnosis of AMI, accounting for 5.8% (n = 6,638) of extracted women's presentations and 9.9% of men's presentations (n = 14,442). Women with AMI were an older average age (mean = 68.97 years; SD 12.25) than men (mean = 62.84 years; SD 13.07, $t(21,078)$, P < 0.001).

Table 1
Baseline characteristics of patient presentations to Victorian public EDs from July 1st 2005 to June 30th 2010 with AMI, UAP, SAP and CP diagnoses.

Variable	Total n (%)	Women n (%)	Men n (%)
AMI	21,080 (8.1)	6638 (5.8)	14,442 (9.9)
UAP	25,319 (9.7)	9677 (8.4)	15,642 (10.7)
SAP	9648 (3.7)	4199 (3.7)	5449 (3.7)
CP	205,581 (78.6)	94,511 (82.2)	111,070 (75.8)
Extracted total	261,628 (100)	115,025 (100)	146,603 (100)

AMI, acute myocardial infarction; CP, chest pain; EDs, emergency departments; SAP, stable angina pectoris; UAP, unstable angina pectoris.

Triage categories

As shown in Table 2, a narrow majority (133,626; 51%) of the total presentations (n = 261,628) were allocated ATS Category 2. A greater proportion of men (n = 77,846; 53.1% of all males) were allocated Category 2 compared to women (n = 55,480; 48.23% of all females; P < 0.001). More women were allocated both ATS Categories 3 (P < 0.001) and 4 proportionately (P < 0.001) than men.

A larger proportion of male patient presentations with AMI were allocated ATS Category 2 than were females with the same diagnosis (Table 2). The difference in probability of a male with AMI being allocated Category 2, as opposed to a female was statistically significant (OR 1.45; 95% CI 1.37–1.55; P < 0.001).

Time to treatment onset

The mean reported time to onset of treatment for all patient presentations across all triage categories for all diagnoses (n = 261,628) was 19.07 min (SD 35.49). For males, the mean treatment time was 17.86 min (SD 33.68) and for females, 20.61 min (SD 37.63, $t(261,626) = -19.678$, P < 0.001). For all diagnostic groups combined, and then filtered for AMI separately, there were no differences in mean treatment times if patients were given ATS Category 1; patients were treated immediately with mean treatment times recorded as less than 1 min for both sexes (Table 2).

Men had shorter times to treatment than women in ATS Categories 2, 3 and 4 for the combined diagnostic groups, however women had shorter times to treatment than men when they were allocated ATS Category 5 [$F(4,261,618) = 17.07$; P < 0.001]. When testing differences in treatment times for patients given ATS Category 2, men were treated statistically significantly faster than women (men, mean = 7.55 min, SD 10.77; women, mean = 8 min, SD 11.17, $t(133,324) = -7.37$, P < 0.001). When women were allocated ATS Categories 3 or 4, they had longer mean treatment times (mean = 32.39 min, SD = 48.22) than men in the equivalent two ATS Categories (mean = 29.78 min, SD 44.84; $t(124,918) = -9.916$, P < 0.001).

A two-way univariate ANOVA test revealed a significant interaction effect between patient sex and diagnosis; male times to treatment were significantly shorter across all diagnoses than were the female mean times for equivalent diagnoses [$F(3,261,628) = 4.143$; P = 0.006].

The mean overall treatment times for patients with principal diagnosis of AMI were significantly shorter for men (mean = 11.76 min; SD 25.71) than women (mean = 14.91 min;

Table 2
Mean times to treatment for all principal diagnoses and AMI only, allocated ATS Categories 1–5.

ATS category	Total (both sexes)		Women		Men		P
	n (%)	Mean TT (SD)	n (%)	Mean TT (SD)	n (%)	Mean TT (SD)	
All principal diagnoses (AMI, UAP, SAP, CP)							
1	1697 (0.6)	0.08 (0.28)	413 (0.4)	0.09 (0.29)	1284 (0.9)	0.08 (0.27)	0.321
2	133,326 (51.0)	7.74 (10.94)	55,480 (48.2)	8.00 (11.17)	77,846 (53.1)	7.55 (10.72)	<0.001
3	100,540 (38.4)	24.64 (36.51)	46,665 (40.6)	25.68 (37.91)	53,875(36.7)	23.73 (35.22)	<0.001
4	24,380 (9.3)	57.25 (68.65)	11,754 (10.2)	59.03 (70.45)	12,626 (8.6)	55.59 (66.90)	<0.001
5	1685 (0.6)	50.51 (62.79)	713 (0.6)	48.67 (57.78)	972 (0.7)	51.86 (66.23)	0.009
Total	261,628 (100)	19.07 (35.49)	115,025 (100)	20.61(37.63)	146,603 (100)	17.86 (33.68)	<0.001
AMI only							
1	1250 (5.9)	0.09 (0.28)	294 (4.4)	0.09 (0.29)	956 (6.6)	0.08 (0.28)	0.45
2	12,161 (57.7)	6.07 (9.54)	3412 (51.4)	6.1 (9.28)	8749 (60.6)	6.06 (9.64)	0.538
3	6404 (30.4)	21.15 (33.09)	2392 (36.0)	21.67 (33.97)	4012 (27.8)	20.83 (32.56)	0.242
4	1178 (5.6)	48.16 (66.13)	511 (7.7)	50.21 (69.17)	667 (4.6)	46.60 (63.71)	0.268
5	87 (0.4)	31.05 (50.80)	29 (0.4)	21.14 (31.94)	58 (0.4)	36.00 (57.60)	0.054
Total	21,080 (100)	12.75 (27.71)	6638 (100)	14.91 (31.53)	14,442 (100)	11.76 (25.71)	<0.001

