Factors influencing in-hospital outcome and mortality in patients with intracerebral haemorrhage – data from the Pomeranian Stroke Register

Piotr K. Sobolewski[1,2], Edyta Brelak[3], Waldemar Brola[1,4], Renata Hatalska-Żerebiec[2], Leszek Bieniaszewski[5], Walenty N. Nyka[6], Grzegorz Kozera[5]

[1]Collegium Medicum, Jan Kochanowski University, Kielce, Poland
[2]Department of Neurology and Stroke Unit in Sandomierz, Jan Kochanowski University, Kielce, Poland
[3]Regional Hospital in Kielce, Department of Neurology and Stroke Unit, Kielce, Poland
[4]Department of Neurology and Stroke Unit, Saint Lukas Hospital, Końskie, Poland
[5]Centre of Medical Simulations, Medical University of Gdańsk, Poland
[6]Department of Neurology, Medical University of Gdańsk, Poland

Medical Studies
DOI: https://doi.org/10.5114/ms/208203

Key words: intracerebral haemorrhage, logistic factors, in-hospital outcome, mortality.

Abstract

Introduction: Intracerebral haemorrhage (ICH) is a critical disease usually leading to severe disability or death. The management of patients with ICH is still a serious challenge for medical services.
Aim of the research: The aim of the study was to identify factors influencing in-hospital outcome and mortality in patients with ICH.
Material and methods: An observational, retrospective study included 8790 patients with acute stroke, including 813 patients with ICH, who had been hospitalised in the stroke units and consequently reported to the Pomeranian Stroke Register (PRUM) in the period 2009–2013.
Results: Factors that affected unfavourable outcome (mRS 3-5) of patients with ICH were as follows: unknown time of ICH onset ($p = 0.019$); living in a rural area ($p = 0.019$); motor deficiency ($p < 0.001$); and high NIHSS score on admission to hospital (median 11 (7–16), $p < 0.001$). Factors that caused higher in-hospital mortality were as follows: unknown time of ICH onset ($p = 0.001$); living in a rural area ($p = 0.023$); age over 80 years ($p = 0.029$); atrial fibrillation ($p = 0.006$); disturbance of consciousness ($p < 0.001$); and severe neurological condition on admission to hospital according to the NIHSS (median 19 (13–23), $p < 0.001$). Professional activity ($p = 0.01$) had a favourable impact on the functional outcome. Dyslipidaemia ($p = 0.001$) and preliminary diagnosis of cerebral stroke ($p = 0.037$) were factors that decreased the in-hospital mortality rate.
Conclusions: The in-hospital prognosis and mortality of patients with ICH depend on the place of residence, which is associated with the possibility of rapid delivery to the Stroke Unit, the severity of the neurological condition, and the coexistence of serious comorbidities.

Introduction

Despite the development of medicine, including methods of prevention, the prevalence of stroke in the world increases with advancing age in both males and females [1–4]. According to the results of the Global Burden of Disease Study 2020, the global prevalence of all stroke subtypes was an increase of 0.77%; however, the global prevalence of intracerebral haemorrhage (ICH) showed a decrease of 3.33% in the age-standardised prevalence rate between 2010 and 2020 [5, 6]. The age-standardised stroke mortality rate has decreased by 15.27%, and ICH mortality has decreased by 17.64% since 2010 [5, 6]. ICH accounts for about 10% to 20% of all strokes. Despite improvements in incidence and mortality rates, ICH is a critical disease usually leading to severe disability or death, and the management of patients with ICH is still a serious challenge for medical services. There are no specific interventions that have been shown to improve clinical outcome after ICH. Over the last years, the impact of haemostatic therapies, acute blood pressure lowering, clearance of intraventricular haemorrhage with intraventricular administration of alteplase, and decompressive craniectomy to improve treatment outcomes of ICH have been assessed [7]. However, the results of treatment of these patients are still unsatisfactory.

According to the recommendations of scientific societies, the pre- and in-hospital logistic management of patients with ICH does not differ from the procedure in ischaemic stroke (IS) [8–11]. It seems that, as in

IS, the success of therapy should depend on the speed of application of the above-mentioned interventions, which can prevent the most dangerous complications of ICH, such as haematoma expansion (HE) [11–13], early recurrence of ICH [14], displacement of blood into the ventricular system [15], and cerebral oedema [16], leading to death of the patient. "Time is brain" also has clinical implications for the management of patients with ICH. Early diagnosis of ICH, and efficient pre- and intra-hospital logistics are of decisive importance in relation to the further outcome of the patient. However, studies are needed to confirm the impact of shortening the procedure time on outcome and mortality in patients with ICH.

