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Abnormalities on ECG and telemetry predict stroke outcome at 3 months

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Abstract

Background: ECG is a useful tool in monitoring vital functions in patients with acute stroke; however, fairly little evidence is available concerning the prevalence and the prognostic impact of ECG findings in patients with acute cerebral infarction and acute intracerebral haemorrhage (ICH).
Methods: This analysis was based on data from 692 patients with acute cerebral infarction, 155 patients with intracerebral haemorrhage (ICH), and 223 patients with transient ischaemic attack (TIA), who were admitted to hospital within 6 h of symptom onset. A 12 lead ECG was obtained on admission, and the patient was on telemetry for the first 12–24 h of hospitalisation.
Results: ECG abnormalities were observed in 60% of patients with cerebral infarction, 50% of patients with ICH, and 44% of patients with TIA. In multivariate analyses 3-month mortality in patients with ischaemic stroke was predicted by atrial fibrillation OR 2.0 (95% CI 1.3–3.1), atrio-ventricular block OR 1.9 (95% CI 1.2–3.9), ST-elevation OR (2.8, 95% CI 1.3–6.3), ST-depression OR 2.5 (95% CI 1.5–4.3), and inverted T-waves OR 2.7 (95% CI 1.6–4.6). This was independent of stroke severity, pre-stroke disability and age. In patients with ICH, sinus tachycardia OR 4.8 (95% CI 1.7–14.0), ST-depression OR 5.2 (95% CI 1.1–24.9), and inverted T-wave 5.2 (95% CI 1.2–22.5) predicted poor outcome. None of the changes reached significance in patients with TIA. In patients with severe cerebral infarction or ICH, heart rate did not decrease within the first 12 h after admission, which was the case in patients with mild to moderate stroke. Rapid heart rate predicted 3-month mortality in multivariate testing OR 1.7 (95% CI 1.02–2.7).
Conclusions: ECG abnormalities are frequent in acute stroke and may predict 3-month mortality.

Keywords: Stroke; ECG

1. Introduction

Abnormal ECGs are frequently recorded in patients with acute stroke. Little evidence, however, exists concerning the prevalence of ECG changes and their prognostic impact for patients with cerebral infarction and intracerebral haemorrhage [1].

The aim of this retrospective analysis was to describe the prevalence of common ECG abnormalities on admission 12-lead ECG and on telemetry in a large patient population admitted to the hospital within 6 h of the onset of a focal neurological deficit, and to evaluate the impact of these findings on functional outcome and mortality 3 months later. Patients with and without history of cardiac disease were included.

2. Patients and methods

The study population includes 1192 consecutive patients with cerebrovascular disease who were admitted to an acute stroke unit within 6 h of symptom onset. Data was registered as previously described [2]. In short, diagnosis was based on clinical and CT-scan findings on admission. Clinical data were collected prospectively.

Stroke severity was assessed on admission by the Scandinavian Stroke Scale (SSS) [3] in which no neurological deficit equals 58 points, and 0 points represent a comatose paralysed state. Outcome was evaluated by the

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modified Rankin Scale (mRS) [4] including death within 3 months after stroke onset. Severe stroke was defined as SSS ≤ 25 and mild to moderate stroke as SSS > 25.

Routine hospital procedure was followed for obtaining ECGs. This includes the nurses obtaining a 12 lead ECG on admission, followed by 12–24 h of telemetry (Teleguard 3200, Danica Biomedical A/S, Denmark). Abnormal rhythms on ECG-telemetry were automatically printed and placed in the patients' chart. Normal telemetry tracings were not stored in the chart.

12 lead ECGs were available for analysis in 1070 of the 1192 patients. 12 lead ECG data was either missing or unreadable (due to resolution of the hospital scanner) in the other 122 patients. The 122 patients with no admission ECG were excluded from the analysis. This may introduce some bias, as these excluded patients had more severe neurological deficits (SSS admission 31 vs. 41 in 1070 included patients). There were no differences in age and pre-stroke mRS. 675 of the 1070 included patients had abnormalities on telemetry, which were included in the analysis.

When ECG abnormalities occurred in the acute stroke unit, they were assessed by the neurologist in charge or by a consultant cardiologist as appropriate, and treated according to usual practice.

