

Outcome after acute traumatic subdural and epidural haematoma in Switzerland: a single-centre experience

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Summary

Background: Acute epidural and subdural haematomas remain among the most common causes of mortality and disability resulting from traumatic brain injury. In the last three decades improvements in rescue, neuromonitoring and intensive care have led to better outcomes. The purpose of this study was to evaluate the impact of these strategies on outcome in patients treated in a single institution in Switzerland.

Methods: A total of 76 consecutive patients who underwent emergency craniotomy for acute traumatic epidural and subdural haematoma at University Hospital Bern between January 2000 and December 2003 were included in this study.

Results: Thirty-seven patients presented with an epidural haematoma and 46 with a subdural haematoma. In seven patients both haematomas could be documented. The median age was 54 years (IQR 28). The median initial GCS score was 7 (IQR 6). The median time from primary injury to surgery was 3 hours (IQR 2.5 hours). The

median stay in the ICU was 3 days (IQR: 3 days). The outcome was favourable (GOS 4 and 5) in 43 patients (57%). Thirteen patients (17%) remained severely or moderately disabled (GOS 3). Finally, a total of 21 patients (28%) died or remained in a persistent vegetative state (GOS 1 and 2). Mortality was 41% for acute subdural haematoma (19/46) and 3% (1/37) for patients with epidural haematoma. Only age, GCS at admission and pupil abnormalities seemed to be associated with outcome. Time to surgery was not.

Conclusion: In patients admitted with acute traumatic epidural and subdural haematomas that are treated within a median of 3 hours after primary injury, factors such as age, initial GCS and pupil abnormalities still appear to be the most important factors correlating with outcome.

Key words: traumatic brain injury; epidural haematoma; subdural haematoma

Introduction

In Western countries, accidents are the leading cause of death among individuals aged under 45. Traumatic brain injury (TBI) accounts for approximately 70% of these traumatic deaths and most of the persisting disabilities in accident survivors [1]. The most important complication of traumatic brain injury is the development of intracranial haematomas. It is estimated that intracranial haematomas occur in 25–45% of severe traumatic brain injuries, 3–12% of moderate cases, and approximately 1 in 500 patients with mild TBI [2]. As a result, acute traumatic epidural haematomas (EDH) and subdural haematomas (SDH) are among the most common clinical entities encountered by any neurosurgical service.

Since the 1970s enormous changes have taken place in the treatment of TBI, thanks to im-

provements in diagnostic and monitoring tools, evacuation and rescue, and early treatment options. These improvements have included, to name but a few, the introduction of the Glasgow

Abbreviations

GCS	Glasgow Coma Scale
GOS	Glasgow Outcome Scale (1: death; 2: persistent vegetative state; 3: severe disability; 4: moderate disability; 5: good recovery)
CT	computerised tomography
IQR	interquartile range
SDH	subdural haematoma
EDH	epidural haematoma
ICP	intracranial pressure
ICU	intensive care unit.

Coma Scale (GCS), computed tomography (CT), continuous recording of intracranial pressure (ICP), aggressive rescue and evacuation to specialised trauma centres and introduction of standardised surgical techniques for removal of intracranial haematomas [3–8]. In spite of these improvements, the quality of outcome after TBI has been shown to vary dramatically between hospitals [9–10]. The impact in Switzerland of the above-mentioned developments in modern neurotraumatology has not yet been reported.

The aim of this study was to evaluate the impact of these strategies on outcome in patients treated for traumatic intracranial haematoma in a single institution in Switzerland. Special emphasis was placed on outcome with respect to initial GCS, age, pupillary status and time to surgery. Other demographic factors analysed included presence of hypoxia/hypotension during rescue, duration of ICU stay and use of intracranial-pressure (ICP) monitoring.

Materials and methods

This retrospective study included 76 consecutive patients with acute traumatic EDH and/or SDH who underwent craniotomy between January 1, 2000, and December 31, 2003, in the Department of Neurosurgery, University Hospital Bern, Switzerland. Data sources included patients' hospital records, rescue and evacuation records, rehabilitation summaries and personal phone calls to general practitioners caring for the patients after discharge from rehabilitation facilities.

The records were analysed for demographic characteristics such as gender, age, GCS on admission, pupil abnormalities, mechanism of injury, and time elapsed from accident to surgery on the basis of rescue team reports. Vital parameters analysed included initial GCS, blood pressure and arterial oxygen saturation (SaO₂) during rescue, perioperative ICP, performance of decompressive craniectomy and duration of stay in the intensive care unit (ICU).

