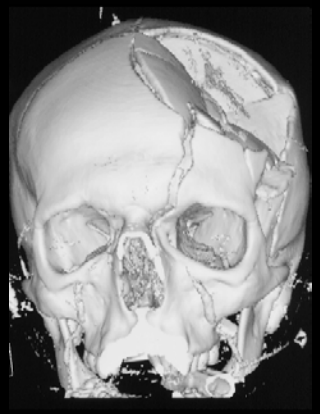
# Strategien zur Vermeidung von Sekundärschäden nach SHT: zeitnahes Management von Notfall –und Intensivmedizin

H. Steltzer, UMA




Primärschaden
Faktor ZEIT
Trauma-ErstOP
Trauma-
Erstversorgung

| Kriterien | Ihre Klinik | | | | TR-DGU | |
|---|---|---|---|---|---|---|
| | 10 Jahre | 2010 | 2011 | **2012** | 2012 | 10 Jahre |
| Primär versorgte Patienten | n=97.101 | n=15.283 | n=22.082 | n=26.377 | n=26.377 | n=97.101 |
| **1. Dauer der präklinischen Zeit** zwischen Unfall und Klinikaufnahme bei Schwerverletzten mit ISS ≥ 16 [∅ min ± SD] | **71** ± 50<br>n=45.466 | **72** ± 53<br>n=6.771 | **71** ± 54<br>n=9.463 | **70** ± 52<br>n=10.414 | **70** ± 52<br>n=10.414 | **71** ± 50<br>n=45.466 |
| **2. Intubationsrate bei bewusstlosen Patienten** (GCS ≤ 8) [%, n / gesamt] | **88%**<br>16.431/18.618 | **88%**<br>2.474/2.814 | **86%**<br>3.035/3.548 | **84%**<br>3.394/4.045 | **84%**<br>3.394 / 4.045 | **88%**<br>16.431 / 18.618 |
| **6.** Zeit bis zur Durchführung einer **Computertomographie des Schädels (CCT)** bei präklinisch bewusstseinsgetrübten Pat. (GCS < 15) [∅ min ± SD] | **24** ± 18<br>n=36.758 | **23** ± 17<br>n=5.678 | **23** ± 18<br>n=8.081 | **23** ± 17<br>n=9.604 | **23** ± 17<br>n=9.604 | **24** ± 18<br>n=36.758 |

Zeitraum

01.01.2013 - 31.12.2013

## 3.2 1.1 Prozessqualität präklinisch

| Angaben beziehen sich auf Patienten der Gruppe 1 und 3 | | Ihre Klinik | Ihr TNW | gesamt |
|---|---|---|---|---|
| Präklinische Zeit Unfall bis Aufnahme (in Min)<br>bei Patienten mit ISS ≥ 16 | n=79 | 60 | Auswertung nur für auditierte Kliniken | 75 |
| Präklinische Zeit ≤ 60 Min.<br>81-100% 71-80% ≤70% | | 70% | | 53% |
| Zeit Eintreffen Notarzt bis Aufnahme (in Min)<br>bei Patienten mit ISS ≥ 16 | n=73 | 35 | | 44 |
| Zeit Eintreffen Notarzt bis Aufnahme ≤ 60 Min<br>81-100% 71-80% ≤70% | | 92% | | 82% |
| Intubation<br>bei Patienten mit GCS ≤ 8<br>100% 96-99% ≤95% | 27/34 | 79% | | 83% |

## 2.4 Outcome

| Angaben beziehen sich auf Patienten der Gruppe 1 und 2 | | | Ihre Klinik | Ihr TNW | gesamt |
|---|---|---|---|---|---|
| Im Krankenhaus verstorben | | n=20 | 11% | Auswertung nur für auditierte Kliniken | 9% |
| Überlebt | Nach Hause entlassen | n=115 | 61% | | 64% |
| | In anderes Krankenhaus | n=22 | 12% | | 7% |
| | In Reha-Einrichtung | n=29 | 15% | | 16% |
| GOS bei Entlassung | Gut erholt | n=97 | 51% | | 61% |
| | Mäßig / schwer behindert | n=69 | 36% | | 21% |
| | Nicht ansprechbar / vegetativ | n=2 | 1% | | 1% |

# Prognostisch relevante Parameter

- GCS plus ALTER
- Hypotension
- Hypoxämie, Hypoxie
- ICP
- ISS , Begleitverletzungen
- SSEP

# GLASGOW COMA SCALE SCORE

| GCS score | Mortality |
|---|---|
| 3 | 65% |
| 4 | 45 |
| 5 | 35 |
| 6 | 24 |
| 7-13 | 10-15 |

| | GOS | |
|---|---|---|
| Age | 1 | 5 |
| 1-4 (N=6) | 17% | 17% |
| 5-9 (N=18) | 22 | 61 |
| 10-14 (N=20) | 20 | 40 |
| 15-19 (N=56) | 25 | 40 |
| 21-40 | 35 | 33 |
| 41-60 | 55 | 15 |
| 61-80 | 80 | 5 |

| GCS score | Mortality | Number of patients |
|---|---|---|
| 3 | 100% | (37) |
| 4 | 90 | (9/10) |
| 5 | 63 | (5/8) |
| 6 | 33 | (2/6) |
| 7 | 22 | (2/9) |
| 8-15 | 0 | (39) |

# HYPOTENSION

| | GOS 1, 2 | Relative Risk of Mortality |
|---|---|---|
| No Hypotension | 17% | |
| Early Hypotension | 47 | 15-fold ($p < 0.001$) |
| Late Hypotension | 66 | 11-fold ($p < 0.001$) |
| Early & Late Hypotension | 77 | |

| | GOS 1 | GOS 2, 3 | GOS 4, 5 |
|---|---|---|---|
| Neither | 24% | 12% | 64% |
| Hypoxia* | 50 | 9 | 41 |
| Hypotension*† | 53 | 12 | 35 |
| Anaemia* | 52 | 9 | 38 |

*Secondary insults not mutually exclusive.

†Hypotension = systolic blood pressure < 95 mm Hg

# Hukkelhoven Score für Mortalität und schlechtes Ergebnis bei SHT ( J Neurotrauma 2005; 22:1025)

- Alter: 0-3 Punkte
- GCS (motorisch): 3-2-1-0
- Pupillen: 0-2
- Prim Hypoxie: 0-1
- Prim Hypotension:0-2
- CT Score: 0-2-4-2-2
- SABL: 0-2
- Primärschäden= höhere Wertigkeit

- Mortalität
- 0 = 4%
- 3= 10%
- 6= 24%
- 9= 52%
- 12= 77%
- 16= 96%

# Assessment of White Matter Injury and Outcome in Severe Brain Trauma

## *A Prospective Multicenter Cohort*

Damien Galanaud, M.D., Ph.D.,* Vincent Perlbarg, Ph.D.,† Rajiv Gupta, M.D., Ph.D.,‡

### What We Already Know about This Topic

- Traumatic brain injury is a major public health problem, and current methods to predict long-term outcome and resource utilization are not strong
- Measuring white matter injury using magnetic resonance diffusion tensor imaging might improve prediction but has not been studied in a multicenter fashion

### What This Article Tells Us That Is New

- In a multicenter study of 105 patients with traumatic brain injury, diffusion tensor imaging, using a normalization process across different machine types, increased the accuracy of long-term outcome prediction compared with standard clinical and imaging approaches