Aim of the research

Therefore, the main aim of the study was to identify factors influencing in-hospital outcome and mortality in patients with ICH.

Material and methods

Study design

We conducted analyses based on a retrospective analysis of data from the Pomeranian Stroke Register (PRUM), which is an open, multi-centre, Internet-based consecutive stroke register established in 2006. The goal of this register is to monitor clinical and epidemiological data, as well as data on the logistics of patients referred to the participating stroke units (SU) [1, 17, 18]. Procedures administered in this study were approved by the Polish health regulatory authorities. All stroke physicians responsible for data collection were previously trained in data collection, patient evaluation – including National Institute of Health Stroke Scale (NIHSS) [19] and modified Rankin Scale (mRS) [20] – and treatment procedures. The patients' records were entered online via a secure Internet connection. All participating centres took responsibility for their data and accepted source data monitoring.

In this study, a retrospective analysis of registry data of patients with acute stroke hospitalised in stroke departments of the Pomorskie, Świętokrzyskie, and Mazowieckie provinces in 2009–2013 was conducted. Those stroke centres are equipped with proper monitoring and diagnostic facilities and provide a 24-hour stroke service seven days a week. In the stroke units, diagnostic and treatment procedure protocols with respect to unified regular protocols of the management of acute IS, according to the Polish national and international recommendations, are in force [21, 22]. In the patients, an mRS score of 3–5 points was considered as an unfavourable outcome [20]. The ethics committee approved all data of analysis (Ethics Committee of Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Poland, Number KB 370/2018).

The aetiological diagnosis was based on the definition of the International Statistical Classification of Diseases and Health Problems ICD-10 (intracerebral haemorrhage – ICD-10 classification: I61; cerebral infarction – ICD-10 classification: I63).

Study population

This study carried out an evaluation of the medical records of 8790 patients with acute stroke, including 7977 patients with acute IS and 813 patients with ICH, who were consecutively reported to the PRUM. The data collected included patient demographics (gender and age) and settlement (rural or urban), pre-hospital procedures (method of transportation and consultation with physician), and time intervals (time from the onset of stroke to call for help, estimated time for ambulance arrival, and time from the onset of stroke to arrival at the ER). Data collection was based on individual patient history, family and primary care reports, medical documentation, and clinical findings. The delay times were assessed on the basis of the exact time of symptom onset, as reported by patients themselves or by witnesses of the incident.

Statistical analysis

This study was based on a retrospective database analysis. Groups of patients with ICH with favourable and unfavourable outcomes, and patients who survived and who died were compared. Data gathering, characteristics, and univariate analysis were performed using Microsoft Excel 2017; statistical analysis was performed with Statistica v. 9.1. All continuous variables were tested for a normal distribution and equality of variances. Because of the non-normality of the variables, non-parametric Mann-Whitney *U* tests were used to perform the univariate analysis of the continuous variables. Categorical data were compared using χ^2 tests, and p-values < 0.05 were considered statistically significant. The multivariate analysis was performed using multiple logistic regression models. Factors identified in the univariate analysis with a p-value < 0.05 were then examined using multivariate models.

Results

Out of 8790 patients entered into the registry, 813 (9.3%) were diagnosed with ICH (mean age: 69.45 ±13.59 years, male gender 54.74%, median NIHSS 11.00 [6.00–19.00]). The demographic, logistic, and clinical characteristics of patients with ICH are presented in Table 1.

