



# Il trauma cranico (con presentazione del nuovo petalo neuro)

arturo chiericato  
cesena

XX Meeting GiViTi  
L' angolo della clinica  
Hr 14-16

# NeuroPetalo Software Team



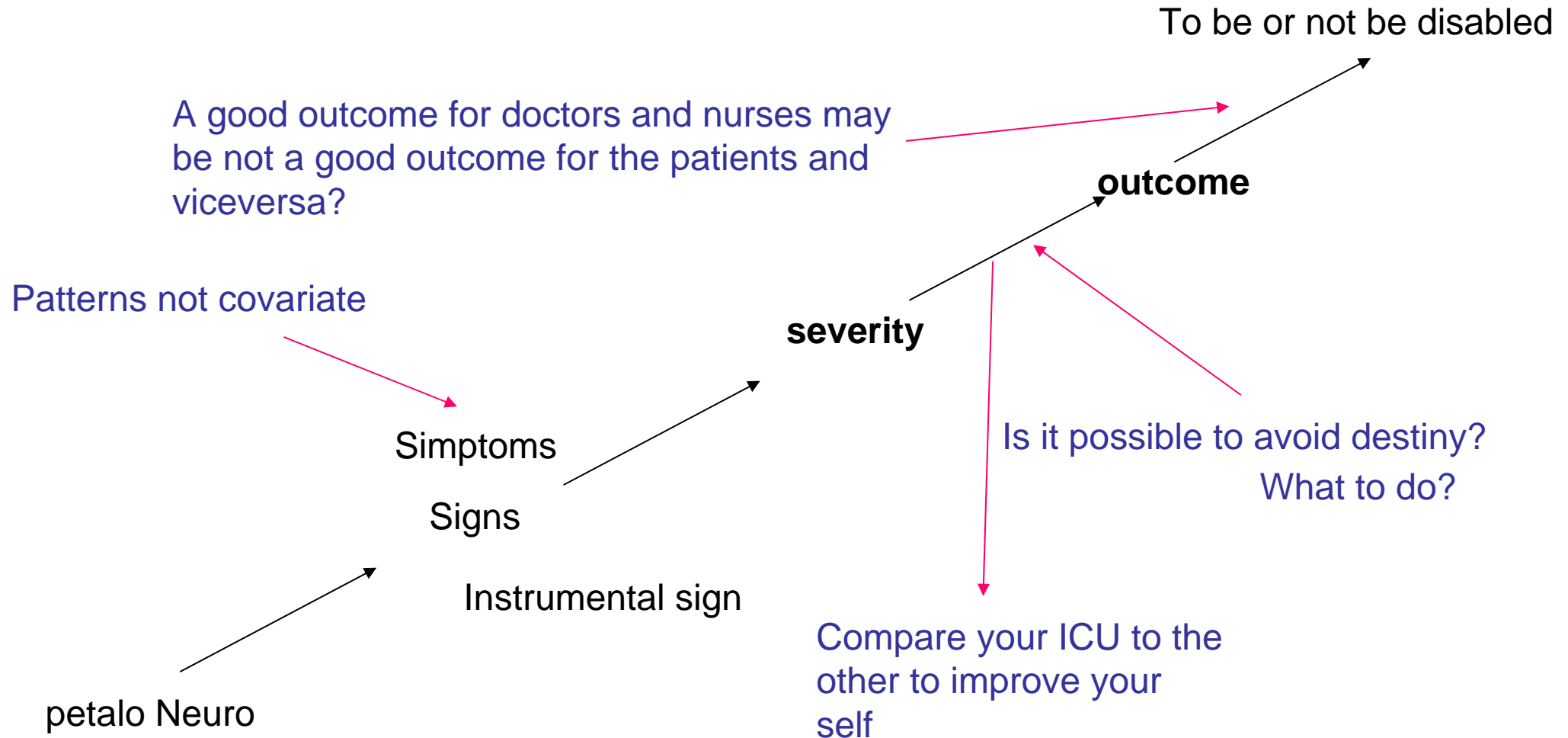
special thanks to Cesena nurses



# issues

- Variables associated to the patient, independently from TBI
- Type of trauma
- Prehospital and preICU phase
- Anatomical severity
- Admission in ICU
- Complications in ICU
- Therapy in ICU
- outcome

# Aims of the talk



Variables associated to the patient,  
independently from TBI

# Sex (core)

Nuovo ricovero

Per aprire un nuovo ricovero, completare le seguenti informazioni. I campi segnati con un asterisco sono obbligatori.

Cognome(\*)

Nome(\*)

Data di nascita(\*) dd/mm/yyyy

Sesso

Data di ingresso(\*) dd/mm/yyyy

Annulla OK

# Sex

- Pre-menopausal women have a better outcome after TBI

Female TBI patients recover better than males

ZEEV GROSWASSER, MARIO COHEN†  
and OFER KEREN

BRAIN INJURY, 1998, VOL. 12, NO. 9, 805–808

Groswasser Z, Cohen M, Keren O. Female TBI patients recover better than males. *Brain Inj* 1998; 12: 805–8  
Bounds TA, Schopp L, Johnstone, Unger C, Goldman H. Gender differences in a sample of vocational rehabilitation clients with TBI. *NeuroRehab* 1995; 18: 189–96.