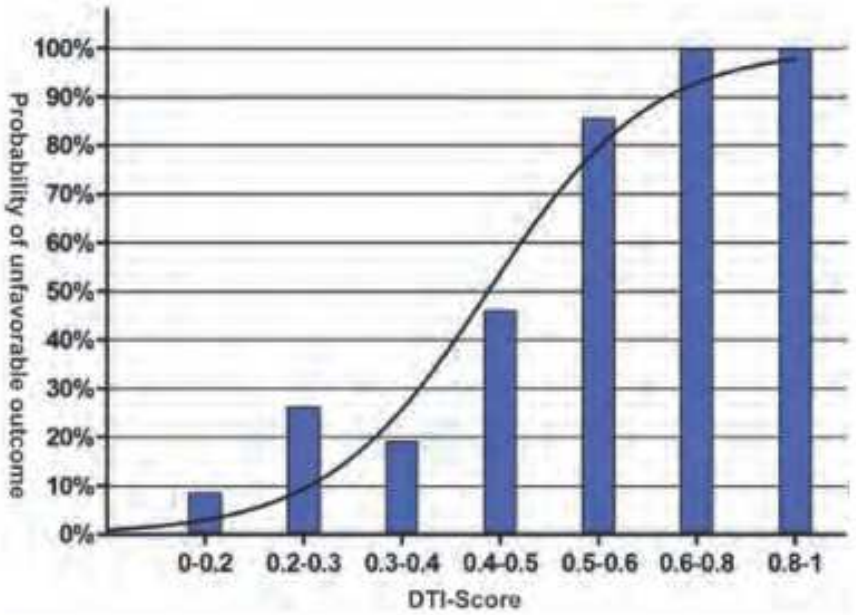
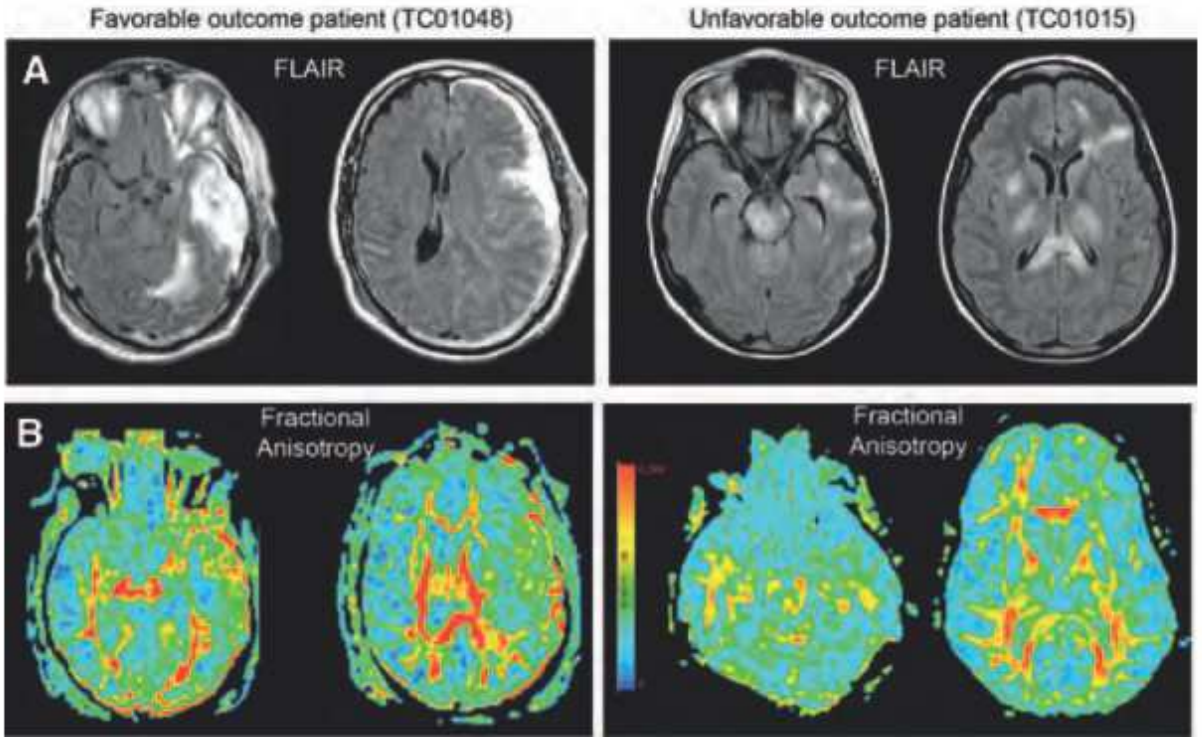
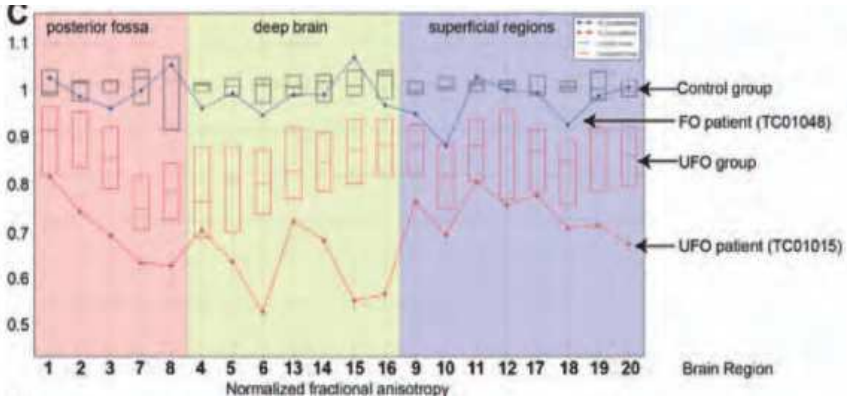
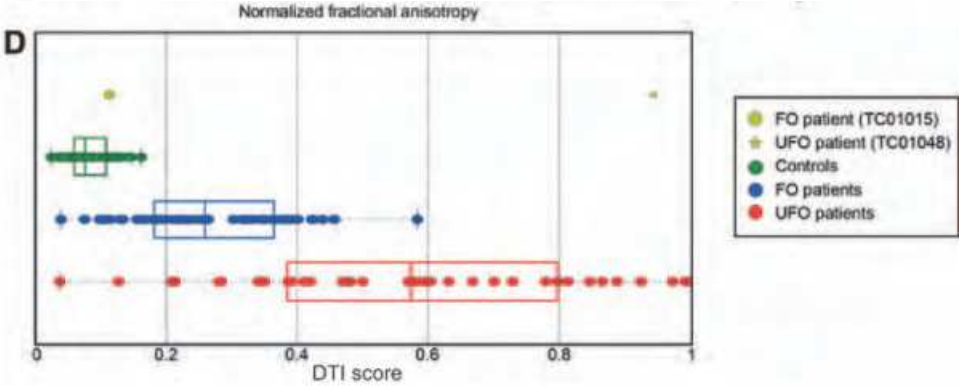



**Fig. 4.** Probability of having an unfavorable outcome as a function of the DTI score in the training cohort. DTI = diffusion tensor imaging.


Favorable outcome patient (TC01048)
Unfavorable outcome patient (TC01015)
A
FLAIR
FLAIR
B
Fractional Anisotropy
Fractional Anisotropy


C
posterior fossa
deep brain
superficial regions
Control group
FO patient (TC01048)
UFO group
UFO patient (TC01015)
1.1
1
0.9
0.8
0.7
0.6
0.5
1 2 3 7 8 4 5 6 13 14 15 16 9 10 11 12 17 18 19 20
Brain Region
Normalized fractional anisotropy


Normalized fractional anisotropy
D
0
0.2
0.4
0.6
0.8
1
DTI score
FO patient (TC01015)
UFO patient (TC01048)
Controls
FO patients
UFO patients

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# Epidemiology, treatment and outcome of patients after severe traumatic brain injury in European regions with different economic status*


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## Key points

- Outcome after traumatic brain injury depends on age, neurological status, trauma severity and quality of care.
- Quality of care depends on the economic status of a region; high-income regions provide better quality of care.
- In conclusion, our study demonstrates a significant association between the economic status of a region and the outcome of patients with severe TBI. This is due to the overall quality of care. Epidemiological factors (higher rates of violence-related TBI), treatment factors (e.g. rates of pre-hospital intubations, direct transfers and intracranial pressure monitoring) and lack of resources (e.g. intensive care nurses, equipment to monitor intracranial pressure) may have contributed to this result. Successful implementation of the guidelines for TBI management requires a well-funded health care system.