In the univariate analysis, the most important factors contributing to unfavourable in-hospital outcome were as follows: mean age, age over 80 years, living in rural areas, low level of education, arterial hypertension, previous stroke, high NIHSS score on admission, disturbance of consciousness, motor deficit, aphasia,

Table 1. The demographic, logistic, and clinical characteristics of patients with ICH

Variables	ICH, *N* = 813 *n* (%)
Demographic factors	
Age (mean; SD) [years]	69.45 (13.59)
Age over 80 years	176 (22.83)
Gender (male)	445 (54.74)
Living alone	112 (13.78)
Living in rural areas	289 (35.55)
Living in a city > 100,000 residents	267 (32.84)
Low level of education	298 (53.41)
Professional activity	151 (18.57)
No regular medical check-up before stroke	122 (15.1)
Cardiovascular risk factors	
Dyslipidaemia	235 (28.91)
Diabetes mellitus	148 (18.20)
Current smoking	182 (27.29)
Coronary heart disease	169 (21.75)
Previous myocardial infarction	46 (5.92)
Arterial hypertension	606 (74.54)
Carotid stenosis > 50% or occlusion	30 (3.83)
Atrial fibrillation	167 (20.67)
Anticoagulant therapy before stroke	89 (11.01)
Previous stroke	156 (19.75)
Clinimetric assessment	
mRS before stroke 0-2	730 (89.72)
NIHSS score on admission (median; range) [points]	11.00 (6.00–19.00)

Variables	ICH, *N* = 813 *n* (%)
Symptoms of stroke	
Headache	202 (24.85)
Disturbance of consciousness	401 (49.32)
Sensory impairment	84 (10.33)
Motor deficit	566 (69.62)
Aphasia	303 (37.27)
Visual disturbance	80 (9.84)
Balance disturbance	27 (3.32)
Seizure	68 (8.36)
Location of ICH	
Right hemisphere	351 (43.17)
Left hemisphere	372 (45.76)
Posterior fossa	90 (11.07)
Logistic factors	
Unknown time of stroke onset	324 (39.85)
Preliminary diagnosis of stroke	747 (91.69)
Delay in calling for assistance > 60 minutes	430 (52.89)
Arrival from another town	401 (49.32)
Arrival from a distance < 5 km	282 (34.69)
Arrival from a distance > 20 km	238 (29.27)
Arrival from another hospital	100 (12.30)
Arrival at the ER by ambulance	714 (87.82)
Initial consultation with a GP	75 (9.23)
Admission to the ER at night	172 (21.50)
Median onset-to-door time (min; mean ± SD)	109.00 (60.00–240.00)
Staying in the ER > 60 minutes	443 (55.93)

ICH – intracerebral haemorrhage, mRS – modified Rankin Scale, NIHSS – National Institutes of Health Stroke Scale, GP – general practitioner, ER – emergency room, SD – standard deviation, pts – points.

unknown time of stroke onset, delay in calling for assistance > 60 minutes, initial consultation with a general practitioner (GP), median onset-to-door time, and staying in the emergency room (ER) > 60 minutes, and the most important factors contributing to a favourable outcome were male gender, professional activity, mRS before stroke 0-2, and arrival at the ER by ambulance (Table 2).

In the univariate analysis, factors impacting mortality were as follows: mean age, age over 80 years, living in rural areas, low level of education, atrial fibrillation, anticoagulant therapy before stroke, high NIHSS score on admission, disturbance of consciousness, motor deficit, unknown time of stroke onset, delay in calling for assistance > 60 minutes, arrival from another town, arrival form a distance < 5 km, initial consultation to a GP, median onset-to-door time, and staying in the ER > 60 minutes, and factors contributing with survival were as follows: living in a city with > 100,000 residents, professional activity, headache, seizure, location of ICH in the left hemisphere, preliminary diagnosis of stroke, and admission to the ER at night (Table 3).

Multivariate regression analysis confirmed that living in rural areas, high NIHSS score on admission, motor deficit, and unknown time of stroke onset were factors contributing to unfavourable in-hospital out-

Table 2. The impact of demographic, logistic, and clinical factors on in-hospital outcome in patients with ICH

