

# Raised ICP Secondary Insults - Analysis of Preceding Blood Pressure Instability and Outcomes from the BrainIT Database

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Brain Monitoring with Information Technology (BrainIT)

## Introduction

By using high time resolution data collected within Brain Monitoring with collaborative Information Technology (BrainIT) [1], secondary ICP insults and preceding blood pressure instability, hypoxia or pyrexia were studied. The relationship between these variables and outcome at 6 months was also assessed. This was done with the aim to bridge the gap between what is known about the physiological mechanisms governing intracranial pressure and what is observed in clinical practice. This knowledge can be used to identify patients who are at an increased risk of adverse outcomes, and highlight potential areas that may be amenable to therapy to improve prognosis.

## Methods

High time-resolution data on 139 patients was extracted from the BrainIT. The Edinburgh University secondary insult grades (EUSIG) [2] were used to categorise the range of abnormal values for raised intracranial pressure (Grade 1: 20 - 29mmHg, Grade 2: >30mmHg), mean arterial hypotension (<90mmHg), mean arterial hypertension (>160mmHg), hypoxaemia (SaO<sub>2</sub> <90%) and pyrexia (>38°C). A raised ICP event was considered to start if it persisted for a minimum of five minutes. Similarly, an event was considered to end if the ICP pressure reading normalised for at least 5 consecutive minutes.

The 30 minute time window immediately prior to a secondary ICP event was studied for presence of hypotension, hypertension, drop in oxygen saturation or pyrexia. A significant period of hypotension, hypertension or hypoxaemia was thought to occur if abnormal values persisted for at least 5 minutes. Similarly, the period was thought to end if abnormal values corrected for a period of 5 consecutive minutes. To reflect the slower changes in core body temperature, persistent abnormal values lasting thirty minutes were used.

Poisson Regression analysis was used to obtain relative risks and robust standard errors using IBM SPSS 19.0.

## Results

Analysis of 139 patients from the database revealed 6140 secondary ICP insults (ICP>20mmHg), of which 6.3% were >30mmHg (Grade2).

4285 (69.8%) of these had no BP instability in the preceding 30mins. 919 (15.0%) had hypotension, and 932 (15.2%) had hypertension. An increased relative risk of BP instability was present when accompanied by hypoxaemia (45.5% vs 29.2%; RR 1.42(1.18-1.71); p<0.001). Females had a reduced risk of suffering from BP instability (28.2% vs 30.3%; RR 0.70(0.68-0.88); p<0.001). The median duration of raised ICP was 16 minutes, but this was not significantly associated with preceding BP instability.

The type of BP instability was not significantly associated with the grade of ICP event, sex, hypoxaemia, pyrexia or duration of event.

Blood pressure instability was more common in the over 60 year old age group (49.3% vs 22.3%; RR 1.80(1.57-2.06); p<0.05), and was less likely to be hypotension (24.1% vs 75.9%; RR 0.75(0.70-0.79); p<0.001).

Grade 2 events were associated with a decreased risk of a favourable outcome, but the difference was not statistically significant (RR 0.93(0.83-1.04); p=0.21). The presence of hypotension preceding a secondary ICP event was significantly associated with a decreased relative risk of a good recovery (27.4% vs 33.8%; RR 0.89(0.84-0.93); p<0.001). However, this difference was not observed in the presence of hypertension (34.6% vs 33.8%; RR 0.96(0.91-1.01); p=0.12). Decreased relative risks of a favourable outcomes were observed in the presence of hypoxaemia (36.5% vs 33.7%; RR 0.91(0.84-0.99); p=0.02) and pyrexia (18.1% vs 37.0%; RR 0.94(0.91-0.98); p<0.001).

Poorer outcomes were observed with advancing age, especially in the over 60 year old age group (22.3% vs 45.4%; RR 0.49(0.42-0.58); p<0.001). Increased duration of events was associated with less favourable outcomes (19.3min vs 20.6min; RR 0.89(0.86-0.93); p<0.001).

## Conclusions

- In this dataset, Rosner's hypothesis [3], which proposes that periods of raised ICP are preceded by blood pressure instability, is supported in the over-60 year old age group. The presence of blood pressure instability was significantly associated with the presence of hypoxaemia.
- The presence of hypotension, hypoxaemia and pyrexia was associated with significantly poorer outcomes at 6 months. However, this was not observed in the presence of hypertension.
- In the presence of BP instability, longer secondary ICP events were more likely to be hypotensive and were associated with poorer outcomes at 6 months.
- Advancing age was associated with poorer outcomes at 6 months.
- Females were less likely to suffer from blood pressure instability and had a relatively favourable outcome compared to males at 6 months.

## Learning Objectives

By the conclusion of this session, participants should be able to: 1) Discuss the significance of blood pressure instability before an ICP secondary insult; 2) Discuss the significance of age in this relationship; 3) Discuss long-term outcomes in patients suffering from ICP secondary insults.

## References

- [1] Piper I, Citerio G, Chambers I, Contant C, Enblad P, et al. The BrainIT group: concept and core dataset definition. *Acta Neurochir* 2003;145:615-629,
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- [3] Rosner MJ, Becker DP. Origin and evolution of plateau waves: Experimental observations and a theoretical model. *J Neurosurg* 1984 Feb;60:312-24