# Prähospitale SHT Studie 2009-10

**Tabelle 1: Zentren und rekrutierte Patienten**

| Zentrum | Sponsor | Patienten |
|---|---|---|
| Graz UKH | AUVA | 8 |
| Linz UKH | AUVA | 21 |
| Salzburg UKH | AUVA | 40 |
| Wien UB | AUVA | 21 |
| Wien UM | AUVA | 28 |
| Amstetten | BMG | 17 |
| Feldkirch | BMG | 28 |
| Graz Uni | BMG | 23 |
| Horn | BMG | 12 |
| Innsbruck Uni | BMG | 66 |
| Klagenfurt | BMG | 23 |
| Linz AKH | BMG | 65 |
| Salzburg LKH | BMG | 15 |
| Schwarzach | BMG | 3 |
| St. Pölten | BMG | 25 |
| Wr. Neustadt | BMG | 53 |
| **Gesamtergebnis** | | **448** |

| Zentrum | Sponsor | Patienten |
|---|---|---|
| Amstetten | BMG | 23 |
| Feldkirch | BMG | 21 |
| Graz Uni | BMG | 15 |
| Horn | BMG | 14 |
| Innsbruck | BMG | 63 |
| Klagenfurt | BMG | 14 |
| Linz AKH | BMG | 26 |
| Schwarzach | BMG | 9 |
| St. Pölten | BMG | 4 |
| Wr. Neustadt | BMG | 48 |
| UKH Böhler | AUVA | 13 |
| UKH Graz | AUVA | 7 |
| UKH Linz | AUVA | 29 |
| UKH Meidling | AUVA | 17 |
| UKH Salzburg | AUVA | 26 |
| **Gesamtergebnis** | | **329** |

# SHT :Epidemiologie Österreich 2009/10

777 Pat ( 210 AUVA)

Sturz, Fall 41%

Sport u Auto 20%

225 verstorben (29%)  93 Pat Hirntod ! (65%)

382 früh intubiert  (49,2%)

NCH Intervention 398 Pat (51,2%)

ICP Monitoring 414 Pat (53,3%)

# Behandlungsziele Notfallmedizin

- Der Einfluss von Zeitfaktoren:
  - rascher Transport an ein geeignetes Zentrum,
  - rasche Durchführung der ersten CT-Untersuchung
  - kurzes Intervall zwischen CT und Operation
- Adäquates Monitoring:
  - Verwendung der Kapnografie bei allen beatmeten Patienten
  - Verwendung des ROTEM zur Optimierung der Gerinnung vor allem bei Patienten jenseits des 60. Lebensjahres, die sehr häufig gerinnungshemmende Mittel einnehmen
- Infusionstherapie:
  - Keine Verwendung von Ringerlaktat
  - Verwendung von HES, Ringerlösung, oder anderen balancierten Elektrolytlösungen
  - Großzügige Indikationsstellung für die Infusion von hypertonem NaCl (bzw. HyperHES)
- Adäquate Ventilation: Normoventilation als Zielgröße, monitiert durch Kapnografie
- Keine Verwendung von Steroiden

***Monitoring:***

Minimal-Anforderungen sind Blutdruckmessung (nicht invasiv, manuell oder maschinell) und Pulsoximetrie, da Hypotonie (systolischer Blutdruck <90 mm Hg) und Hypoxie ($SaO_2$ <90%) die gefährlichsten „secondary brain insults" darstellen, die die Prognose des Patienten entscheidend verschlechtern[2, 16-17].

***Für die Gabe von Volumen gilt:***

Ziele sind konsequente Vermeidung bzw. rasche Behebung der Hypotonie und Erhaltung der zerebralen Perfusion durch großzügige Volumengabe zur Erzielung von Normovolämie **(Level B)**.

Der systolische Blutdruck sollte etwa 120 mm Hg betragen[8]. Als Mindestwert gilt nach internationalen Empfehlungen ein Blutdruck von 90 mmHg[2]; dies erscheint uns jedoch zu niedrig, um eine adäquate Perfusion des Gehirns zu garantieren. Für Kinder gelten die folgenden Werte als Grenze der Hypotonie: 1-28 Tage: <60 mm Hg, 1-12 Monate: <70 mm Hg, 1-10 Jahre: <70 + (Alter in Jahren x 2) mm Hg, >10 Jahren: <90 mm Hg[2].

Mittel der Wahl sind isotone Elektrolyt- oder Kolloidlösungen.

Bei kreislaufinstabilen Patienten sollte die Indikation zur Gabe eines Bolus von 4 ml/kg 7,2% NaCl-Lösung (evtl. in Kombination mit Hydroxyäthylstärke (HES) als Hyperhes®) oder eines adäquaten Volumens einer anderen hypertonen Infusionslösung (3 ml/kg 10% NaCl, etc.) großzügig gestellt werden[18].

Bei Patienten mit Zeichen der Einklemmung (siehe oben) kann versucht werden, durch Gabe von Hyperhes®[19], Gabe von hypertonem NaCl [7], oder Gabe von 20% Mannit[7] das Hirnödem zu verringern.

# OUTCOME nach SHT

**Kollektiv INRO Studie 2009-10**

**448 Patienten**

**35% versterben**

**45% rehabilitierbar**

**20% schwer behindert-vegetativ**

| Typical Data for Outcome After Severe Traumatic Brain Injury | | | | |
|---|---|---|---|---|
| dead | vegetative | severe | moderate | good |
| 30% | 2% | 15% | 20% | 33% |

# Systemische Insulte

- Hypoxie
- Hypotension
- Anämie
- Ungeeignetes $PaCO_2$
- Hypo- and Hyperglykämia
- Fieber
- Elektrolyt- und Säure-Basen Störungen
- SIRS/Sepsis

Corral et al. Critical Care 2012, 16:R44
http://ccforum.com/content/16/2/R44

CRITICAL CARE

RESEARCH Open Access

# Impact of non-neurological complications in severe traumatic brain injury outcome

Luisa Corral[1,2*], Casimiro F Javierre[2], Josep L Ventura[1], Pilar Marcos[3], José I Herrero[1] and Rafael Mañez[1,4]

**Abstract**

**Introduction:** Non-neurological complications in patients with severe traumatic brain injury (TBI) are frequent, worsening the prognosis, but the pathophysiology of systemic complications after TBI is unclear. The purpose of this study was to analyze non-neurological complications in patients with severe TBI admitted to the ICU, the impact of these complications on mortality, and their possible correlation with TBI severity.

**Methods:** An observational retrospective cohort study was conducted in one multidisciplinary ICU of a university hospital (35 beds); 224 consecutive adult p
to the ICU were included. Neurological an

**Results:** Sepsis occurred in 75% of patient
failure (arterial oxygen pressure/oxygen in
(AKI) in 8%. The multivariate analysis show
associated with age, initial GCS 3 to 5, wo
scan and the presence of intracranial hype
with initial GSC 3 to 5, worst TCDB first CT
AKI regardless of GCS multiplied risk of de
while ICU hypotension increased the risk
(95% CI: 1.22 to15.07) ($P < 0.05$).

**Conclusions:** Low initial GCS, worst first C
severe TBI patients. Besides the direct effe
with ICU hypotension which increases hos
previous studies that showed that non-ne
ICU but do not increase mortality, with th

## Key messages

- GCS 3 to 5, first CT scan and intracranial hypertension are neurological variables that determine mortality in severe TBI patients.
- AKI and the association of low GCS with hypotension were the non-neurological complications independently associated with ICU mortality.
- Non-neurological complications increase length of stay and morbidity in ICU, but do not increase mortality.

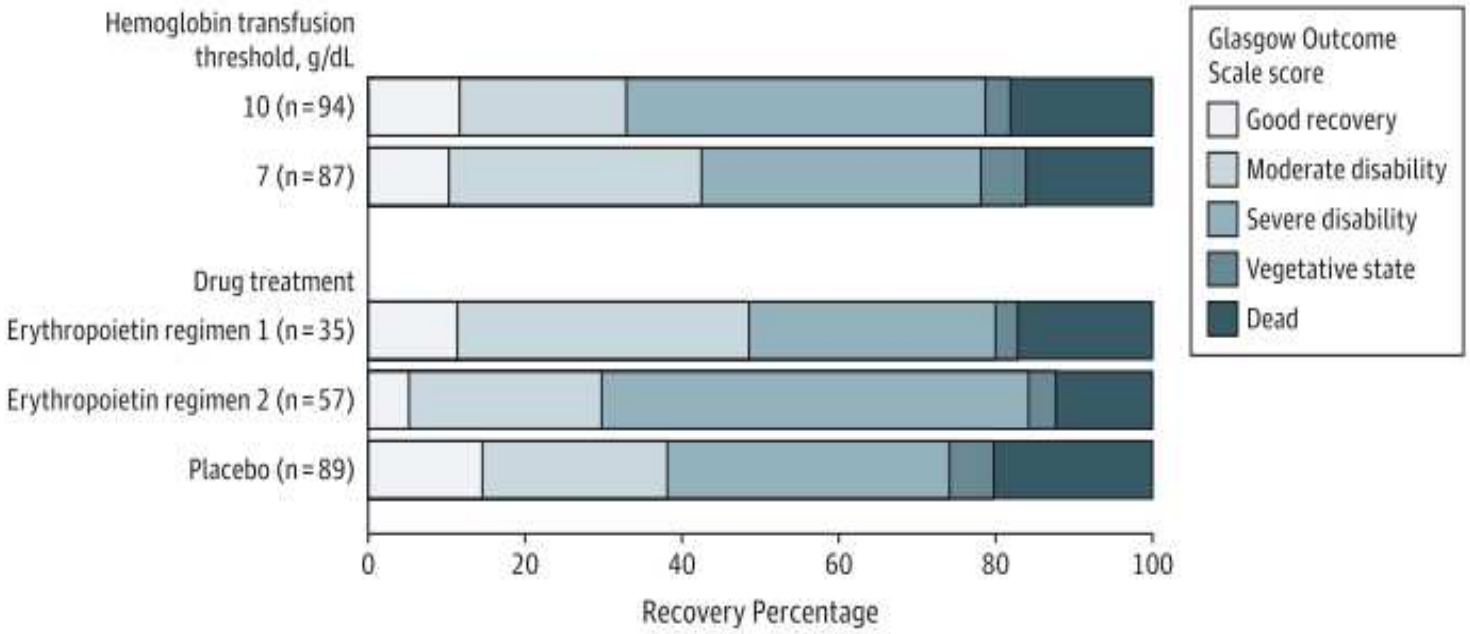
Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