Variables	mRS 0-2 *n* (%)	mRS 3-5 *n* (%)	*P*-value
N (%)	219 (43.45)	285 (56.55)	
Demographic factors			
Age (mean; SD) [years]	***63.42 ±13.60***	***70.25 ±13.27***	***< 0.001***
Age over 80	***19 (9.18)***	***64 (24.06)***	***< 0.001***
Gender (male)	***135 (61.64)***	***144 (50.63)***	***0.013***
Living alone	29 (13.29)	45 (15.79)	0.423
Living in rural areas	***53 (24.20)***	***98 (34.39)***	***0.013***
Living in a city > 100,000 residents	87 (39.73)	106 (37.19)	0.562
Low level of education	***66 (37.29)***	***109 (55.05)***	***< 0.001***
Professional activity	***66 (30.14)***	***42 (17.74)***	***< 0.001***
No regular medical check-up before stroke	117 (53.43)	153 (53.68)	0.954
Cardiovascular risk factors			
Dyslipidaemia	82 (37.44)	90 (31.58)	0.169
Diabetes mellitus	41 (18.72)	44 (15.44)	0.329
Current smoking	61 (29.90)	67 (28.54)	0.771
Coronary heart disease	43 (20.19)	54 (19.42)	0.833
Previous myocardial infarction	15 (7.04)	16 (5.76)	0.561
Arterial hypertension	*150 (68.49)*	*232 (81.40)*	*< 0.001*
Carotid stenosis > 50% or occlusion	7 (3.27)	16 (5.67)	0.208
Atrial fibrillation	35 (16.06)	49 (17.19)	0.734
Anticoagulant therapy before stroke	23 (10.55)	19 (6.67)	0.119
Previous stroke	***31 (14.16)***	***64 (22.78)***	***0.015***
Clinimetric assessment			
mRS before stroke 0–-2	***213 (97.26)***	***246 (86.32)***	***< 0.001***
NIHSS score on admission (median; range) [points]	***4.00 (2.00–7.00)***	***11.00 (7.00–16.00)***	***< 0.001***
Symptoms of stroke			
Headache	***80 (36.53)***	***67 (23.51)***	***0.001***
Disturbance of consciousness	***50 (22.83)***	***127 (44.56)***	***< 0.001***
Sensory impairment	19 (8.68)	36 (12.63)	0.158
Motor deficit	95 (43.38)	233 (81.75)	< 0.001
Aphasia	68 (31.05)	119 (41.75)	0.014
Visual disturbance	27 (12.33)	28 (9.92)	0.371
Balance disturbance	8 (3.65)	7 (2.46)	0.433
Seizure	27 (12.33)	27 (9.47)	0.304
Location of ICH			
Right hemisphere	78 (35.62)	123 (43.16)	0.086
Left hemisphere	104 (47.49)	131 (45.96)	0.734
Posterior fossa	20 (9.13)	24 (8.42)	0.779

Table 2. Cont.

Variables	mRS 0-2 *n* (%)	mRS 3-5 *n* (%)	*P*-value
Logistic factors			
Unknown time of stroke onset	***105 (36.84)***	***117 (53.42)***	***< 0.001***
Preliminary diagnosis of stroke	264 (94.62)	187 (90.78)	0.101
Delay in calling for assistance > 60 minutes	***148 (51.93)***	***141 (64.38)***	***0.005***
Arrival from another town	144 (50.53)	123 (56 (16)	0.209
Arrival from a distance < 5 km	99 (34.74)	90 (41.10)	0.144
Arrival from a distance > 20 km	78 (27.37)	63 (28.77)	0.729
Arrival from another hospital	36 (12.63)	27 (12.33)	0.919
Arrival at the ER by ambulance	***261 (91.58)***	***156 (71.23)***	***< 0.001***
Initial consultation with a GP	***21 (7.37)***	***44 (20.09)***	***< 0.001***
Admission to the ER at night	59 (21.07)	13 (16.88)	0.223
Median onset-to-door time	***108.00 (55.00–235.00)***	***206.50 (66.00–671.00)***	***0.003***
Staying in the ER > 60 minutes	***163 (58.63)***	***144 (67.29)***	***0.049***

ICH – intracerebral haemorrhage, mRS – modified Rankin Scale, NIHSS – National Institutes of Health Stroke Scale, GP – general practitioner, ER – emergency room, SD – standard deviation, pts – points, significant p-values are shown in **bold** *font and* ***italics****.*

come while professional activity was a factor impacting favourable outcome (Table 4). In turn, age over 80 years, living in a rural area, atrial fibrillation, high NIHSS score on admission, disturbance of consciousness, and unknown time of stroke onset were factors contributing to mortality, whereas dyslipidaemia and preliminary diagnosis of stroke affected survival (Table 4).

Discussion

This study shows that living in a rural area and unknown time of the ICH onset were factors that affected unfavourable outcome (mRS 3-5) and mortality in patients with ICH. In the literature there are only single reports discussing results of treatment of rural patients with ICH.

