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# Risk factors and in-hospital outcomes in stroke and myocardial infarction patients

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## Abstract

**Background:** Acute stroke (AS) and acute myocardial infarction (AMI) share major risk factors such as age, gender, and high blood pressure. The main objective of this study was to compare vascular risk factor profiles with in-hospital outcomes in AS and AMI patients.

**Methods:** We evaluated 486 consecutive patients who were admitted to Bjelovar General Hospital with diagnoses of AS (ischaemic stroke or intracerebral haemorrhage; N = 380) or AMI (N = 106) during a one year period. The frequency of risk factors and in-patient mortality rates were assessed in both groups. For statistical analysis we used t-tests and $\chi^2$ tests.

**Results:** AS patients were significantly older than AMI patients: the mean age for AS patients was 68.9 ± 9.1 years, and for AMI patients was 62.8 ± 11.7 years ($p < 0.001$). AMI was significantly more common than AS in patients younger than 65 years; 51% of this group had AMI and 26% had AS ($p < 0.001$). Hypertension was a more common risk factor in AS patients (69% AS patients vs. 58% AMI patients; $p = 0.042$). Patients who died did not differ significantly in age between the groups. In-patient mortality rates were significantly higher in AS than AMI cases (31% vs. 12%, $p < 0.001$ for all patients; 37% vs.5%, $p < 0.001$ for men). Women hospitalized for AMI were more likely to die in hospital than men (28% vs. 5%; $p = 0.002$).

**Conclusions:** We found that age at the time of presentation was a significant differentiating factor between patients with AS and AMI. The only exceptions were women, whose ages at the onset of AS and AMI were similar. In contrast, patients who died did not differ significantly in age. We observed significantly higher inpatient mortality for men (when adjusted for age) than for women with AS. The five-fold higher in-patient mortality rate in women than in men with AMI is most likely to have resulted from other factors related to treatment.

## Background

Epidemiological studies [1-5] have shown that acute stroke (AS) and acute myocardial infarction (AMI) have common risk factors such as age, gender and hypertension, but the strength and directions of the associations may be different. Whereas AMI is a disease caused by ischemic changes of the myocardium, the diagnosis of AS refers to a heterogeneous group of cerebrovascular diseases.

Several practice guidelines for prevention and treatment of each of these disorders have recently been published

[2,6-9]. Furthermore, some groups have proposed plans for regionalization of the care of AS and AMI patients [10-13].

A substantial population of patients with AS and AMI receive medical care in regional county hospitals. However, only a few articles [14-16] have evaluated the quality of care in these institutions, which have limited diagnostic and therapeutic facilities.

In our study we examined the differences in demographic characteristics of AS and AMI patients in the county hospital in Croatia, their common risk factors, and the uniformity of recommendations for drugs for secondary prevention of AS and AMI at the time of discharge. We also evaluated the in-patient mortality rates for these two disorders.

## Methods

### *Patients and setting*

This was a retrospective study of patients admitted to Bjelovar General Hospital. This is the only hospital in Bjelovar-Bilogora County, which is a centrally located region in continental Croatia, with area 2637 $km^2$ and a population of 144,042 inhabitants.

During a one-year period, a total of 486 consecutive patients were admitted to the Department of Neurology with diagnosis of AS and to the Department of Internal Medicine with diagnosis of AMI. Demographic and clinical data, laboratory results, 12-lead ECG findings, lists of all medications and clinical outcome data were collected from medical records and stored in our computer database.

### *Definitions*

Acute stroke was defined using the World Health Organization (WHO) definition [17] as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function lasting more than 24 h (unless interrupted by surgery or death) with no apparent cause other than that of vascular origin". Patients with both ischaemic stroke and intracerebral haemorrhage were included in the study.

Acute myocardial infarction was diagnosed according to the WHO definition [17] when the patients had at least two of the following three criteria: typical chest pain for myocardial ischaemia, initial and serial conventional electrocardiographic changes in standard or precordial leads, and enzymatic evidence of myocardial necrosis.

In-patient mortality rate was used to assess the mortality rates of patients during hospitalization.

### *Risk factors*

Patients with a history of hypertension in their medical records or with three or more successive blood pressure measurements exceeding 140/90 mmHg during hospitalization were considered hypertensive. Patients with left-ventricular failure had symptoms of breathlessness accompanied by basal crepitations, and/or a third heart sound and radiological signs of interstitial or alveolar pulmonary oedema. Diabetes mellitus was determined if a history of this disease had been documented in prior medical records or if patients required dietary sugar restriction, insulin, or oral hypoglycaemic drugs during hospitalization, in addition to the positive criteria for diabetes [18].