# Effect of Erythropoietin and Transfusion Threshold on Neurological Recovery After Traumatic Brain Injury
## A Randomized Clinical Trial

Claudia S. Robertson, MD; H. Julia Hannay, PhD; José-Miguel Yamal, PhD; Shankar Gopinath, MD; J. Clay Goodman, MD; Barbara C. Tilley, PhD; and the Epo Severe TBI Trial Investigators

JAMA July 2, 2014 Volume 312, Number 1

Figure 2. Glasgow Outcome Scale Scores at 6 Months for Complete Cases



# Behandlungsziele Intensivmedizin

**Unterstützung der Organsysteme**

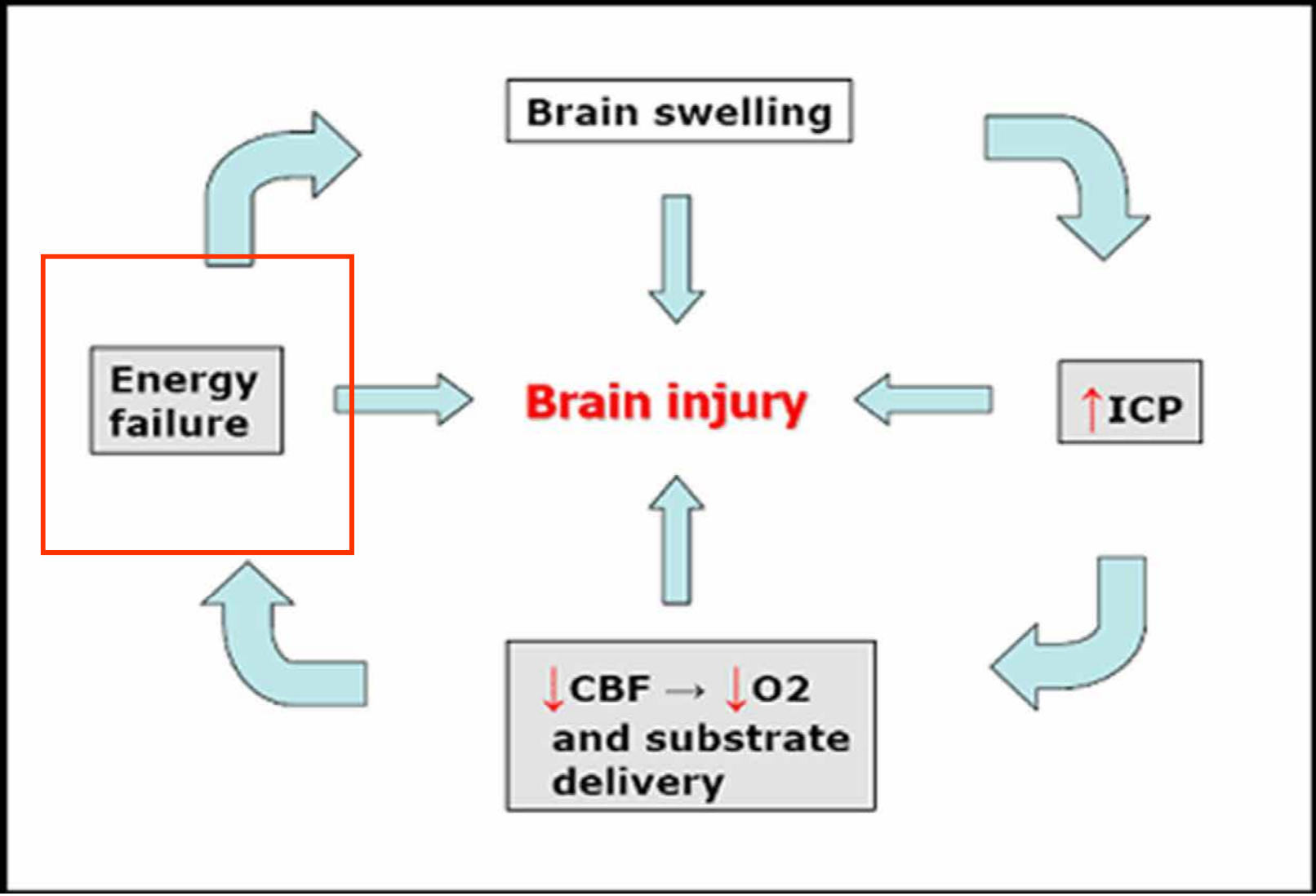
**Vermeidung**

**Rechtzeitige Erkennung und sofortige Therapie**

**von *sekundären Schädigungen*.**

**„NEUROPROTEKTION“**

# Hirnödem als wichtiger sekundärer Insult



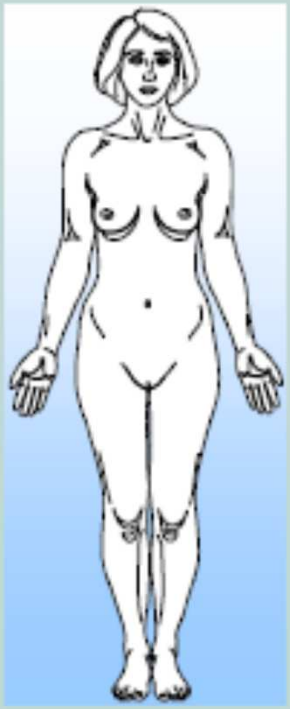
# Erweitertes Neuromonitoring

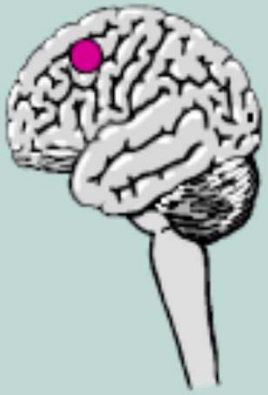
Bildgebung (CT, MRT)

MAP

ICP

CPP





Klin. Befund

Metabolismus (MD)

PtiO2 Monitor

CBF (Blutfluß)

# Guidelines for the management of severe head injury

## ICP or CPP guided therapy?

**ICP < 25 mm Hg**

**CPP > 70 mm Hg ( MAP- ICP)**

Bullock R et al. J Neurotrauma 1996

**ICP< 20 mm Hg**

**Optimal CPP = 60 - 70 mm Hg**

(Grände P.O. Int Care Med 2006: 32:1475, LUND CONCEPT aus 1988)

# IX. Cerebral Perfusion Thresholds

*B. Level II*

Aggressive attempts to maintain cerebral perfusion pressure (CPP) above 70 mm Hg with fluids and pressors should be avoided because of the risk of adult respiratory distress syndrome (ARDS).

*C. Level III*

CPP of <50 mm Hg should be avoided.

The CPP value to target lies within the range of 50–70 mm Hg. Patients with intact pressure autoregulation tolerate higher CPP values.

this would suggest a general threshold in the realm of 60 mm Hg, with further fine-tuning in individual patients based on monitoring of cerebral oxygenation and metabolism and assessment of the status of pressure autoregulation. Such fine-tuning would be indicated in patients not readily responding to basic treatment or with systemic contraindications to increased CPP manipulation. Routinely using pressors and volume expansion to maintain CPP at >70 mm Hg is not supported based on systemic complications.