# Sex

*Neurotherapeutics: The Journal of the American Society for Experimental NeuroTherapeutics*

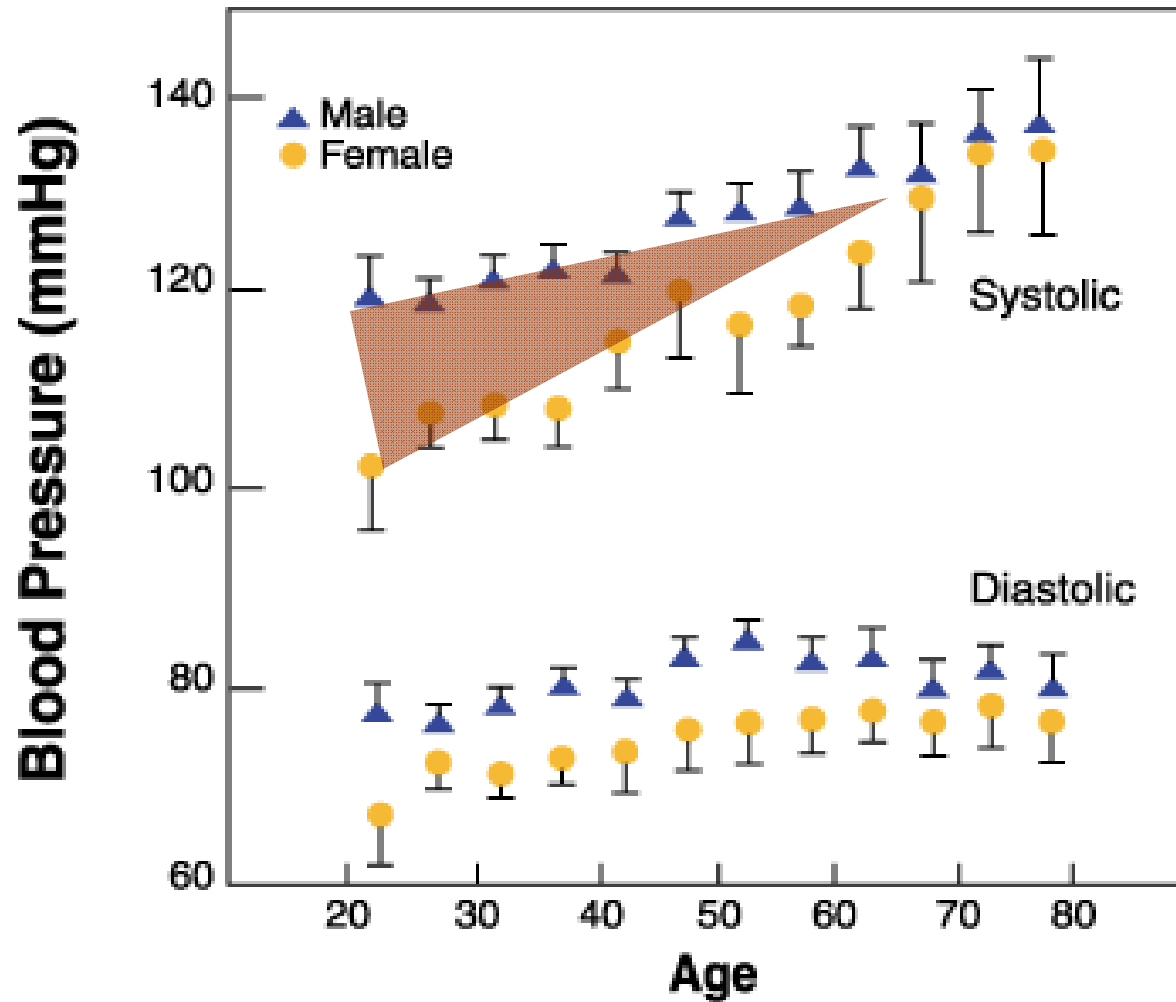
## Traumatic Brain Injury and Aging: Is a Combination of Progesterone and Vitamin D Hormone a Simple Solution to a Complex Problem?

Milos Cekic and Donald G. Stein

Vol. 7, 81–90, January 2010 © The American Society for Experimental NeuroTherapeutics, Inc.

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# Age Changes in Systolic and Diastolic Blood Pressure



# Sex and clinical management

- Pre-menopausal
  - Targets for arterial pressure and CPP
    - Lower than male
  - pregnancy
- Progesterone
  - Single multiple target neuroprotective agent

# Age (core)

Nuovo ricovero

Per aprire un nuovo ricovero, completare le seguenti informazioni. I campi segnati con un asterisco sono obbligatori.

Cognome(\*)

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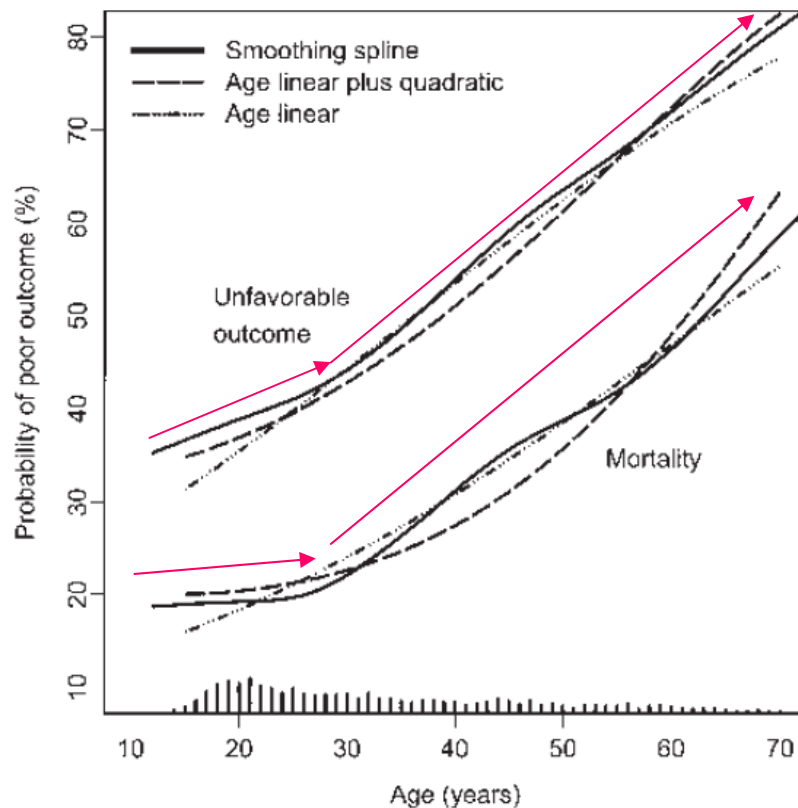