The identification of patients with different stroke subtypes as early as possible on symptom onset may help to improve pre- and in-hospital management. Jin *et al.* found that certain medical parameters such as vomiting, systolic blood pressure ≥ 180 mm Hg, and age < 65 years were more typical of ICH and could help doctors accurately predict ICH, which is espe-

Table 3. The impact of demographic, logistic, and clinical factors on mortality in patients with ICH

Variables	Patients who survived *n* (%)	Patients who died *n* (%)	*P*-value
N (%)	504 (61.99)	309 (38.01)	–
Demographic factors			
Age (mean; SD) [years]	***67.26 ±13.82***	***72.92 ±12.48***	***< 0.001***
Age over 80	***83 (17.55)***	***93 (31.21)***	***< 0.001***
Gender (male)	279 (55.36)	166 (53.72)	0.649
Living alone	74 (14.68)	38 (12.30)	0.338
Living in rural areas	***151 (29.96)***	***138 (44.66)***	***< 0.001***
Living in the city > 100,000 residents	***193 (38.29)***	***74 (23.95)***	***< 0.001***
Low level of education	***175 (46.67)***	***123 (76.21)***	***< 0.001***
Professional activity	***108 (21.43)***	***43 (13.92)***	***0.007***
No regular medical check-up before stroke	71 (14.09)	51 (16.50)	0.348
Cardiovascular risk factors			

Table 3. Cont.

Variables	Patients who survived *n* (%)	Patients who died *n* (%)	*P*-value
Dyslipidaemia	***172 (34.13)***	***63 (20.39)***	***< 0.001***
Diabetes mellitus	85 (16.87)	63 (20.39)	0.206
Current smoking	128 (29.22)	54 (23.58)	0.120
Coronary heart disease	97 (19.76)	72 (25.17)	0.077
Previous myocardial infarction	31 (6.31)	15 (5.24)	0.543
Arterial hypertension	382 (75.79)	224 (72.49)	0.294
Carotid stenosis > 50% or occlusion	23 (4.64)	7 (2.44)	0.123
Atrial fibrillation	***84 (16.70)***	***83 (27.21)***	***< 0.001***
Anticoagulant therapy before stroke	***42 (8.35)***	***47 (15.41)***	***0.002***
Previous stroke	95 (19.00)	61 (21.03)	0.489
Clinimetric assessment			
mRS before stroke 0–2	459 (91.07)	271 (87.70)	0.123
NIHSS score on admission (median; range) [points]	***7.00 (4.00–14.00)***	***19.00 (13.00–23.00)***	***< 0.001***
Symptoms of stroke			
Headache	***147 (29.17)***	***55 (17.80)***	***< 0.001***
Disturbance of consciousness	***177 (35.12)***	***224 (72.49)***	***< 0.001***
Sensory impairment	55 (10.91)	29 (9.39)	0.487
Motor deficit	***328 (65.08)***	***238 (77.02)***	***< 0.001***
Aphasia	187 (37.10)	116 (37.54)	0.900
Visual disturbance	55 (10.91)	25 (8.09)	0.190
Balance disturbance	15 (2.98)	12 (3.88)	0.483
Seizure	***54 (10.71)***	***14 (4.53)***	***0.002***
Location of ICH			
Right hemisphere	201 (39.88)	130 (42.07)	0.537
Left hemisphere	***235 (46.83)***	***117 (37.86)***	***0.014***
Posterior fossa	44 (8.73)	38 (12.3)	0.101
Logistic factors			
Unknown time of stroke onset	***102 (33.01)***	***222 (44.05)***	***0.002***
Preliminary diagnosis of stroke	***296 (97.69)***	***451 (92.99)***	***0.004***
Delay in calling for assistance > 60 minutes	***141 (45.63)***	***289 (57.37)***	***0.001***
Arrival from another town	***134 (43.37)***	***267 (52.98)***	***0.008***
Arrival from a distance < 5 km	***93 (30.10)***	***189 (37.50)***	***0.031***
Arrival from a distance > 20 km	97 (31.39)	14 (27.98)	0.299
Arrival from another hospital	37 (11.97)	63 (12.50)	0.825
Arrival at the ER by ambulance	***297 (96.12)***	***417 (92.74)***	***< 0.001***
Initial consultation with a GP	***10 (3.24)***	***65 (12.90)***	***< 0.001***
Admission to the ER at night	***82 (26.97)***	***90 (18.15)***	***0.003***
Median onset-to-door time	***90.00 (60.00–168.00)***	***120.00 (60.00–330.00)***	***0.003***
Staying in the ER > 60 minutes	***136 (45.33)***	***307 (62.40)***	***< 0.001***