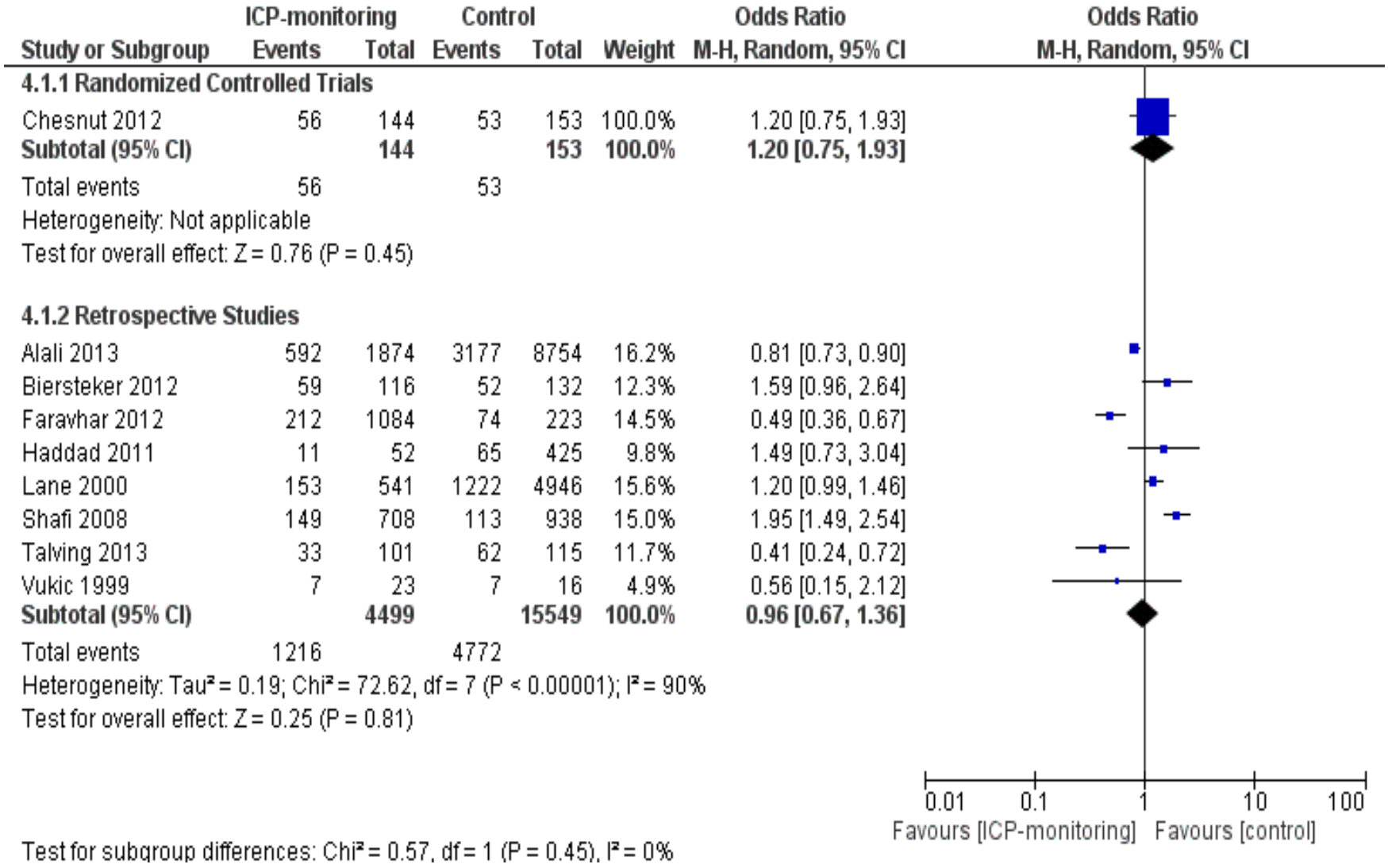
**Kein gewaltsames Anheben des MAP > 70 mm Hg**

**Kein CPP < 50 mm Hg**

**Zielwert CPP > 60 mm Hg plus Feineinstellung von Oxygenierung und Metabolik**

**BZ, Laktat, Temp**

# Effect of ICP monitoring on mortality in severe TbI



# Basistherapie bei Patienten mit schwerem SHT

- **Normoxämie: $SaO_2$ > 90%**
- **Normokapnie: $paCO_2$= 35-45 mm Hg**
- **Oberkörperhochlagerung ( max 30°)**
- **Kopf achsengerecht lagern**
- **Normothermie 36-37°C**
- **Normotension: MAP > 70 mm Hg**
- **Normoglykämie: ? 100- 140 mg/dl**
- **Adäquate Analgosedierung: Ramsay >4**

# Schrittweise Therapie des ICP-Anstiegs

Vertiefung der Sedierung

Narkose (Propofol )

milde Hypothermie ( 34-36 °C)

Osmotherapie ( Mannit, hypertones NACL 3- 10%)

Ventrikeldrainage

Intermittierende Relaxierung

Intermittierende Hyperventilation ( 30 mm)

Thiopentalkoma (+ SvJO2 Monitoring)

# Kreislauf

**normaler MAP ( Vasopressoren )**

**adäquates Blutvolumen ( Hb > 10g/dl)**

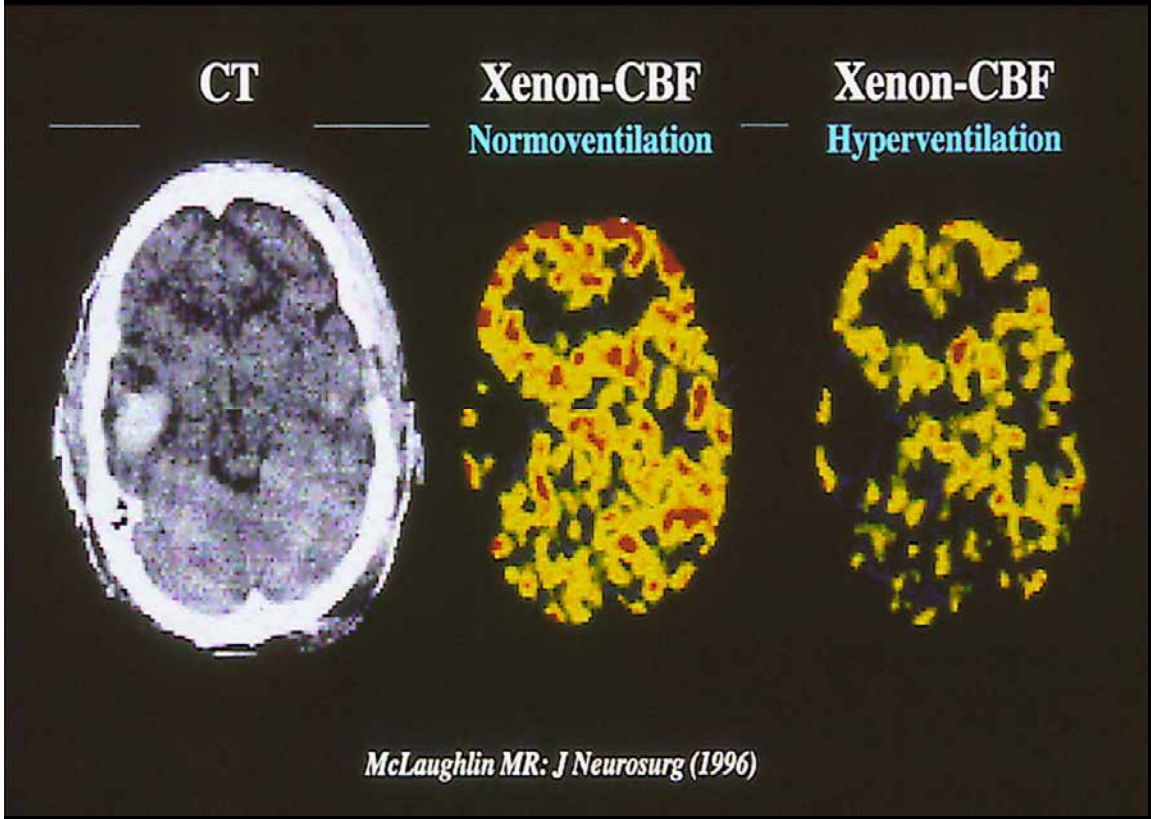
**Keine hypotonen Lösungen (Ringerlactat, Glukose 5%)**