All patients with a GCS <8 were intubated at the scene of the accident and mechanically ventilated. All patients were maintained normocapnic prior to hospital admission. After initial cardiorespiratory stabilisation in the emergency room, computed tomography (CT) of the skull was performed immediately. If relevant EDH or SDH were documented the patients were brought to the operating room. The indications for surgical treatment of intracranial haematomas in our institution include rapid deterioration of the level of consciousness and the presence of neurological deficits. In asymptomatic patients surgery is indicated if the diameter of the haematoma is 1 cm or greater. The decision whether to operate on pa-

tients aged over 70 was usually taken by the attending staff neurosurgeon and includes consideration of factors which may influence the outcome, such as comorbidities, previous quality of life, time to surgery, clinical presentation and documented wishes of patients and their relatives.

Initial hypotension (at the accident scene or on admission) was defined as systolic blood pressure values of 90 mm Hg or lower. Hypoxia was defined as SaO₂ of 90% or lower. The surgical technique for intracranial haematomas has been described elsewhere in detail [7].

Monitoring of ICP was performed using an infrared parenchymal catheter (Camino, Integra Life Science Corporation, Plainsboro, NJ, USA). Abnormal ICP values were defined as 20 mmHg or greater. The surgeon decided whether to implant the bone flap depending on the intraoperative presence of brain oedema. If the bone flap was not implanted a "decompressive craniectomy" after haematoma removal was described in the surgical summary. The bone flaps not inserted during the first surgery were frozen and stored to be reimplanted six months after TBI.

Perioperative mortality was defined as mortality within 30 days after surgery. Outcome was assessed according to the Glasgow Outcome Scale (GOS) at the time of discharge from hospital or rehabilitation centre.

Since we present observational data of a small population size only, no inferential statistics was performed. Results are expressed as mean or, in case of skewed data or ordinal scale variables, as median with interquartile range (IQR).

Results

Demographic characteristics and vital parameters

During the study period 76 consecutive patients were admitted. Fifty-five patients (73%) were male and 21 (27%) female. The demographic characteristics are summarised in table 1. The median age was 54 years (IQR 28). This series included only one child aged 7 years. The median GCS score on admission was 7 (IQR: 6). A total of 37 patients (48.6%) presented with an EDH and 46 (60.5%) with an SDH. Seven patients (9.2%) presented with both haematomas involving one or both hemispheres. 14 patients (18%), had intracerebral haemorrhagic con-

tions, all of whom presented with SDH. The mechanisms of injury included falls (59%), bicycle accidents (13%), motor cycle accidents (8%), car accidents (7%), assaults (7%), ski accidents (3%) and accidents involving pedestrians (3%). Initial pupillary abnormalities were documented as follows: 43 patients (57%) had symmetrical reactive pupils, 11 (14%) presented homolateral reactive mydriasis and 22 (29%) homolateral unreactive mydriasis. The median time elapsing from accident to surgery was 3 hours (IQR: 2.5 hours). Hypotension at the site of the accident or on admission was recorded in 7 patients (9%). A total of 16 patients (21%) were hypoxic at the rescue site. In

Table 1

Summary of demographic characteristics, clinical findings and outcome.

Total # of patients	76
Median age (years)	54 (IQR 28)
Gender (m:f)	55 (72%):21 (28%)
Type of haematoma	
SDH	46 (61 %)
EDH	37 (49 %)
SDH + EDH	7 (9 %)
Initial median GCS score	7
Patients with GCS >8	28 (36.8%)
Patients with GCS ≤8	48 (63.1%)
Pupil examination	
reactive to light	43 (57%)
anisocore but reactive to light	11 (14%)
areactive to light	22 (29%)
Decompressive craniectomy	35 (46%)
Median time to surgery (hours)	3
Hypotension at rescue	7 (9%)
Hypoxia at rescue	16 (21%)
Perioperative ICP monitoring	11 (14%)
Median duration of ICU stay (days)	3
Outcome	
GOS 1 and 2	21 (28%)
GOS 3	12 (16%)
GOS 4 and 5	43 (57%)

Figure 1

Documenting the association of age with overall outcome, showing a clear decline in age with improved outcome. Abbreviations: GOS: Glasgow Outcome Scale (1: death; 2: persistent vegetative state; 3: severe disability; 4: moderate disability; 5: good recovery).