ECG's were analysed retrospectively by one observer, AFC, who was blinded to all clinical data. The following changes were recorded when abnormal, according to general guidelines [5]: atrial fibrillation, atrial flutter, sinus tachycardia: HR > 120, sinus bradycardia: HR < 45, atrio-ventricular block (all degrees), ventricular tachycardia > 5 s, ectopic beats, ST-elevation, ST-depression, isoform T-wave, inverted T-wave, U-wave, and QTc > 0.44 s. QTc was calculated as $QT/\sqrt{R-R}$.

Cerebral infarction was diagnosed in 692 patients, ICH in 155 patients, and TIA in 223 patients. Statistical analysis was performed using SPSS for Windows 9.0 (SPSS Inc. Chicago, USA) and included descriptive statistics and multiple logistic regression analysis, which were performed as enter analyses. Outcome was death at 3 months. Beside the various investigated ECG-abnormalities, we also included SSS on admission, pre-stroke mRS, and age. These possibly confounding variables were selected as possible confounders based on literature and our previous findings. The significance level was set at 0.05. Student's *t*-test was used in comparing continuous variable, and chi-square-test was used in assessing the independence of row and column variables in a cross tab.

The Scientific–Ethics committee of the Copenhagen and Frederiksberg area reviewed the study protocol and had no objections to its conduct.

3. Results

ECG-abnormalities of some kind were found in 55.3% (592) of this acute stroke unit population. Patients' characteristics are summarised in Table 1; 36.7% of all patients had a history of hypertension, 10.1% a history of acute myocardial infarction, 12.7% a history of angina, and 12.0% had history of congestive heart failure. Increasing stroke severity augmented the frequency of ECG-abnormalities; median SSS on admission was 37 in patients with ECG-abnormalities in comparison to 44 in patients without ECG-abnormalities, Mann–Whitney's test $p < 0.001$.

Table 1
Clinical data in 1070 patients with acute cerebrovascular disease

Diagnose	ACI ($N=692$)	ICH ($N=155$)	TIA ($N=223$)
Age (years)	76 (67–82)	74 (62–81)	70 (58–79)
Delay from symptom onset to admission and 12 lead ECG (h)	2 (1.1–3.5)	2 (1–3.1)	2.2 (1.1–3.5)
Scandinavian Stroke Scale on admission	39 (22–49)	25 (10–35)	55 (50–58)
Modified Rankin Scale (3 months after stroke)	3 (2–4)	4 (2–6)	1 (0–2)
3 months fatality rate	16.5% (114)	38.1% (59)	4% (9)
Recurrent stroke <=12 months	9% (60)	3.9% (6)	8.9% (19)
History of MI	13.3% (78)	7.1% (11)	8.1% (18)
History of angina	14.6% (101)	5.2% (8)	13% (29)
History of congestive heart failure	14.2% (98)	5.8% (9)	7.6% (17)
History of hypertension	35.4% (245)	38.7% (60)	35% (78)

Median and interquartile range or percent and number are presented.
ACI: Acute cerebral infarction.
ICH: Intracerebral haemorrhage.
TIA: Transient ischaemic attack.

4. Patients with cerebral infarction ($N=692$)

An abnormal ECG was observed in 416 patients (60.1%). The most frequent findings were sinus tachycardia (24.3%), atrio-ventricular block (21.4%), and ectopic beats (30.9%), Table 2. Repolarization changes were observed in 32.5% of patients. Some ECG abnormalities were related to severity of neurological deficits; atrial fibrillation median SSS 28 vs. 39, $p=0.12$, prolonged QTc median SSS 26 vs. 39, $p=0.007$, atrio-ventricular block median SSS 34.5 vs. 39 $p=0.038$, ST-depression median SSS 33.5 vs. 39 $p=0.016$, and ST-elevation median SSS 30 vs. 39 $p=0.046$. In multivariate logistic regression analysis, atrial fibrillation, OR 2.0 (95% CI 1.3–3.1), A-V block OR 1.9 (95% CI 1.2–3.9), ST-elevation OR 2.8 (95% CI 1.3–6.3), ST-depression OR 2.5 (95% CI 1.5–4.3), and inverted T-wave OR 2.7 (95% CI 1.6–4.6) predicted 3-month mortality independent of pre-stroke handicap, stroke severity, and age. Ectopic beats > 10%, atrial flutter, sinus bradycardia, isoform T-wave, and ventricular and sinus tachycardia did not affect prognosis in multivariate