**Kolloide zur Expansion des Blutvolumens ( HES 6%)**

**Ideales Plasma Na =140 - 150 mmol/l; ev. Gabe von hypertonem NaCl ( 3-10%)**

**Insulin zur Sicherstellung von BZ < 140 mg/dl**

# Hyperventilation ??




**KEINE ROUTINE-MASSNAHME (Gefahr der Ischämie!)**

**ohne ICP Monitoring nur bei massiver Hirnschwellung (im OP) oder bei Gefahr der Herniation erlaubt**

**für wenige Minuten akzeptabel**

**Prolongierte HV ist nur bei gleichzeitigem Monitoring der $S_jO_2$ erlaubt**

# SEDOANALGESIE

- ✓ **Propofol** < 5 mg/kg/h
- ✓ Midazolam 2,5 mg/h (max 10 mg/h)
- ✓ Piritramid (Dipidolor) ( max 10 mg/h)
- ✓ Morphinsulfat < 4 mg/ h
- ✓ **Ketanest S** 50 mg/h (max 100 mg/h)
- ✓ Sufentanil 0,05 mg/h (max 0,2 mg/h)
- ✓ **Remifentanil** ( 0,25-0,50 ug/kg/min)
- ✓ Clonidin, Dexdor ( 0,2-1.4mcg/kg/h)

# Therapeutische Hypothermie

**Moderate Hypothermie** 34-36°C) reduziert den Metabolismus und das CBV, ist aber noch umstritten


**Anstreben von Normothermie!**

Anwendung von Kühldevices nur bei stressfreien ( sedierten) Patienten.

# SHT und Blutungsneigung

Gerinnungsstörung erhöht die Mortalität mehrfach

40-70% der > 60 Jährigen SHT nehmen TASS/ CLOP/ Cumarine

( Fremd) Anamnese- INR- TEG

Bei Pat mit Rotem Anwendung = sign niedrigere Mortalität 24% vs 35% ( INRO 2010 )

Desmopressin 0,4 ug/Kg  zur Thrombostabilisierung

Vit K ( Konakion) contra Cumarine

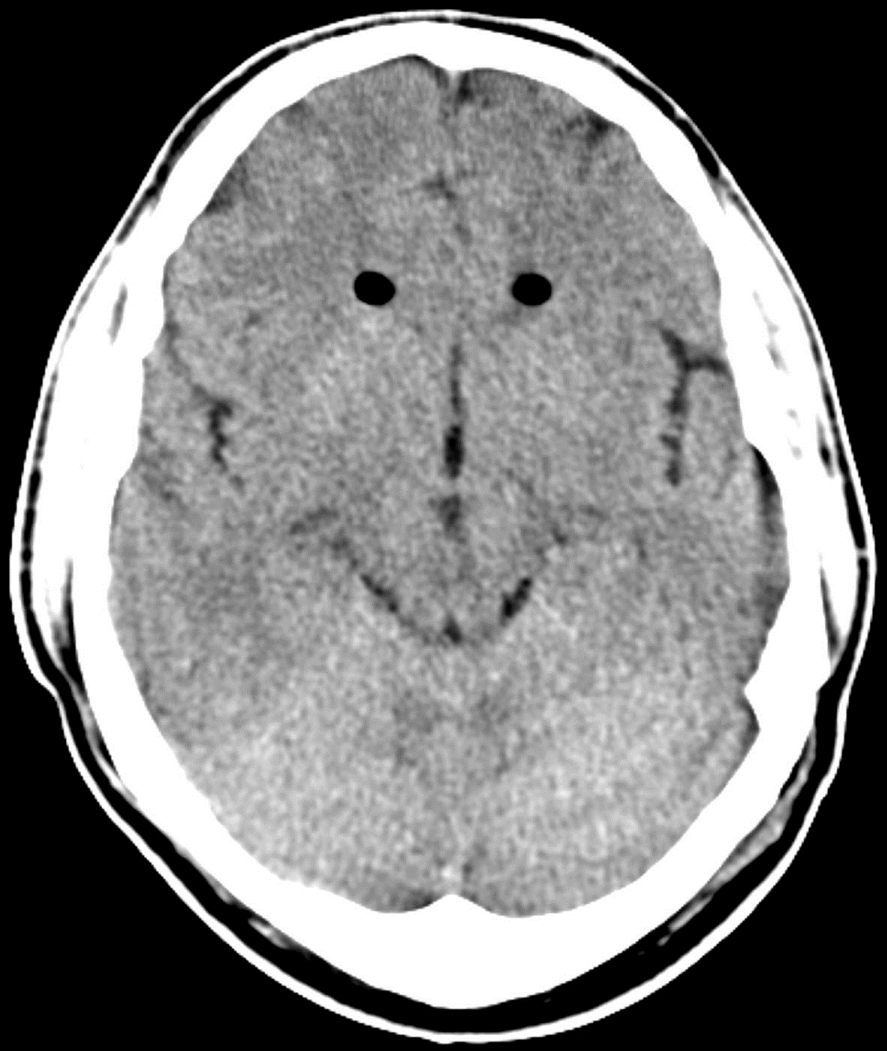
Tranexamsäure ( Cyclocapron) 15-20 mg/Kg

Normothermie

# Clinical protocol ( adults, GCS< 9)

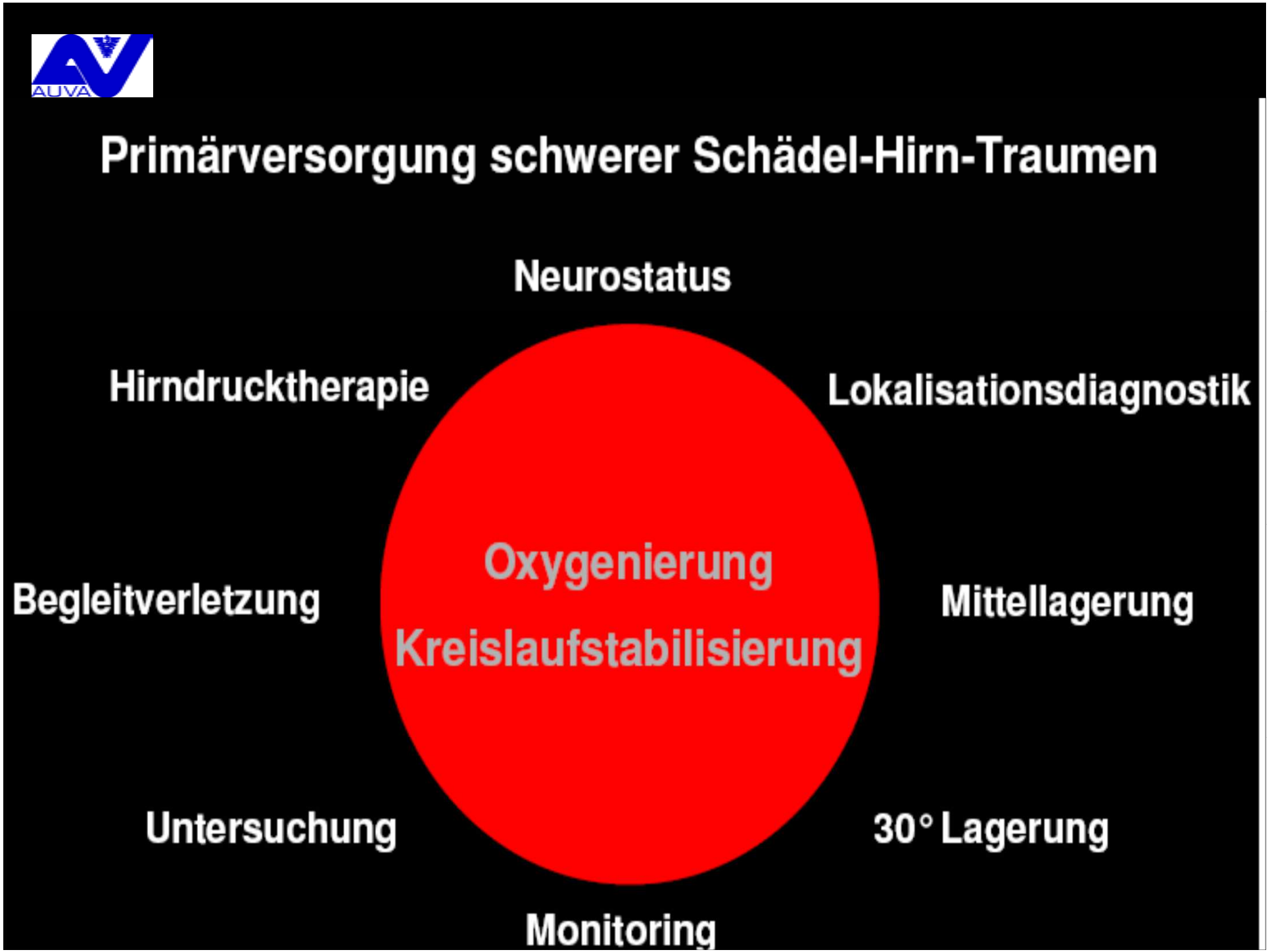
- neuro/trauma-ICU
- place ICP monitor
- ventriculostomy preferred
- ROTEM
- no prophylactic hyperventilation
- arterial line
- Monitoring
- mannitol , sosmo< 320
- normothermia
- sedation with midazolam & opiates (Remifentanil)
- CPP > 60 mm Hg
- ICP< 20 mm Hg
- volume, neuromuscular blockers,
- decompressive surgery,
- pentobarbital coma
- hypothermia