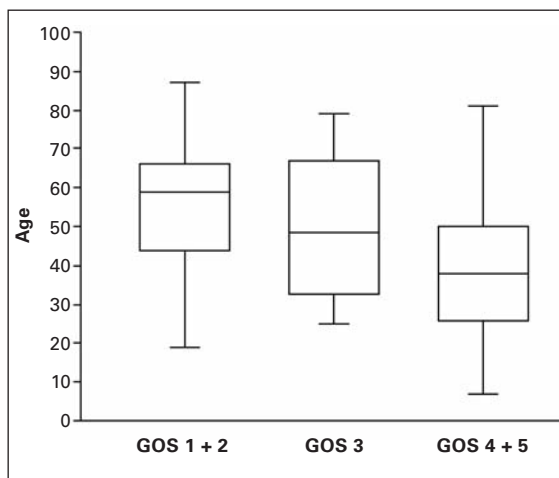
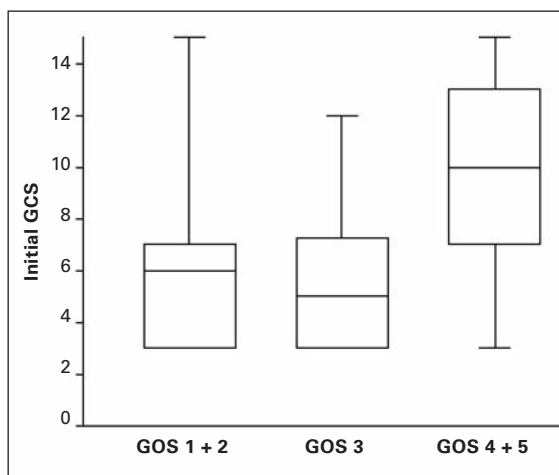


Figure 2

Analysing the impact of initial GCS on overall outcome: Similar distribution of initial GCS for unfavourable outcome (GOS1-3); with favourable outcome (GOS 4 and 5) associated with a higher initial GCS (GOS 4 and 5). Abbreviations: GCS: Glasgow Coma Scale; GOS: Glasgow Outcome Scale (1: death; 2: persistent vegetative state; 3: severe disability; 4: moderate disability; 5: good recovery).



12 patients (16%) alcohol intoxication was documented. Perioperative ICP probes were inserted in 11 patients (15%). Decompressive craniectomy was performed in 35 (46%). The median duration of ICU stay was 3 days (IQR: 3 days).

Analysis of demographics

The overall perioperative mortality was 26% (20 patients). Of these only one of the patients who died presented with an epidural haematoma (initial GCS 3), while all other mortalities involved an acute subdural haematoma (table 1). Two patients with SDH who died had an associated contralateral EDH. This translates into a mortality rate of 41% for patients with SDH and of 3% for patients with EDH. Over half the patients (52%) died within the first 3 days after surgery despite maximum treatment in the ICU. Median outcome as assessed by the GOS was 4 (IQR: 4). The outcome was favourable (GOS 4 and 5) in 43 patients (57%). Thirteen patients (17%) remained severely or moderately disabled (GOS 3). Finally, a total of 21 patients (28%) died or remained in a persistent vegetative state (GOS 1 and 2).

We analysed possible factors affecting outcome, specifically age, initial GCS, time to surgery and pupillary status. The association of these variables in respect to outcome is demonstrated in box plots figures 1–4. While graphically there appears to be a clear association of outcome and age (figure 1), initial GCS (figure 2) and pupillary status (figure 4), time to surgery (figure 3) shows clearly there is no difference with respect to various outcomes.

Initial GCS was an important predictor of outcome in our patient population. Of the 21 patients with a bad outcome, only 3 (14%) had a GCS >8 on admission, whereas 86% had a GCS <8. Of the patients with a favorable outcome

Figure 3

Impact of time to surgery on final outcome showing almost identical distribution of time to surgery for all outcomes (favourable and unfavourable). Abbreviations: GOS: Glasgow Outcome Scale (1: death; 2: persistent vegetative state; 3: severe disability; 4: moderate disability; 5: good recovery).