FIG. 1. Graph demonstrating the univariable association between age and 6-month outcome in 2664 patients with severe TBI. Age was described as a continuous linear term (age linear), an age linear plus quadratic term, and a smoothing spline. The vertical strokes at the base of the graph indicate the age distribution. For ease of interpretation, the probability scale is presented in this figure, rather than the logistical log-odds scale generally used in logistic regression models. A linear association on the log-odds scale corresponds to a sigmoid curve on the probability scale. Model parameters for age linear (age per 10 years) were as follows:  $\text{logit (mortality)} = -2.18 + 0.34 * \text{age}$  and  $\text{logit (unfavorable outcome)} = -1.34 + 0.37 * \text{age}$ . Model parameters for age linear plus age quadratic (age per 10 years) were as follows:  $\text{logit (mortality)} = -1.26 - 0.18 * \text{age} + 0.06 * \text{age}^2$  and  $\text{logit (unfavorable outcome)} = -0.77 + 0.03 * \text{age} + 0.04 * \text{age}^2$ .

## Linear (nearly) effect of age

J Neurosurg 99:666–673, 2003

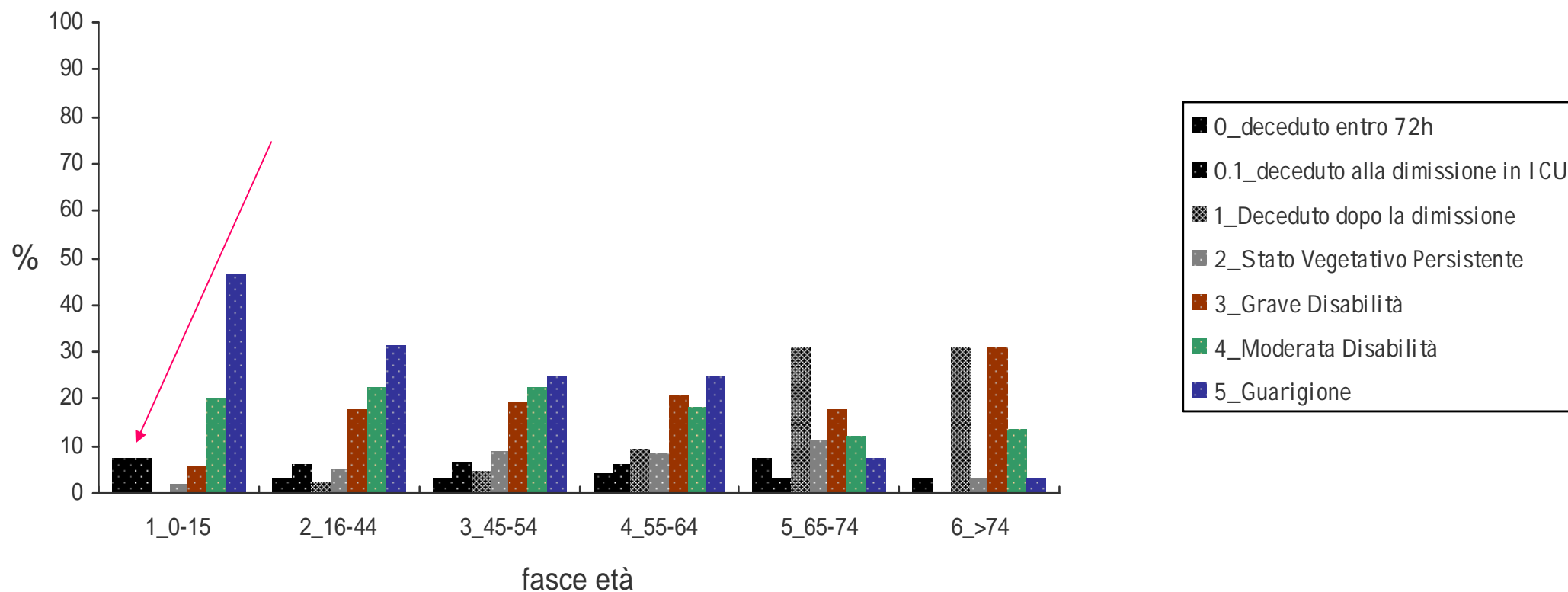
### Patient age and outcome following severe traumatic brain injury: an analysis of 5600 patients

CHANTAL W. P. M. HUKKELHOVEN, M.Sc., EWOUT W. STEYERBERG, Ph.D.,  
ANNEKE J. J. RAMPEN, M.Sc., ELANA FARACE, Ph.D., J. DIK F. HABBEMA, Ph.D.,  
LAWRENCE F. MARSHALL, M.D., GORDON D. MURRAY, Ph.D.,  
AND ANDREW I. R. MAAS, M.D., Ph.D.