# Fragen?



# TR-DGU (2011)

- 267.000 Pat mit SHT
- Kosten ca 2,8 Mrd Euro
- 5% schweres SHT ( ISS>16, AISkopf >3)
- 7700 Tote
- Rasche neurochir Intervention! (9%)


Primärversorgung schwerer Schädel-Hirn-Traumen
Neurostatus
Hirndrucktherapie
Lokalisationsdiagnostik
Oxygenierung
Kreislaufstabilisierung
Begleitverletzung
Mittellagerung
Untersuchung
30° Lagerung
Monitoring

# EARLY INDICATORS OF PROGNOSIS IN SEVERE TRAUMATIC BRAIN INJURY

Age.....

Glasgow Coma Scale Score....

Hypotension.

CT Scan Features.

Pupillary Diameter & Light Reflex..

| Angaben beziehen sich auf alle Patienten (Gruppe 1 bis 3) | | | Ihre Klinik | Ihr TNW | gesamt |
|---|---|---|---|---|---|
| Patienten mit | SHT (AIS-Kopf ≥ 3) | n=71 | **36%** | Auswertung nur für auditierte Kliniken | 29% |
| | Penetrierendem Trauma | n=24 | **12%** | | 4% |
| | Schock präklinisch (RR≤90mmHg) ohne Patienten der Gruppe 2 | n=23 | **12%** | | 8% |
| | Schock bei Aufnahme | n=20 | **10%** | | 6% |
| | GCS ≤ 8 präklinisch ohne Patienten der Gruppe 2 | n=34 | **18%** | | 13% |
| Injury Severity Score (Mittelwert) | | | **16,8** | | 15,3 |
| Davon Schwerverletzte (ISS≥16) | | | **92** | | 13425 |

# Reserve

## SHT perioperativ

# Thrombosevermeidung mittels Kompressionsstrümpfe

als Prävention der tiefen Venenthrombose

18 RCTs

effizient, vor allem in Verbindung mit einer weiteren Maßnahme

(low dose Heparin)

Cochrane Database 2010

# EBM- COCHRANE

- Hyperventilation
- Hypertonic saline
- Mannitol
- Volume to increase CPP?
- barbiturate coma
- sedoanalgesia
- hypothermia
- steroids

- RCT required
- RCT required
- RCT required
- colloids are superior and safe
- no outcome improvement
- more investigations?
- prevention of fever-yes
- No evidence

# Spezielle Fragen:

**Ernährung:** voll parenteral, enteral so früh wie möglich (Beginn am 1. Tag) 15-20 kcal/ kg/Tag

**Frühernährung** möglicherweise mit besserem Outcome assoziiert ( Cochrane 2008)

**Darmparalyse:** Erythromycin 3x200 mg p.o., Stressulkusprophylaxe: Sucralfat, Omeprazol

**Thromboseprophylaxe:** mechanisch, low dose Heparin als Bypass, Niedermolekulare Heparine.

**Infektionsprophylaxe:** zurückhaltender Einsatz von AB, strikte Hygiene, Screening

**Delirprophylaxe:** ß- blocker, Anticholium?

# I. Blood Pressure and Oxygenation

## I. RECOMMENDATIONS

*A. Level I*

There are insufficient data to support a Level I recommendation for this topic.

*B. Level II*

Blood pressure should be monitored and hypotension (systolic blood pressure < 90 mm Hg) avoided.

*C. Level III*

Oxygenation should be monitored and hypoxia ($PaO_2$ < 60 mm Hg or $O_2$ saturation < 90%) avoided.

## VI. KEY ISSUES FOR FUTURE INVESTIGATION

The major questions for resuscitating the severe TBI patient are as follows:

- The level of hypoxia and hypotension that correlates with poor outcome
- Treatment thresholds
- Optimal resuscitation protocols for hypoxia and hypotension
- The impact of correcting hypoxia and hypotension on outcome
- Specification of target values

**Monitoring des Blutdrucks**

**Vermeidung jeder Hypotension ( Systolisch < 90 mm Hg)**

**Vermeidung von Hypoxämie : SaO2 < 90%, PaO2 < 60 mm Hg**

**Entsprechende Protokolle fehlen**

**Korrelationen mit dem Outcome?**

# VI. Indications for Intracranial Pressure Monitoring

*B. Level II*

Intracranial pressure (ICP) should be monitored in all salvageable patients with a severe traumatic brain injury (TBI; Glasgow Coma Scale [GCS] score of 3–8 after resuscitation) and an abnormal computed tomography (CT) scan. An abnormal CT scan of the head is one that reveals hematomas, contusions, swelling, herniation, or compressed basal cisterns.

*C. Level III*

ICP monitoring is indicated in patients with severe TBI with a normal CT scan if two or more of the following features are noted at admission: age over 40 years, unilateral or bilateral motor posturing, or systolic blood pressure (BP) < 90 mm Hg.

**ICP Monitoring bei allen schweren SHT**

**GCS<9 und pathologischem CCT**

**bei schwerem SHT**

**Alter > 40**

**BP < 90 mm Hg**

# Outcomedaten TR-DGU

| | Ihre Klinik 2012 | | TR-DGU 2012 | | TR-DGU 10 | |
|---|---|---|---|---|---|---|
| Anzahl Patienten gesamt | **28.805** | | 28.805 | | 108.986 | |
| **Outcome** (ohne früh weiterverlegte Patienten) | % | n | % | n | % | n |
| überlebende Patienten | **90,0%** | 24.239 | **90,0%** | 24.239 | **88,4%** | 91.286 |
| verstorben im Krankenhaus | **10,0%** | 2.679 | **10,0%** | 2.679 | **11,6%** | 11.940 |
| 30-Tage-Letalität | **9,6%** | 2.573 | **9,6%** | 2.573 | **11,1%** | 11.458 |
| verstorben innerhalb der ersten 24 Stunden | **4,7%** | 1.258 | **4,7%** | 1.258 | **5,9%** | 6.119 |
| **Verlegung / Entlassung** (alle Patienten) | % | n | % | n | % | n |
| Lebend die Klinik verlassen und … | | 26.126 | | 26.126 | | 96.769 |
| in ein anderes Krankenhaus verlegt | **15,7%** | 4.103 | **15,7%** | 4.103 | **16,9%** | 16.343 |
| darunter früh (<48h) weiterverlegt | **7,2%** | 1.887 | **7,2%** | 1.887 | **6,0%** | 5.760 |
| in eine Reha-Klinik verlegt | **18,6%** | 4.867 | **18,6%** | 4.867 | **24,3%** | 23.488 |
| nach Hause entlassen | **62,0%** | 16.207 | **62,0%** | 16.207 | **56,1%** | 54.286 |
| **Zustand bei Verlegung/Entlassung (Glasgow Outcome Scale, GOS)** (ohne früh weiterverlegte Patienten) | % | n | % | n | % | n |
| Patienten mit GOS Angabe | | 25.923 | | 25.923 | | 72.662 |
| davon überlebende Patienten | **100%** | 23.244 | **100%** | 23.244 | **100%** | 63.401 |
| – gut erholt | **70,0%** | 16.278 | **70,0%** | 16.278 | **62,3%** | 39.502 |
| – mäßig behindert | **21,8%** | 5.067 | **21,8%** | 5.067 | **26,0%** | 16.513 |
| – schwer behindert | **6,7%** | 1.563 | **6,7%** | 1.563 | **9,8%** | 6.199 |
| – nicht ansprechbar; vegetativ | **1,4%** | 336 | **1,4%** | 336 | **1,9%** | 1.187 |