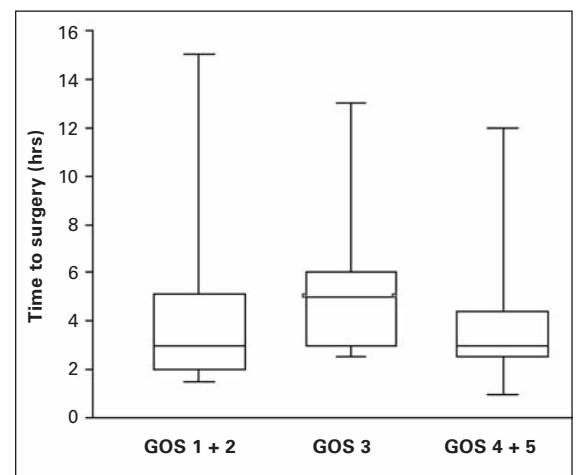
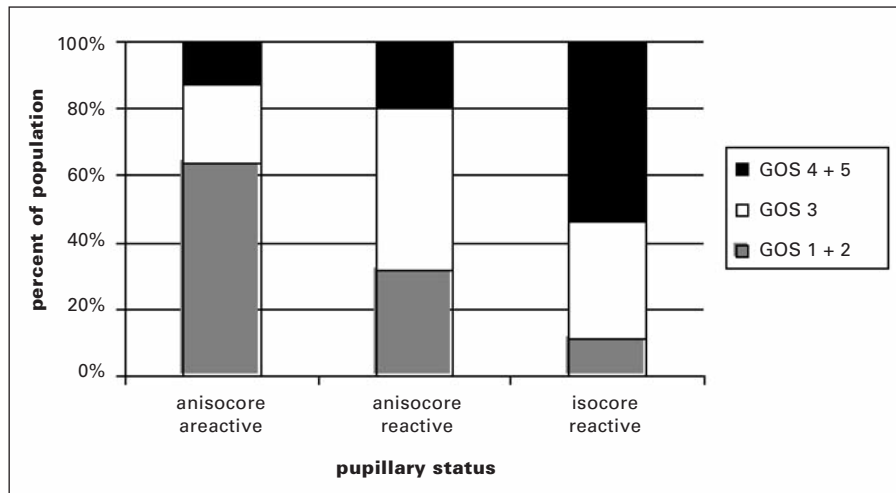


Figure 4

Documenting outcome with respect to initial pupillary status classified as anisocore reactive, anisocore reactive and isocore reactive. Anisocore reactive pupillary status associated with a higher percentage of unfavourable outcome as opposed to isocore reactive status showing a higher percentage of favourable outcome.

Abbreviations:

GOS: Glasgow Outcome Scale (1: death; 2: persistent vegetative state; 3: severe disability; 4: moderate disability; 5: good recovery).



(GOS 4 and 5), only 13 (30%) had a GCS of 8 or lower at admission, whereas 31 (70%) had a GCS greater than 8.

Age appeared to be associated with outcome, with 89% of patients under 20 having a favourable outcome (GOS 4 and 5), and only one (11%) dying. Conversely, in the group of patients aged 60 or over, 48% had a poor outcome (GOS 1 and 2), and only 29% a favourable one (GOS 4 and 5).

The median time elapsed from primary injury or accident to surgery was 3 hours (IQR: 2.5 hours). Interestingly, as figure 3 shows, there appears to be no association between time to surgery and outcome. Results for time to surgery are almost identically distributed with respect to unfavourable (GOS 1 and 2) and favourable (GOS 4 and 5) outcome.

Discussion

To the best of our knowledge the present study is the first to analyse outcome after acute traumatic EDH and SDH since the introduction of new rescue strategies and modern intensive care management strategies for the treatment of patients admitted with TBI in the last two decades in Switzerland. Consequently, we were interested to compare our results with earlier similar published series so as to evaluate our therapeutic strategies. The majority of studies conducted since CT scanning has become widely available have reported mortality of around 12% for acute traumatic EDH and 50–70% for acute SDH [11–15]. The results of this study demonstrated an improvement in terms of overall mortality (26%) and number of patients with a favourable outcome (GOS 4 and 5) (57%) compared to these series.

While we believe that these results can be ascribed to improvements in rescue and evacuation practices in Switzerland, they must be interpreted with caution. Time elapsed from accident to surgery was not correlated with outcome for our patient population. However, considering the short time documented from accident to surgery, namely a median time frame of 3 hours, and early prevention of hypoxia and hypotension at the scene of the accident in most of the patients, time to surgery may not play the important role in outcome documented in prior studies.