achiere@ausl-cesena.emr.it

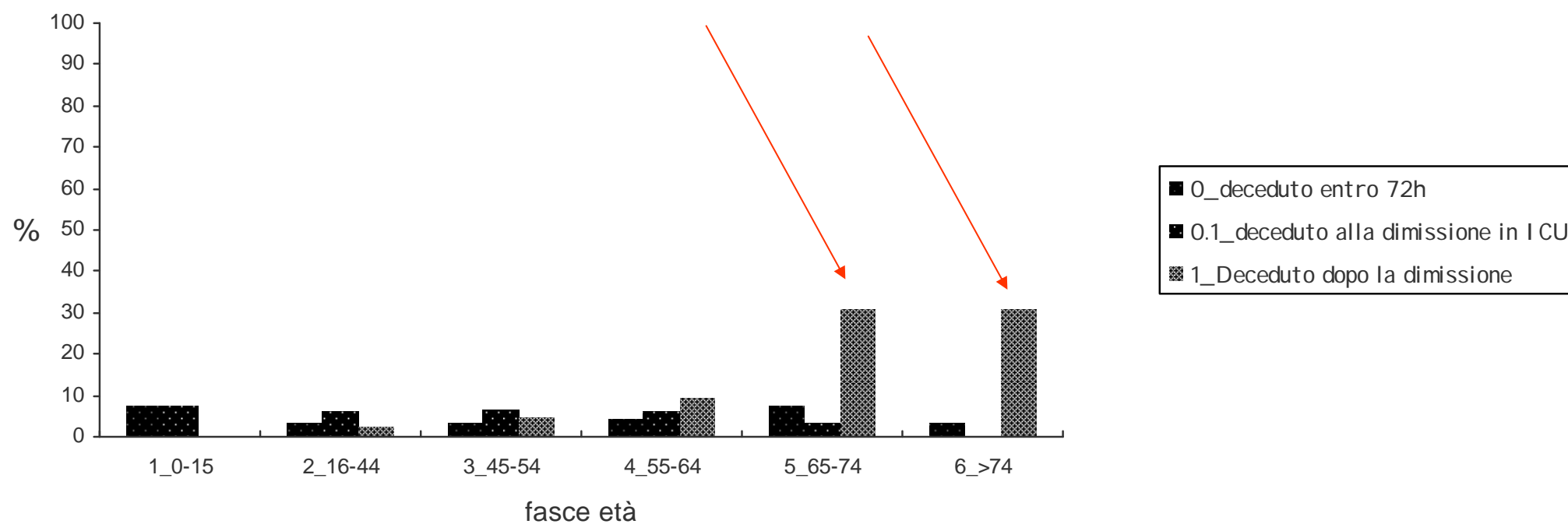
# GOS and age

834 patients with ICP monitoring  
Cesena 1997-2011

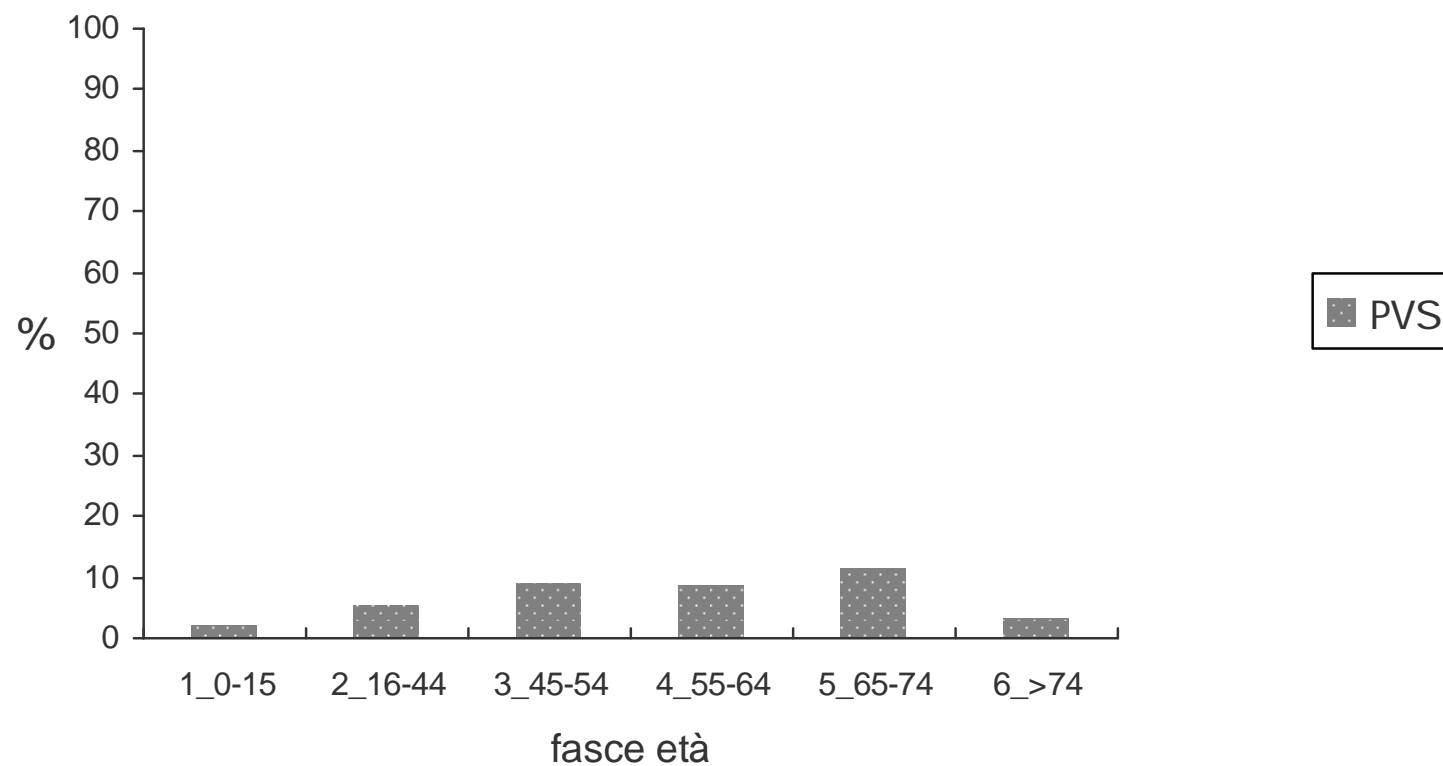