ICH – intracerebral haemorrhage, mRS – modified Rankin Scale, NIHSS – National Institutes of Health Stroke Scale, GP – general practitioner, ER – emergency room, SD – standard deviation, pts – points, significant p-value are shown in **bold** *font and* ***italics****.*

Table 4. Multivariate regression analysis showing the factors influencing unfavourable in-hospital outcome and mortality in patients with ICH

Variables	mRS 3-5			Mortality		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value
Age over 80	2.21	0.91–2.88	0.080	***1.98***	***1.07–3.64***	***0.029***
Gender (male)	0.95	0.51–1.76)	0.868	–	–	–
Living in rural areas	***2.29***	***1.15–4.57***	***0.019***	***2.19***	***1.11–4.04***	***0.023***
Low level of education	1.15	0.57–2.22	0.686	1.25	0.70–2.21	0.443
Professional activity	***0.36***	***0.17–0.78***	***0.010***	0.62	0.29–1.31	0.209
Dyslipidaemia	–	–	–	***0.36***	***0.20–0.67***	***0.001***
Coronary heart disease	–	–	–	1.53	0.70–3.34	0.286
Atrial fibrillation	–	–	–	***2.57***	***1.31–5.01***	***0.006***
Previous stroke	1.07	0.47–2.46	0.868	–	–	–
mRS before stroke 0–2	0.99	0.34–2.88	0.989	–	–	–
NIHSS score on admission	***1.29***	***1.19–1.40***	***< 0.001***	***1,14***	***1.09–1.19***	***< 0.001***
Headache	0.72	0.35–1.45	0.362	0.71	0.38–1.33	0.288
Disturbance of consciousness	1.63	0.78–3.37	0.189	***3,89***	***2.10–6.91***	***< 0.001***
Motor deficit	***3,70***	***1.78–7.73***	***< 0.001***	1.14	0.57–2.27	0.706
Aphasia	1.35	0.70–2.56	0.375	–	–	–
Seizure	–	–	–	0.52	0.17–1.61	0.257
Unknown time of stroke onset	***2.17***	***1.15–4.17***	***0.019***	***2.78***	***1.49–5.00***	***0.001***
Preliminary diagnosis of stroke	–	–	–	***0.13***	***0.02–0.89***	***0.037***
Delay in calling for assistance > 60 minutes	1.41	0.72–2.67	0.317	–	–	–
Arrival from another town	–	–	–	1.21	0.65–2.23	0.550
Arrival at the ER by their own transportation	1.08	0.42–2.78	0.867	1.32	0.39–4.35	0.663
Initial consultation with a GP	2.00	0.69–5.88	0.199	1.02	0.31–3.45	0.974
Admission to the ER at night	–	–	–	0.60	0.33–1.10	0.095
Staying in the ER (mean ± SD)	1.02	0.53–1.96	0.963	1.19	0.68–2.08	0.536

ICH – intracerebral haemorrhage, mRS – modified Rankin Scale, NIHSS – National Institutes of Health Stroke Scale, GP – general practitioner, ER – emergency room, SD – standard deviation, pts – points, significant p- value are shown in **bold** *font and* ***italics****.*

cially important in rural areas where modern equipment is not yet available, and it may contribute to faster arrival of patients to stroke units [23]. Most studies that assessed the impact of residence on outcome and mortality did not differentiate between ICH and IS strokes. Wang *et al.*, by analysing the Chinese population, showed that the ICH mortality rate in rural areas was higher than that in urban areas [24]. The retrospective identification of all cases of ICH in the United States (US) over the period 2004–2014 showed that despite current efforts to reduce disparity in stroke care, ICH patients hospitalised in rural hospitals had two times the odds of dying compared to those in urban hospitals. In addition, the ICH mortality gap between rural and urban centres was increasing during the whole period [25]. A large retrospective cohort study in the US, which included data from 119,891 patients, failed to identify factors explaining the difference in mortality between rural and urban patients with ICH. The authors suggest that rural-urban disparities in ICH outcomes are probably multifactorial, but intensive care unit availability may contribute to the disparity [26].