Cohen et al. reported 100% mortality in a series of patients with acute EDH and mydriatic

pupils for more than 70 minutes. Moreover, the authors reported that the presence of mydriatic pupils for less than 70 minutes was associated with GOS 4 and 5 [14]. In a series of patients with acute SDH and EDH, Haselsberger et al. documented that patients undergoing surgery within 2 hours of coma had a mortality rate of 17%, whereas patients operated on later had a mortality of 56% [15]. Similar results were reported by Sakas et al., with a time frame of 3 hours [16]. Seelig et al. documented that the timing of surgery (4 hours from injury) was of prognostic significance in severely injured patients with acute subdural haematoma [4].

Although other studies have reported no evidence of a correlation between outcome and time to surgery [17–20], we still believe that time to surgery plays a crucial role in overall outcome. It is possible that time to surgery was not correlated with outcome in our study due to aggressive resuscitation management by the rescue services at the accident site (the “stay and play” approach), as well as the extremely short overall time elapsed from accident to surgery. In summary, we assume that within the time frame from accident to surgery in our patient series (median 3 hours), and aggressive resuscitation management at the site of the accident with rapid correction of hypotension and hypoxia, other traditional factors (initial GCS, age, pupillary status) are factors determinant of final outcome in patients presenting with acute traumatic SDH and

EDH. The correlation of outcome with age, GCS on admission and pupillary abnormalities, as demonstrated in our series, has been well established by earlier studies [3, 7, 11–14].

This study has a number of limitations. First, the main one is the fact that our study was based on a retrospective analysis of the records. Since patients with TBI are not routinely followed up in our department, we used discharge notes either from our hospital or the rehabilitation centre. If there was a lack of outcome information we contacted the general practitioners for further clinical information. However, in most of the patients there was a lack of standardised neuropsychological evaluation, which has to be considered an important part of outcome evaluation [26–29]. Secondly, a detailed description of additional CT findings was not possible. Associated radiological factors such as extent of midline shift, compressed basal cistern and the presence of traumatic subarachnoid haemorrhage were not documented and may have played an additional role in the outcome of this series [12, 22–25].

In terms of quality control we were surprised

to find that ICP monitoring was performed in only 11 of 48 patients (23%) who arrived with a GCS of 8 or lower. Not only does raised ICP correlate with poor outcome, but its aggressive treatment in an ICU setting has been associated with an improvement in outcome [30–33]. Consequently, all patients admitted with TBI and presenting with a GCS score of 8 or less should undergo ICP monitoring.

Taking into account the analysis of the different factors influencing the outcome in this series, as well as the results presented in this study, we believe that prospective studies are needed in Switzerland to further improve current treatment strategies.