### *Therapy*

Standard care for AS and AMI patients in our hospital consists of monitoring vital functions, pulmonary function support, repeated blood pressure measurement, glucose metabolism, and fluid and electrolyte evaluation. Acetylsalicylic acid (ASA), hemodilution therapy and neuroprotective agents were used in patients with ischaemic AS. Anti-ischaemic and antiplatelet agents were used in the AMI patients.

Thrombolytic therapy (TT) was used only in AMI patients who had ST-segment elevation and whose onset of disease occurred in less than 12 h. It was administered together with standard or low-molecular-weight heparin, which was also used for patients without persistent ST-segment elevation. TT was not used in the AS patients.

Frequency of use of ASA, beta-blockers, angiotensin converting enzyme inhibitors, calcium blockers, and statins at the time of discharge were also evaluated in both groups of patients.

In general, patients with AS and AMI are hospitalized for 13 to 15 days.

### *Statistical analysis*

Data were analyzed as mean ± SD for continuous variables and as frequencies for variables on a nominal scale. For group comparisons we used Student's t-test and the $\chi^2$ test (Yates corrected test, if indicated, and Fisher exact test for comparisons of small samples). Values of $p < 0.05$ were considered significant.

## Results

During a one-year period, 380 patients were treated for AS: 310 (82%) had ischaemic stroke and 70 (18%) had intracerebral haemorrhage. There was no gender difference between the two patient groups. Urgent computerized tomography (CT) was performed on 43% of patients with AS (63% with intracerebral haemorrhage vs. 39% with ischaemic stroke; $p < 0.001$).

**Table 1: Age (years) and gender of patients with acute stroke and acute myocardial infarction**

| Group† | Gender | | | | | | Men vs. Women |
|---|---|---|---|---|---|---|---|
| | Men | | | Women | | | |
| | N | Range | Mean ± SD | N | Range | Mean ± SD | |
| AS | 178 | 30–86 | 66.7 ± 9.4 | 202 | 39–89 | 70.8 ± 8.4 | p* < 0.001 |
| AMI | 74 | 32–84 | 59.9 ± 11.6 | 32 | 47–85 | 69.7 ± 8.9 | p* < 0.001 |
| AS vs. AMI | | | p* < 0.001 | | | p* = 0.056 | |
| AS+AMI | 252 | 30–86 | 64.7 ± 10.5 | 234 | 39–89 | 70.6 ± 8.5 | |

†AS = acute stroke; AMI = acute myocardial infarction. *p value for two-sided t-test.

**Table 2: Risk factors and prior medical history in patients with acute stroke and acute myocardial infarction**

| Risk factors | Percent of patients with a risk factor and | | OR† (95% CI) | p* |
|---|---|---|---|---|
| | acute stroke | acute myocardial infarction | | |
| Hypertension | 69 | 58 | 1.62 (1.02–2.58) | 0.043 |
| Diabetes mellitus | 29 | 25 | 1.22 (0.73–2.06) | 0.494 |
| Previous myocardial infarction | 3 | 13 | 0.23 (0.10–0.55) | <0.001 |
| Previous stroke | 29 | 9 | 4.39 (2.06–9.66) | <0.001 |
| Heart failure | 18 | 31 | 0.50 (0.30–0.84) | 0.006 |
| Atrial fibrillation | 16 | 10 | 1.65 (0.80–3.47) | 0.193 |

* p value for Yates corrected $\chi^2$ test. †OR (95% CI) = Odds Ratio (95% confidence interval for OR).

During the same year, 106 patients were treated for AMI. The majority (N = 74, 70%) of AMI patients were men and 32 were women; p < 0.001. In contrast, there were 178 male and 202 female AS patients; p < 0.001 (Table 1). AS patients were significantly older than AMI patients: the mean age for AS patients was 68.9 ± 9.1 (range 30–89) years, and for AMI patients it was 62.8 ± 11.7 (range 32–85) years (p < 0.001). In patients younger than 65 years, AMI was significantly more common; 51% of this group had AMI and 26% had AS (p < 0.001).