# GOS and age

834 patients with ICP monitoring  
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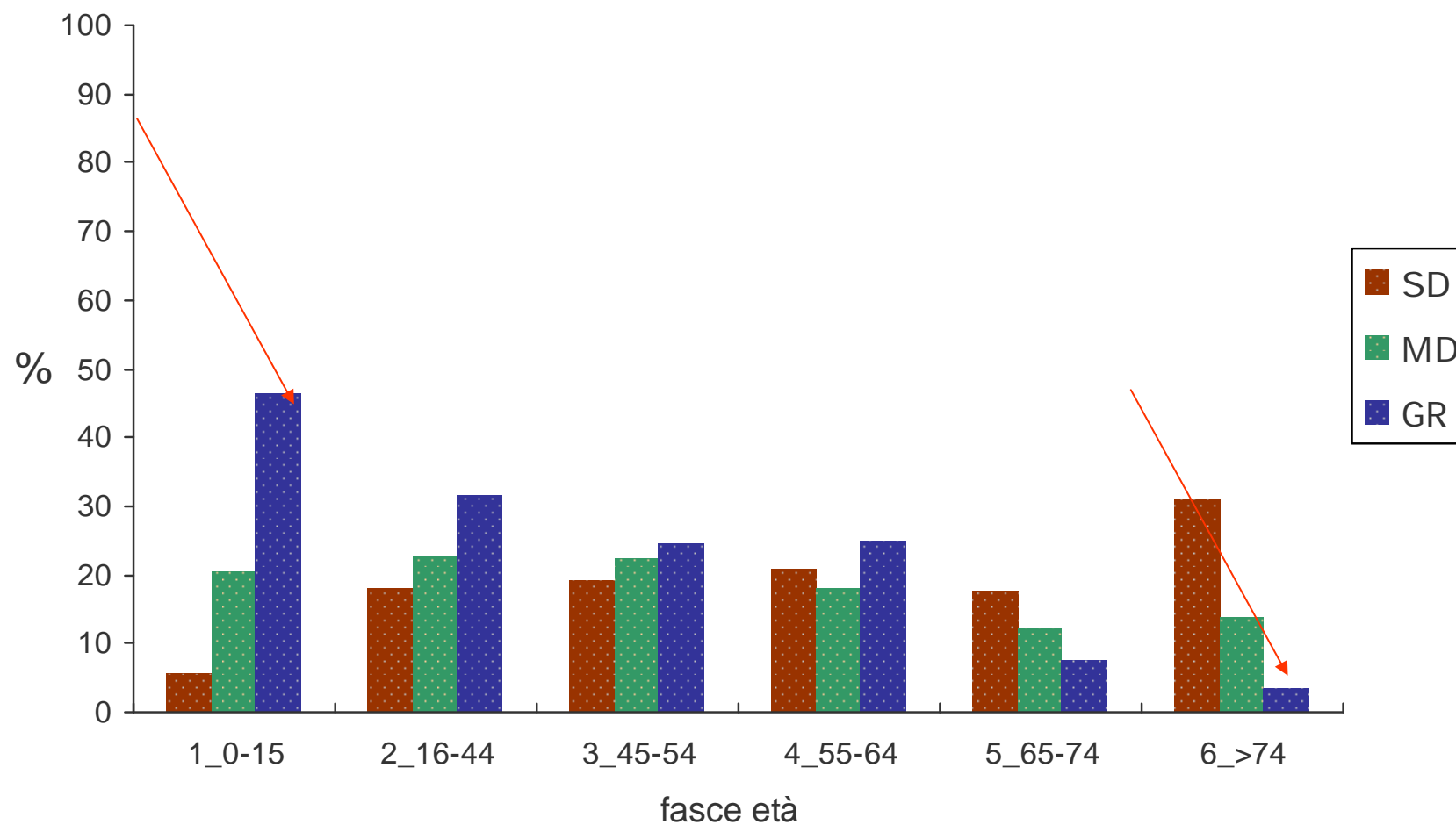