# EARLY INDICATORS OF PROGNOSIS in Severe Traumatic Brain Injury

Authors:

Randall M. Chesnut, M.D.
Associate Professor of Neurosurgery

## Prognostic Parameters

for Traumatic Brain Injury Methodology

| | DEAD | ALIVE |
|---|---|---|
| PROGNOSTIC FACTOR PRESENT | a | b |
| PROGNOSTIC FACTOR ABSENT | c | d |

# CT SCAN FEATURES

I. Conclusions

A. Which feature of the parameter is supported by Class I and strong Class II evidence and has at least a 70% positive predictive value (PPV) in severe head injury?

a. Presence of abnormalities on initial computed tomography (CT) examination
b. CT classification
c. Compressed or absent basal cisterns
d. Traumatic subarachnoid hemorrhage (tSAH):
   Blood in the basal cisterns
   Extensive tSAH

B. Parameter measurement:

1. How should it be measured?
   Compressed or absent basal cisterns measured at the midbrain level.
   tSAH should be noted in the basal cisterns or over the convexity.
   Midline shift should be measured at the level of the septum pellucidum.
2. When should it be measured?
   Within 12 hours of injury
   The full extent of intracranial pathology, however, may not be disclosed on early CT examination.
3. Who should measure it?
   A neuroradiologist or other qualified physician, experienced in reading CT-scans

Individual CT characteristics found to be particularly relevant in terms of prognosis were:

a. Status of basal cisterns
b. tSAH
c. Presence and degree of midline shift
d. Presence and type of intracranial lesions

On average 65% of patients with severe head injury have normally reactive pupils after resuscitation, 12% have one abnormal pupil, and 28% have bilateral pupillary nonreactivity.

There is significant interaction between pupillary reactivity and other early indicators of prognosis; Glasgow Coma Scale (GCS) score, [4] hypotension,[1] and CT basal cisterns,[22] as seen in the following table:

| | GCS 3-5 | GCS 6-7 | SBP < 60 | SBP 60-90 | Cisterns Partly Open | Cisterns Closed |
|---|---|---|---|---|---|---|
| Unreactive Pupils (%) | 56 | 20 | 65 | 53 | 15* | 38* |

*Includes bilateral and unilateral unreactive pupils

In reviewing large studies (> 200 patients), there was a strong association between bilaterally unreactive pupils and poor outcome as shown in the following table:

| | | % Vegetative/Dead (Glasgow Outcome Scale Score [GOS] 1, 2) | | |
|---|---|---|---|---|
| First Author | # of Patients | Bilateral Reactive Pupils | Unilateral Unreactive | Bilateral Unreactive |
| Jennett,[8] 1976 | 600 | 42% | —% | 95% |
| Braakman,[4] 1980 | 305 | 29 | 54 | 90 |
| Heiden,[7] 1983 | 213 | 36 | — | 91 |
| Marshall,[12] 1991 | 746 | 32 | 34 | 74 |
| | **Average** | **35** | **44** | **88** |

# Traumaregister 2013

| | Ihre Klinik | | | | TraumaRegister DGU® | |
|---|---|---|---|---|---|---|
| | 10 Jahre | 2010 | 2011 | **2012** | 2012 | 10 Jahre |
| ISS [MW] | 19,3 | 18,8 | 18,3 | **17,0** | 17,0 | 19,3 |
| ISS ≥ 16 [%] | 57% | 55% | 53% | **48%** | 48% | 57% |
| SHT (AIS-Kopf ≥ 3) [%] | 38% | 36% | 35% | **32%** | 32% | 38% |
| **Versorgung am Unfallort** (nur Primäraufnahmen): | | | | | | |
| Intubation durch Notarzt [%] | 33% | 30% | 26% | **23%** | 23% | 33% |
| Bewusstlos (GCS ≤ 8) [%] | 21% | 20% | 17% | **17%** | 17% | 17% |
| Schock (RR ≤ 90 mmHg) [%] | 13% | 13% | 12% | **10%** | 12% | 10% |
| Volumengabe [ml] | 874 | 816 | 755 | **698** | 698 | 874 |
| Intensivpflichtige Pat. [%] | 81% | 79% | 79% | **78%** | 78% | 81% |
| Intensivstation [2)] [Tage] | 8,3 | 8,0 | 7,2 | **6,8** | 6,8 | 8,3 |
| Beatmete Intensivpat. [2)] [%] | 56% | 53% | 48% | **45%** | 45% | 56% |

# LEITLINIEN

- Brain trauma foundation (BTF)
- ( J Neurotrauma 2007; 24: S1-106)
- ESICM ( PACT Modul)
- European Brain injury consortium (EBIC)
- ( Acta NCH, Wien 1997 )
- Italienische Neurotraumagruppe
- ( J Neurosurg Sci 2000 )
- Deutsche Gesellschaft für Neuroanästhesie (DGAI)
- Britische NICE Clinical Guidelines
- Relevante und neue Literatur zum Thema SHT

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# Traumatic brain injuries caused by traffic accidents in five European countries: outcome and public health consequences

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**Background:** Road traffic accidents (RTAs) have been identified by public health organizations as being of major global concern. Traumatic brain injuries (TBIs) are among the most severe injuries and are in a large part caused by RTA. The objective of this article is to analyse the severity and outcome of TBI caused by RTA in different types of road users in five European countries. **Methods:** The demographic, severity and outcome measures of 683 individuals with RTA-related TBI from Austria, Slovakia, Bosnia, Croatia and Macedonia were analysed. Five types of road users (car drivers, car passengers, motorcyclists, bicyclists and pedestrians) were compared using univariate and multivariate statistical methods. Short-term outcome [intensive care unit (ICU) survival] and last available long-term outcome of patients were analysed. **Results:** In our data set, 44% of TBI were traffic related. The median age of patients was 32.5 years, being the lowest (25 years) in car passengers. The most severe and extensive injuries were reported in pedestrians. Pedestrians had the lowest rate of ICU survival (60%) and favourable long-term outcome (46%). Drivers had the highest ICU survival (73%) and car passengers had the best long-term outcome (59% favourable). No differences in the outcome were found between countries with different economy levels. **Conclusion:** TBI are significantly associated with RTA and thus, tackling them together could be more effective. The population at highest risk of RTA-related TBI are young males (in our sample median age: 32.5 years). Pedestrians have the most severe TBI with the worst outcome. Both groups should be a priority for public health action.

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healthcare

ORIGINAL ARTICLE

# Hospital admissions for traumatic brain injury of Austrian residents vs. of visitors to Austria

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**Abstract**

*Background*: The goal was to compare epidemiology of hospital admissions for traumatic brain injury (TBI) in Austrian residents vs. visitors to Austria.

*Methods*: Data on all hospital admissions due to TBI (ICD-10 codes S06.0–S06.9; years 2009–2011) was provided by the Austrian Statistical Office. Data on Austrian population and on tourism (visitor numbers, nights spent) was retrieved from www.statistik.at. Age, sex, mechanism of injury, season and mortality was analysed for Austrian residents vs. visitors.

*Results*: Visitors contributed 3.9% to the total population and 9.2% of all TBI cases. Incidence of hospital admissions was 292/100 000/year in Austrian residents and was 727/100 000/year in visitors. Male:female ratio was 1.39:1 in Austrian residents and 1.55:1 in visitors. Austrian cases were older than visitors' cases (mean age 41 vs. 28 years). Austrian cases were distributed evenly over the seasons, while 75% of the visitors' cases happened during winter and spring. The most frequently observed causes of TBI in Austrian residents were private accidents, while sports caused almost half of the visitors' cases. Hospital mortality was lower in visitors than in Austrian residents (0.8 vs. 2.1%).

*Conclusion*: Sports-related TBI of visitors causes a significant workload for Austrian hospitals. Better prevention is warranted.

**Keywords**

Age, outcome, sex, tourists, traumatic brain injury, winter sports

**History**

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