AMI, acute myocardial infarction; ATS, Australasian Triage Scale; CP, chest pain; ED, emergency department; Mean TT, Mean Time to Treatment (minutes); P, significance value for mean time for patient sex; SAP, stable angina pectoris; SD, standard deviation; UAP, unstable angina pectoris.

SD 31.53; $t(21{,}078) = -7.671$, $P < 0.001$). When given any of the possible triage categories lower than expected (i.e. Cats 3, 4 and 5), as a composite group, mean treatment times for men (mean = 24.65 min; SD 39.88) were significantly shorter than they were for women (mean = 26.64 min; SD 43.6; $t(7667) = -2.054$, $P = 0.04$). However, when patients with AMI were assigned the expected ATS Category 2, there was no statistical difference observed in mean treatment times between males (mean = 6.06 min; SD 9.64) and females (mean = 6.10 min; SD 9.28; $t(12{,}159) = -2.25$, $P = 0.538$). This was the case for all treatment time comparisons between men and women for all individual ATS scores, analysed for AMI separately. There were no statistical differences observed between men's and women's treatment times for any of the ATS Categories (1–5) for this group diagnosed with AMI (Table 2).

Discussion

We have evaluated triage score allocation proportions and times to recorded treatment onset to establish whether women were more often undertriaged than men for AMI, and whether any triage disparity was associated with delays in women's treatment for AMI, UAP and SAP and CP potentially of cardiac origin in Victorian EDs. Analysis of the complete dataset demonstrated an association between sex and triage score allocation; women were less likely to receive correct triage score allocation for AMI, UAP, SAP and undifferentiated chest pain than men, and this was associated with prolonged times to treatment. Although limited to one Australian state, analysis of triage practice for ischaemic heart disease on this dataset is likely to enlighten other health jurisdictions about ED practice performance measures and outcomes in their own systems.

Numerous researchers have demonstrated women receive less evidence based management during hospitalisation for AMI than do their male counterparts (Milcent et al., 2007; Radovanovic et al., 2007; Jneid et al., 2008). Our data revealed that for this statewide population of patients who presented to ED triage nurses with either potential or actual AMI, a smaller proportion of women received the expected triage score than did men over the period investigated. We found the comparative triage differences between the sexes to have been even greater for patients with the principal diagnosis of AMI; women were even less likely to receive an adequate triage score when experiencing AMI than men. Triage score allocation was poor for both sexes however; it was incorrect for almost 50% of women and 40% of men and is worthy of further research to clarify the issue and improve performance.

We then aimed to investigate whether triage score allocation made a difference to mean treatment times for patients from the aggregate diagnoses (AMI, UAP, SAP and CP), and then specifically for those diagnosed with AMI. Our findings suggest that for these five years, triage score was likely an important determinant of treatment onset times for both sexes, if they were undertriaged (given ATS Categories 3, 4 or 5). For all diagnostic groups combined, and then filtered for AMI separately, there were no differences in mean treatment onset times if they were given ATS Category 1; both sexes' mean waiting times were a matter of seconds.

Disparities in treatment times for the sexes varied statistically between the aggregate and AMI-only groups when allocated ATS Category 2. For women from the aggregate group, allocation of the correct Category 2 meant their mean treatment times were statistically significantly longer than men from the equivalent sample group. We do not believe this would have been clinically significant however as many of these patients' conditions could not have justifiably been allocated ATS Category 2 on clinical grounds. This was not the case for patients selected with the principal diagnosis of AMI; men and women with AMI had statistically equivalent treatment times when given the expected ATS Category 2. Both men and women with AMI allocated ATS Category 2 were treated in less than 10 min, although proportions of each sex triaged to this expected Category were disappointing.

When allocated ATS Categories 3 or 4, men from the aggregate group were treated faster than women from the same group; this inequity reached statistical significance. This was not the case when the sample was limited to the principal diagnosis of AMI; mean treatment onset times for women were observably slower than men's with AMI when allocated ATS Categories 3 or 4. Whilst this may have had clinical ramifications, it did not reach statistical significance. The result of being undertriaged with AMI was poor for both sexes, with mean waiting times well in excess of the 10 min recommended for treatment of patients who should have received ATS Category 2 (ACEM, 2000).