Significant differences were found between previous myocardial infarction or stroke episodes and the current disease. A history of AS was more common in patients with current ischemic AS; 31% had suffered ischaemic stroke in the past compared to 19% with intracerebral haemorrhage (p = 0.048). Also, hypertension was more common in the AS than in the AMI group (Table 2). As anticipated, heart failure was more common in the AMI patients.

A significantly higher number of recommendations for ASA, statins and beta-blocking agents was found at the time of discharge in patients with AMI than in those with AS (Table 3).

AS patients with fatal outcome were younger than AMI patients, but not significantly (AS patients were 69.1 ± 8.9 (range 30–86) years old, vs. 70.8 ± 11.4 (range 50–85) years for AMI; p = 0.533). Overall, there were no significant age differences in patients who died (Table 4).

Patients with AS had a significantly higher overall in-patient mortality rate than those with AMI (31.1% vs. 12.3%; p < 0.001). Also, we found a significant difference in in-patient mortality rates for men (men with AS 37.1% vs. men with AMI 5.4%; p < 0.001) but not for women (25.7% vs. 28.1%; p = 0.775, Table 5).

We also found a significantly higher mortality rate in patients with intracerebral haemorrhage than with ischaemic stroke (54.3% vs. 25.8%; p < 0.001). In patients with ischemic stroke, mortality in males was higher than in females (31.5% for men vs. 20.9% for women; p = 0.047).

**Table 3: Prescribed medications in surviving patients with acute stroke (N = 262) and acute myocardial infarction (N = 93)**

| Medication | Percent of patients at discharge who had medication and had | | p* |
|---|---|---|---|
| | acute stroke | acute myocardial infarction | |
| Aspirin | 69 | 84 | 0.007 |
| Statins | 3 | 14 | <0.001 |
| ACE inhibitors | 76 | 70 | 0.276 |
| Beta-blockers | 2 | 10 | 0.001† |
| Calcium channel blockers | 18 | 9 | 0.057 |

ACE inhibitors = angiotensin converting enzyme inhibitors. * p value for Yates corrected $\chi^2$ test. †p value for lower Fisher exact test.

**Table 4: Age (years) and gender of patients who died with acute stroke or acute myocardial infarction**

| Group† | Gender | | | | | | Men vs. Women |
|---|---|---|---|---|---|---|---|
| | Men | | | Women | | | |
| | N | Range | Mean ± SD | N | Range | Mean ± SD | |
| AS | 66 | 30–85 | 68.0 ± 9.1 | 52 | 41–86 | 70.5 ± 8.4 | p* = 0.137 |
| AMI | 4 | 50–84 | 66.8 ± 14.0 | 9 | 54–85 | 72.6 ± 10.4 | p* = 0.495 |
| AS vs. AMI | | | p* = 0.868 | | | p* = 0.581 | |
| AS+AMI | 70 | 30–85 | 68.0 ± 9.3 | 61 | 41–86 | 70.8 ± 8.7 | |

†AS = acute stroke; AMI = acute myocardial infarction. *p value for two-sided t-test.

**Table 5: In-patient mortality rates according to sex and age in acute stroke and acute myocardial infarction**

| Group (age in years) | No. of patients with the event/ No. of patients in the given group (%) who had | | RR† (95% CI) | p* |
|---|---|---|---|---|
| | acute stroke | acute myocardial infarction | | |
| Men | | | | |
| ≤64 | 20/65 (30.1%) | 2/48 (4.2%) | 7.38 (1.81–30.09) | <0.001 |
| >64 | 46/113 (40.1%) | 2/26 (7.7%) | 5.29 (1.37–20.41) | 0.001 |
| all | 66/178 (37.1%) | 4/74 (5.4%) | 6.86 (2.59–18.13) | <0.001 |
| Women | | | | |
| ≤64 | 9/35 (25.7%) | 1/6 (16.7%) | 1.54 (0.24–10.07) | 0.633‡ |
| >64 | 43/167 (25.7%) | 8/26 (30.8%) | 0.84 (0.45–1.57) | 0.589 |
| all | 52/202 (25.7%) | 9/32 (28.1%) | 0.92 (0.50–1.67) | 0.775 |

* p value for Yates corrected $\chi^2$ test. †RR (95% CI) = relative risk for in-patient mortality rate in acute stroke vs. acute myocardial infarction. ‡p value for lower Fisher exact test.

## Discussion

Despite the continuing decline in the incidence of cardiovascular diseases (CVD) in developed countries, the incidence is still increasing in developing nations [2,3,5]. In Croatia, for example, death rates from coronary heart disease increased by over 60% in both men and women between 1988 and 1998 [19].