GOS and age  
834 patients with ICP monitoring  
Cesena 1997-2011

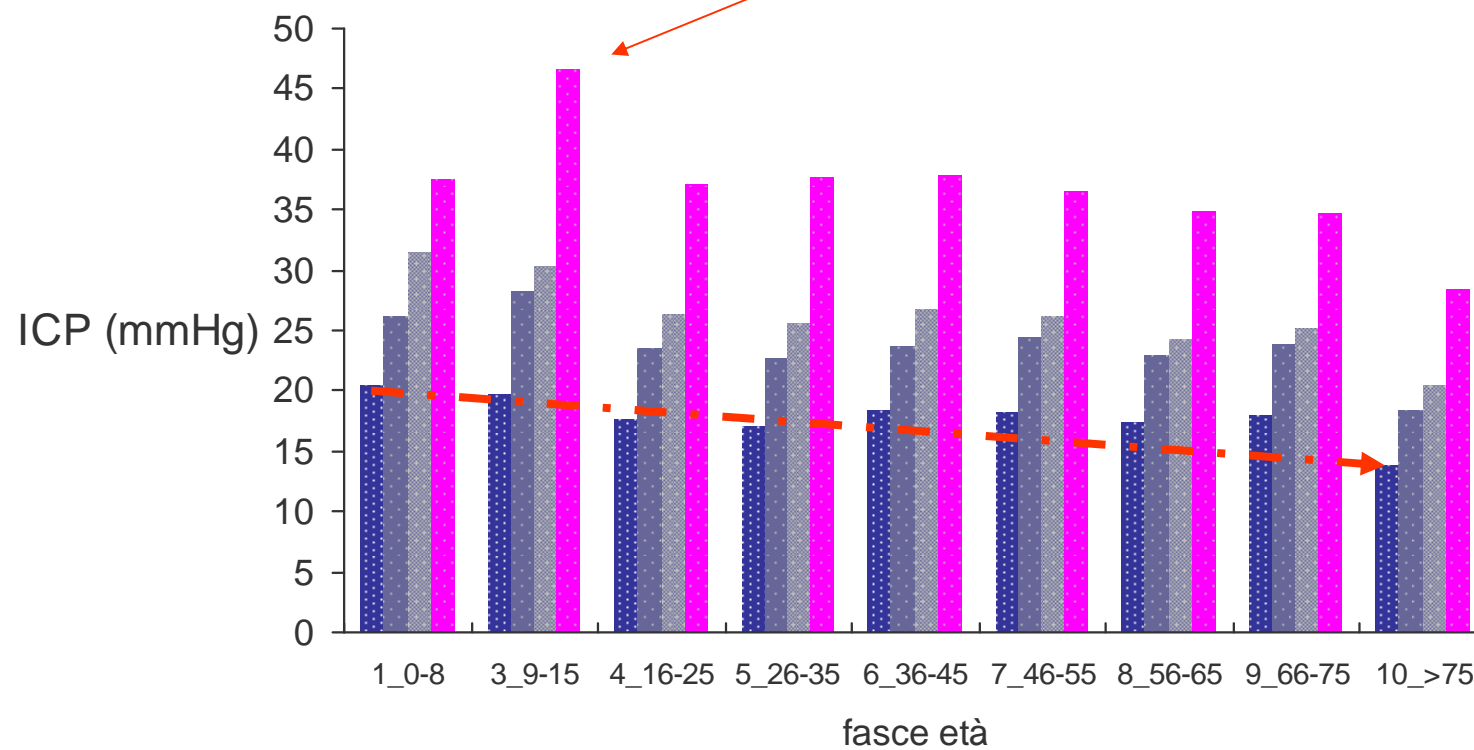




GOS and age  
834 patients with ICP monitoring  
Cesena 1997-2011

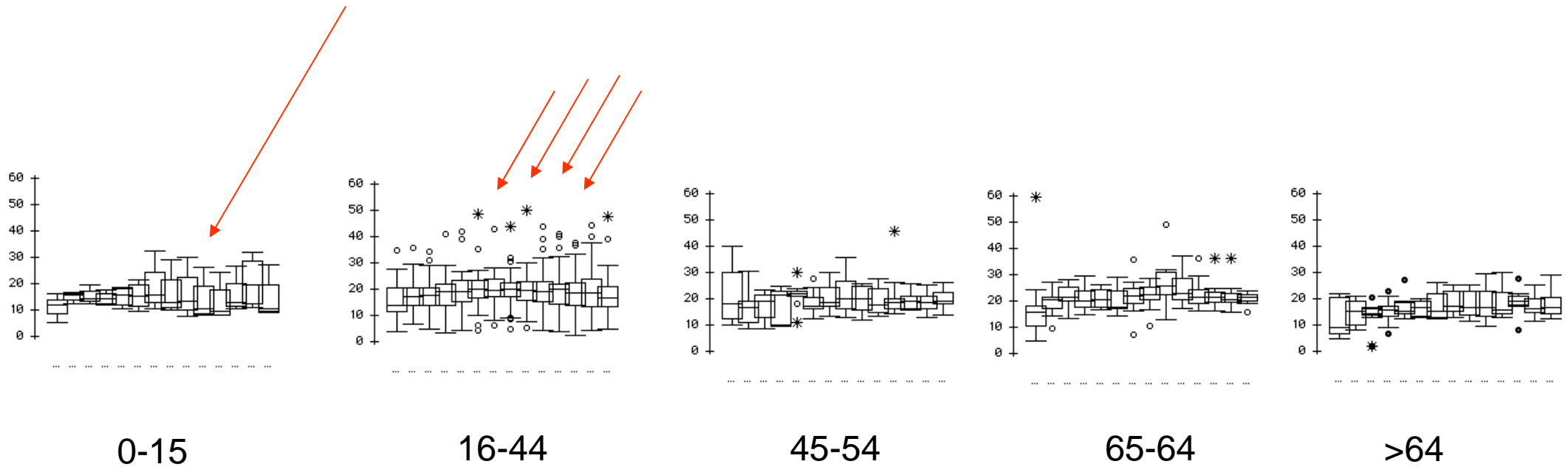


ICP and age  
834 patients with ICP monitoring  