Interpretation of analyses for patients of both the aggregate group, as well as those filtered for AMI by sex were intriguing; men were treated more slowly than women when allocated ATS Category 5. This reached statistical significance when the aggregate group was analysed, but narrowly failed to reach statistical significance for patient presentations filtered for the principal diagnosis of AMI. Men allocated ATS Category 5 with AMI waited almost 15 min longer on average to commence treatment than their equivalent cohort of women, but the sample sizes were small compared to those in the other triage categories. Reasons for this capricious result are unclear. We recommend further prospective research to identify whether this pattern of triage score allocation continues and determine the basis of the divergence of the decision making at triage.

Also of interest was the fact that patients of both sexes tended to be treated faster when given ATS Category 5 than 4. This finding was unexpected, and may have been due to unequal sample sizes, but we wonder whether it was due in part to the *fast track* systems operating in Victorian EDs for patients triaged to lower levels of acuity (O'Brien et al., 2006; Considine et al., 2008). Without the fast track systems, these patients could wait protracted periods of time if their treatment was repeatedly deferred due to arrival of other patients with more urgent conditions. Hence, patients of either sex were more fortunate in terms of times to treatment when allocated the least acute ATS Category 5, than they generally were when given ATS Category 4.

Limitations

This research has a number of limitations requiring elaboration. Even though the database is likely to contain all patient presentations to Victorian public hospital EDs with the principal diagnoses researched, it fails to provide detail regarding outcomes such as classification of AMI, AMI resolution and morbidity. It is an administrative dataset.

Lack of available data linkage at the time of data extraction means we are unable to gauge if the same patients have returned on multiple occasions and have been counted numerous times. Comprehensive linkage of datasets may enable the determination of patients who have represented to EDs or presented with escalating disease and the impact on their outcomes. In such a large dataset, knowledge of repeated presentations and establishment of patterns of subsequent major adverse cardiac events or death may be feasible with improved data linkage and are likely to be useful epidemiologically. It is hoped the Australasian Cardiac Outcomes Registry anticipated to have been launched nationally in 2012 (CSANZ, 2011) will address a number of these issues when it becomes fully operational.

Limited detail in available data at the time of extraction has meant we do not know how long patients had symptoms prior to seeking medical assistance or whether they had been seen by local medical practitioners prior to their ED presentations. It is also unknown how long patients waited for ambulances or whether they were subjected to *ramping* prior to commencement of ED triage, thus artificially reducing real waiting times. The practice of ramping occurs at some Victorian EDs and involves leaving patients on ambulance trolleys for longer to be attended to by paramedics due to resource limitation issues within the EDs (VEPA, 2011). We do not have data reflecting whether usual practice dictates triage evaluation as the ambulances arrive, or whether this first ED assessment is delayed.

Despite the acknowledged shortcomings inherent in this type of research, the application of the ATS throughout Victoria, coupled with the collection of ICD-10 coded data has enabled important inferences regarding equity between patient sexes to be drawn on the accuracy of triage score allocation and the influence of triage on a large population of patients with suspected and actual AMI. Until further prospective studies are undertaken, these findings can be viewed as correlations rather than causes.

Conclusions

Key findings emanating from our analyses of five years of contemporary public hospital ED data include:

1. Incorrect triage score allocation for patients with AMI of either sex is common. However, analysis revealed women were more disadvantaged than their male counterparts. A statistically significant smaller proportion of women diagnosed with AMI were given the correct triage score than the proportion of men with AMI.
2. Incorrect triage score allocation was associated with prolonged treatment times for Victorian patients with AMI. When allocated lower triage acuity than Category 2, treatment delays were prolonged for both sexes.
3. Correct allocation of triage score for AMI was and is important; when patients of either sex were given ATS Category 2, there was no significant difference in treatment times, which were under 10 min.

Hence, when triage nurses allocate correct ATS scores for heart disease, the triage system is working well and generally enables early implementation of time-sensitive therapies, when indicated. However, this research is exploratory and more detailed analysis needs to be done as comprehensive datasets and improved linkage between datasets become available. Ideally, future health management will be based on evidence ascertained nationally, which may be feasible due to the nationwide use of the disease classification and triage systems. In addition to this, further research needs to address whether inequities in triage score allocation and subsequent delays do affect patient outcomes for heart disease and if so, how they can best be overcome. At this stage, we have shown an association, but this needs further validation and evaluation of relevant patient outcomes. Future work may include incorporation of sex-specific heart disease assessment and management into ED triage educational processes and a promotional campaign to increase awareness of issues which continue to confound opportunities to minimise myocardial damage.

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