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References

- Bundesamt für Statistik http://www.bfs.admin.ch/bfs/portal/de/index/themen/gesundheit/gesundheitszustand/sterblichkeit_todesursachen/kennzahlen0/todesursachen0/wichtigste_todesursachen.html
- Thurman D, Guerrero J. Trends in hospitalization associated with traumatic brain injury. *JAMA*. 1999;282:954–7.
- Becker DP, Miller JD, Ward JD, et al. Outcome from severe head injury with early diagnosis and intense management. *J Neurosurg*. 1977;47:491–502.
- Seelig JM, Becker DP, Miller JD. Traumatic acute subdural haematoma: major mortality reduction in comatose patients treated within four hours. *N Engl J Med*. 1981;304:1511–8.
- Marshall LF, Marshall SB, Grady MS. Modern neurotraumatology: A brief historical review. In: Winn HR, ed. *Youmans Neurological Surgery*, 5th edition. Philadelphia, PA: Saunders; 2004:5019–24.
- Becker DP, Miller JD, Ward JD, et al. The outcome from severe head injury with early diagnosis and intensive management. *J Neurosurg*. 1977;47:491–502.
- Prabhu SS, Zauner A, Bullock R. Surgical management of traumatic brain injury. In: Winn HR, ed. *Youmans Neurological Surgery*, 5th edition. Philadelphia, PA: Saunders; 2004:5145–80.
- Cordobes F, Lobato RD, Rivas JJ, et al. Observations on 82 patients with extradural hematoma. Comparison of results before and after the advent of computerized tomography. *J Neurosurg*. 1981;54:179–86.
- Bricolo A, Pasut L. Extradural hematoma. toward zero mortality. A prospective study. *J Neurosurg*. 1984;14:8–12.
- Klauber MR, Marshall LF, Luerssen TG, et al. Determinants of head injury mortality: Importance of the low risk patient. *Neurosurgery*. 1989;24:31–6.
- Kuday C, Uzan M, Hanci M. Statistical analysis of the factors affecting the outcome of extradural hematomas: 115 cases. *Acta Neurochir (Wien)*. 1994;131:203–6.
- Lee EJ, Hung YC, Wang LC, et al. Factors influencing the functional outcome of patients with acute epidural hematomas: analysis of 200 patients undergoing surgery. *J Trauma*. 1998;45:946–52.
- Wu JJ, Hsu CC, Liao SY, Wong YK. Surgical outcome of traumatic intracranial hematoma at a regional hospital in Taiwan. *J Trauma*. 1999;47:39–43.
- Cohen JE, Montero A, Israel ZH. Prognosis and clinical relevance of anisocoria-craniotomy latency for epidural hematoma in comatose patients. *J Trauma*. 1996;41:120–2.
- Haselsberger K, Pucher R, Auer LM. Prognosis after acute subdural or epidural hemorrhage. *Acta Neurochir. (Wien)* 1988;90:111–6.
- Sakas DE, Bullock MR, Teasdale GM. One year outcome following craniotomy for traumatic hematoma in patients with fixed dilated pupils. *J Neurosurg*. 1995; 82:961–5.
- Shenkin HA. Acute subdural hematoma: review of 39 consecutive cases with high incidence of cortical artery rupture. *J Neurosurg*. 1982;57:254–7.
- Wilberger JE, Harris M, Diamond DL. Acute subdural hematoma: morbidity, mortality, and operative timing. *J Neurosurg*. 1991;74:212–8.
- Stone JL, Lowe RJ, Jonasson O, et al. Acute subdural hematoma: direct admission to a trauma center yields improved results. *J Trauma*. 1986;26:445–50.
- Uzan M, Yentur E, Hanci M, et al. Is it possible to recover from uncal herniation? Analysis of 71 head injured cases. *J Neurosurg Sci*. 1998;42:89–94.
- Kotwica Z, Jakubowski JK. Acute head injuries in the elderly. An analysis of 136 consecutive patients. *Acta Neurochir*. 1992;118:98–102.
- Kotwica Z, Brzezinski J. Acute subdural hematoma in adults: an analysis of outcome in comatose patients. *Acta Neurochir*. 1993;121:95–9.
- Yanaka K, Kamezaki T, Yamada T, et al. Acute subdural hematoma – prediction of outcome with a linear discriminant function. *Neurol Med Chir. (Tokyo)*. 1993;33:552–8.
- Zumkeller M, Behrmann R, Heissler HE, et al. Computed tomographic criteria and survival rate for patients with acute subdural hematoma. *Neurosurgery*. 1996;39:708–13.
- Servadei F, Nasi MT, Giuliani G, et al. CT prognostic factors in acute subdural haematomas: the value of the ‘worst’ CT scan. *Br J Neurosurg*. 2000;14:110–6.
- Eames P, Wood RL. Rehabilitation after severe brain injury: a follow-up study of a behavior modification approach. *J Neurol Neurosurg Psychiatry*. 1985;48:613–9.
- Brooks DN, Campsie L, Symmington C, et al. A five-year outcome of severe blunt head injury. A relative’s view. *J Neurol Neurosurg Psychiatry*. 1986;49:764–70.
- Prigatano GP, Fordyce DJ, Zeiner HK, et al. Neuropsychological rehabilitation after closed head injury in young adults. *J Neurol Neurosurg Psychiatry*. 1984;47:505–13.
- Prigatano GP. *Principles of Neuropsychological Rehabilitation*. New York, NY: Oxford University Press; 1999.
- Al-Rawi PG, Hutchinson PJA, Gupta AK, et al. Multiparameter brain tissue monitoring – correlation between parameters and identification of CPP thresholds. *Zentralbl Neurochir*. 2000;61:74–9.
- Czosnyka M, Pickard JD. Monitoring and interpretation of intracranial pressure. *J Neurol Neurosurg Psychiatry*. 2004;75:813–21.
- Eddy VA, Vitsky JL, Rutherford EJ, et al. Aggressive use of ICP monitoring is safe and alters patient care. *Am Surg*. 1995;61:24–9.
- O’Sullivan MG, Statham PF, Jones PA, et al. Role of intracranial pressure monitoring in severely head-injured patients without signs of intracranial hypertension on initial computerized tomography. *J Neurosurg*. 1994;80:46–50.

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