Unknown time of the ICH extends the time to correct diagnosis, and prolonged time to diagnosis can result in delays in obtaining appropriate blood pressure control, reversal of coagulopathy, or surgical intervention. This is especially important in patients with ICH, because more than 20% of them experience a decrease of 2 or more points in their Glasgow Coma Scale (GCS) after their initial assessment by ER [27], and 15–23% of patients have HE and neurological de-

cline in the first several hours [8]. We also found that preliminary diagnosis of ICH correlated with survival. Patients with motor deficit are usually admitted to the hospital faster. In the group of patients with ICH analysed by Ovenden *et al.* the majority of patients with ICH presented within 8 hours of ictus and they were mostly hemiplegic patients [28]. Prevention of HE is one of the main therapeutic goals in ICH. Morotti *et al.* showed that the diagnostic performance of non-contrast computed tomography markers is influenced by imaging time [29]. In the meta-analysis by Al-Shahi Salman *et al.*, 20% of patients had ICH growth. Among other factors, the multivariate model showed that the time from symptoms of ICH onset to baseline imaging was an independent predictor of ICH growth [30]. HE is common in patients with unclear symptom onset, and it is independently associated with worse outcome [31].

In our analysis, professional activity contributed to favourable outcomes because working patients were faster transported to hospital. There is no information on this subject in the available literature. It has been shown that job strain is a major cerebrovascular disease risk factor, but also adverse work conditions, including job loss and unemployment and long work hours, have been linked to stroke risk [32, 33]. It has been shown in the Japanese population that job-lost men and women and reemployed men had increased risk for ICH incidence and mortality [34]. The relative risk of ICH was highest in women in low job-control occupations [35].

In our analysis we found also that high NIHSS score on admission, disturbance of consciousness, atrial fibrillation, and age over 80 years were factors contributed to mortality in patients with ICH. The results of many studies have shown that high NIHSS score on admission to hospital was a factor that affected in-hospital unfavourable outcome and mortality in patients with ICH [36, 37]. The influence of age over 80 years, diagnosis of atrial fibrillation, and disturbance of consciousness on mortality was also reported [38, 39].

This study has some limitations. Firstly, the analysis was retrospective, although the data collection was conducted prospectively. Secondly, there was a lack of complete data in our patient database, resulting from incomplete reporting of all factors collected in the PTUM registry by the participating centres, which is typical of most registers. Thirdly, in the PTUM registry, there were no data about haematoma volume and factors influencing haematoma expansion.

The study indicated logistic and clinical factors negatively affecting the outcome of treatment and mortality of patients with ICH. It is necessary to notify the emergency services more efficiently about the occurrence of a stroke and to improve the operation of medical services in rural areas. The study indicates the need to keep a registry of the management of patients with ICH, which is particularly lacking in the Polish population.

We conclude that in-hospital prognosis and mortality of patients with ICH depend on the place of residence, which is associated with the possibility of rapid delivery to the stroke unit, the severity of the neurological condition, and the coexistence of serious comorbidities. Multicentre studies and registries evaluating different factors among patients with ICH are needed to improve outcomes and reduce mortality.

Funding

No external funding.

Ethical approval

Ethics Committee of Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Poland, Number KB 370/2018.

Conflict of interest

P. Sobolewski has received lectureship fees and travel expenses to scientific conferences covered by Boehringer-Ingelheim, Everpharma, AbbVie, Novartis. G. Kozera has undertaken research activities funded by the Ministry of Science and High Education, Poland, Office of the Governor of Pomerania, Poland; he has received speaker's honoraria from Boehringer-Ingelheim, Everpharma, Bayer, and Phizer. W. Brola has received lectureship fees and travel expenses to scientific conferences covered by Boehringer-Ingelheim. E. Brelak, J. Antecki, W. Szczuchniak, A. Antecka, and L. Bieniaszewski declare that they have no conflict of interest.

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Address for correspondence

Piotr K. Sobolewski
Collegium Medicum
Jan Kochanowski University
Kielce, Poland
E-mail: piotrsobolewski@poczta.onet.pl

Received: 5.05.2024
Accepted: 13.07.2025
Online publication: 3.08.2026