Cesena 1997-2011

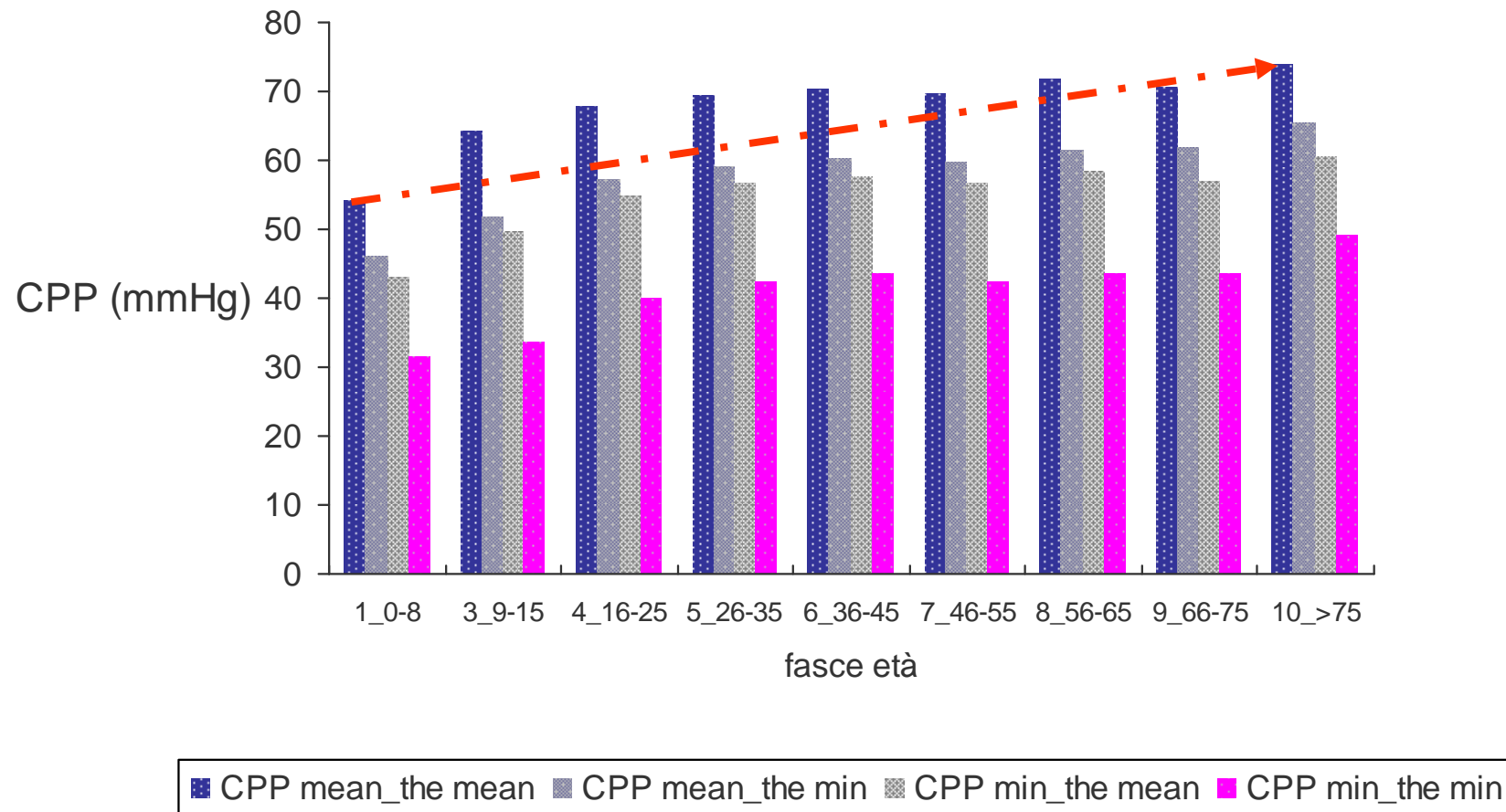


■ ICP mean\_the mean ■ ICP mean\_the max ■ ICP max\_the mean ■ ICP max\_the max

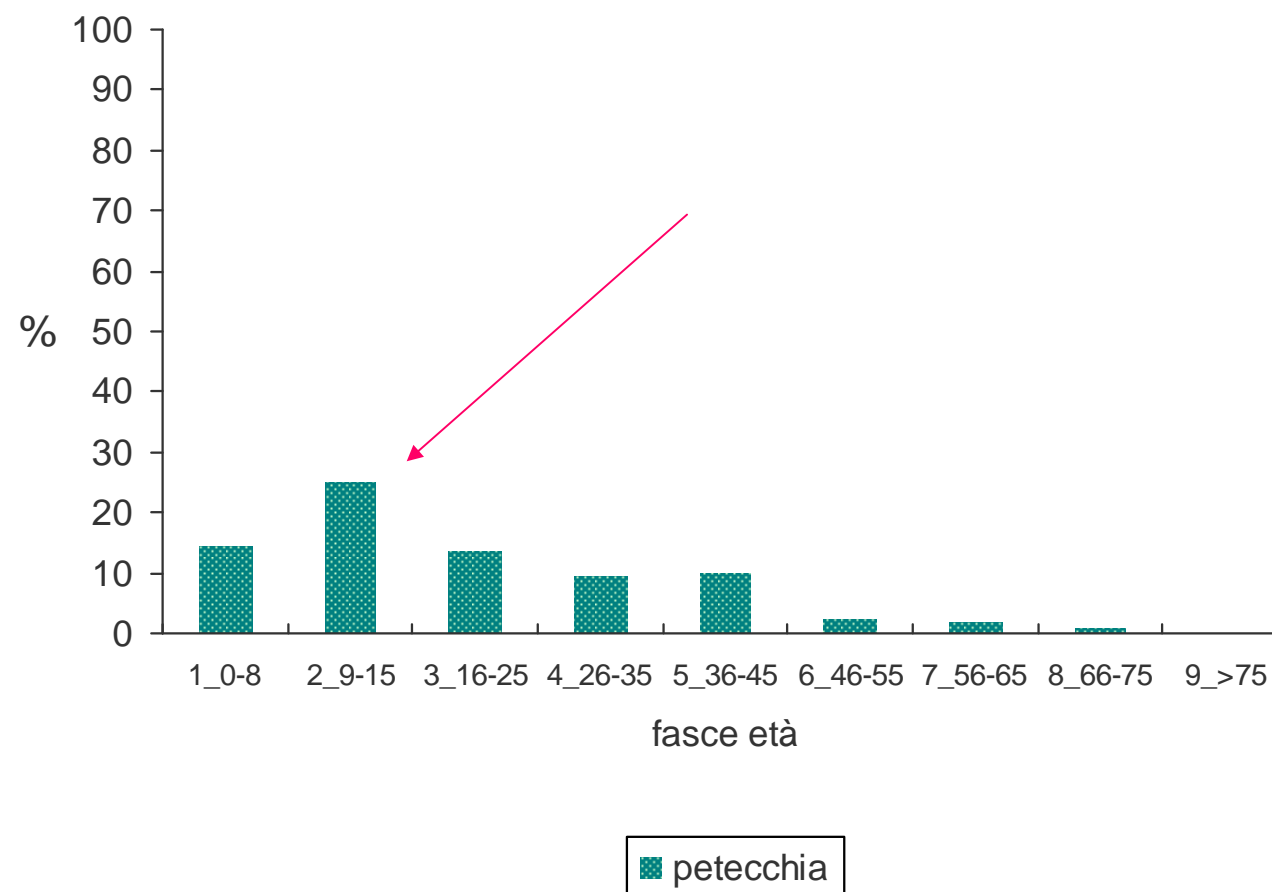
ICP during the first 14 gg days  
834 patients with ICP monitoring  
Cesena 1997-2011