In the current study, we assessed all patients admitted to Bjelovar General Hospital during a one-year period with

AS (ischaemic stroke or intracerebral haemorrhage) and AMI.

Our data show that the number of AS patients admitted was three times greater than the number of AMI patients. We hypothesize that more AMI patients died at home; it has previously been suggested that AMI is the most common cause of sudden death [20].

The number of acute CT scans performed on our hospitalized AS patients was relatively low, as noted in previous reports from developing countries [21].

The majority of our AMI patients were men (70%) and this is in agreement with other hospital based registries [22-24]. Further, most of these patients were younger than 65 years, as in the European Network for Acute Coronary Treatment (ENACT) group of patients [25]. In contrast, most of our AS patients were older than 65, as reported in other studies [14,26,27]. Nearly one half (47%) of our AS patients were men, which is also consistent with recent studies [26].

We found more hypertensive patients with AS, and especially with AMI, than some groups have reported [25,26,28,29]. The frequencies of other risk factors did not differ from those reported by other groups [14,26,27].

Hospitals vary greatly in their approaches to secondary prevention treatment for AS patients. About 65–70% of our AS patients received ASA and antihypertensive drugs at the time of discharge. Only a very small proportion of AS patients (3%) received statins. The reasons for this were probably uncertainty about the benefit of these drugs and their high cost [14,26,30,31].

The percentage of AMI patients who were given ASA at the time of discharge was similar to that reported in the European Action on Secondary Prevention through Intervention to Reduce Events II (EUROASPIRE II) study [22]. We prescribed ACE inhibitors more frequently than reported in EUROASPIRE II, but fewer patients were prescribed beta-blockers and statins. Critical reviews by the EUROASPIRE I and II groups [22] and Cohen [32] argued that such inconsistency in medical practice in Europe and North America is a major problem for reducing the risk of recurrent disease and death.

Our data also showed an increased mortality rate for in-patients with AS compared those with AMI. The overall mortality rate for AMI in-patients was 12.3%, which is similar to other studies using hospital-based registries [33,34]. The overall mortality rate for AS in-patients was 31.1%, which is similar to the studies from Italy [35], and Poland [36] but higher than the rates observed in Western Europe, North America and Australia [14,21,22,25-27,37-39]. We can partially explain this by the high prevalence of hypertension; also, our patients had higher rates of intracerebral haemorrhage than other groups have reported (18% vs. <15% in Western Europe) [21]. We also observed significantly higher inpatient mortality for men (when adjusted for age) than for women with AS. Previous studies have indicated gender differences in outcome for patients with CVD. Women who present with AMI are older and have more co-morbidity than men; they are more likely to be misdiagnosed, possibly because "atypical" symptoms can potentially delay their treatment and diminish its aggressiveness [39]. This is associated with higher in-patient and outpatient mortality rates for AMI. However, for patients with AS, the influence of gender on outcomes is controversial [40-43].

In summary, we found that age at the time of presentation was a significant factor in patients with AS and AMI. The only exception was that women were of similar ages at the onset of AS and AMI. In contrast, patients who died did not differ significantly in age. The five-fold higher in-patient mortality rate in women than in men with AMI is most likely to be the result of other factors related to treatment. We believed that the major reasons for observed geographical differences in hospital mortality are largely related to methodological differences between studies compared (e.g. local differences in approaches to hospitalization, availability of acute stroke services etc.).

Our study has several limitations. We assessed patients from a single county hospital, which has particular restrictions; so, for example, our CT scanning rates for AS patients were relatively low. Therefore, these findings should not be generalized.

Our results suggest that appropriate measures are needed to reduce the high mortality rates in our patients and to increase the awareness of putative risk factors for patients with cardiovascular disease. At the county level, reducing the burden of AS and AMI will require continuous public education and focus on controlling common risk factors, early recognition of symptoms, and the importance of urgent transport to the hospital. In county hospitals, there is a burning need for easier access to health-care facilities with better and more efficacious organization of the emergency care system. Further, developing countries should improve the management of AS and AMI in hospitals with appropriate evaluation and early treatment of these patients.

## Competing interests

None declared.

## Authors' contributions

MI and ZI participated in all phases of preparation of manuscript (acquisition of data, analysis and interpretation of data, drafting the manuscript). Both authors read and approved the final manuscript.

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