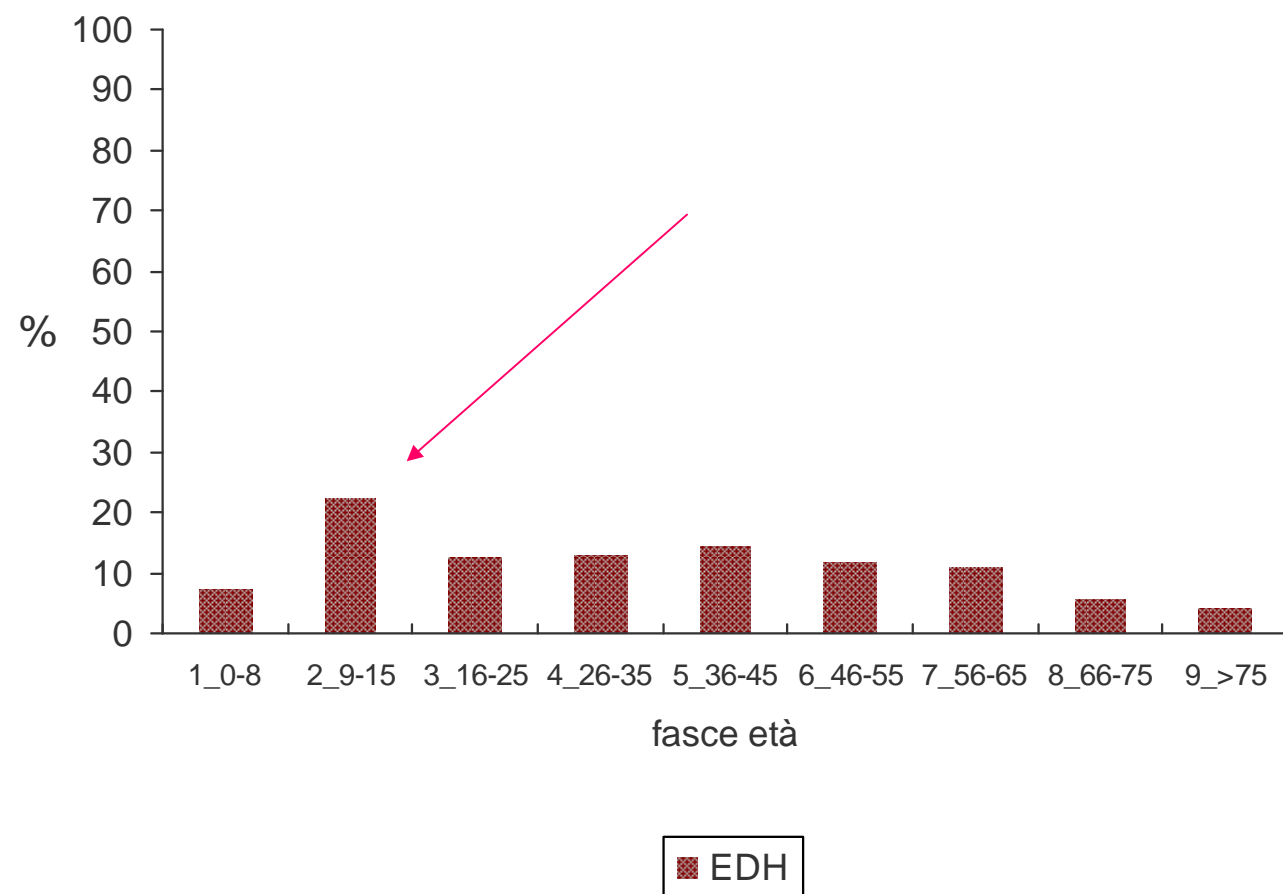
CPP and age  
834 patients with ICP monitoring  
Cesena 1997-2011



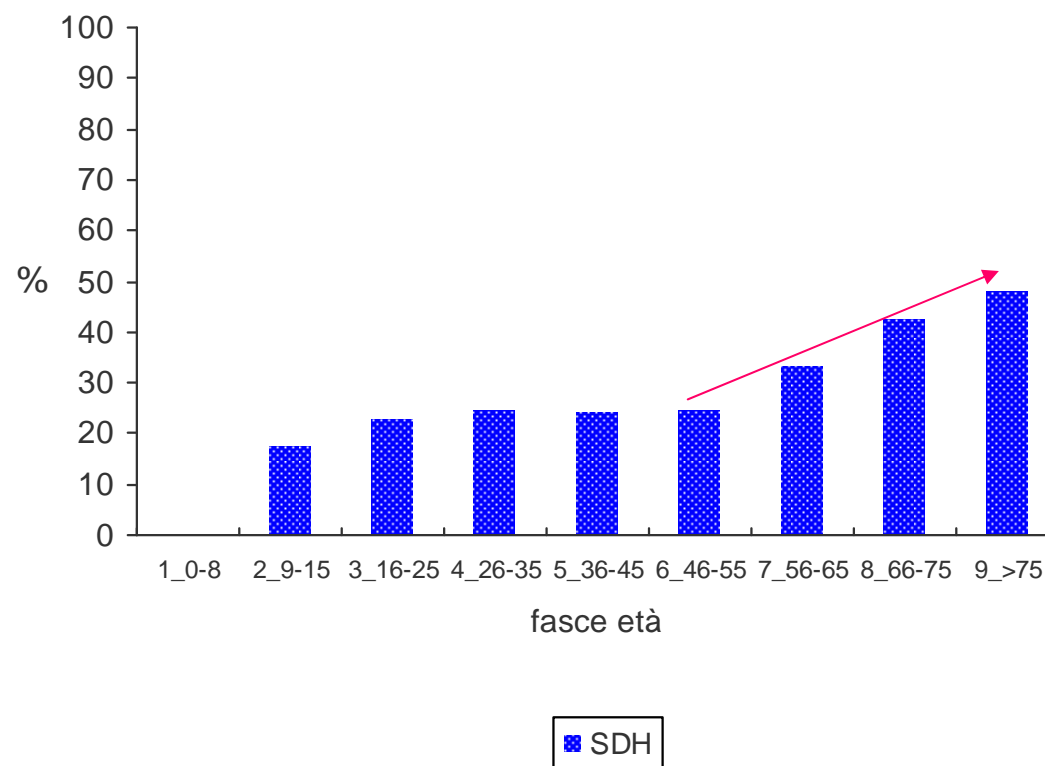
petecchia and age  
834 patients with ICP monitoring  
Cesena 1997-2011



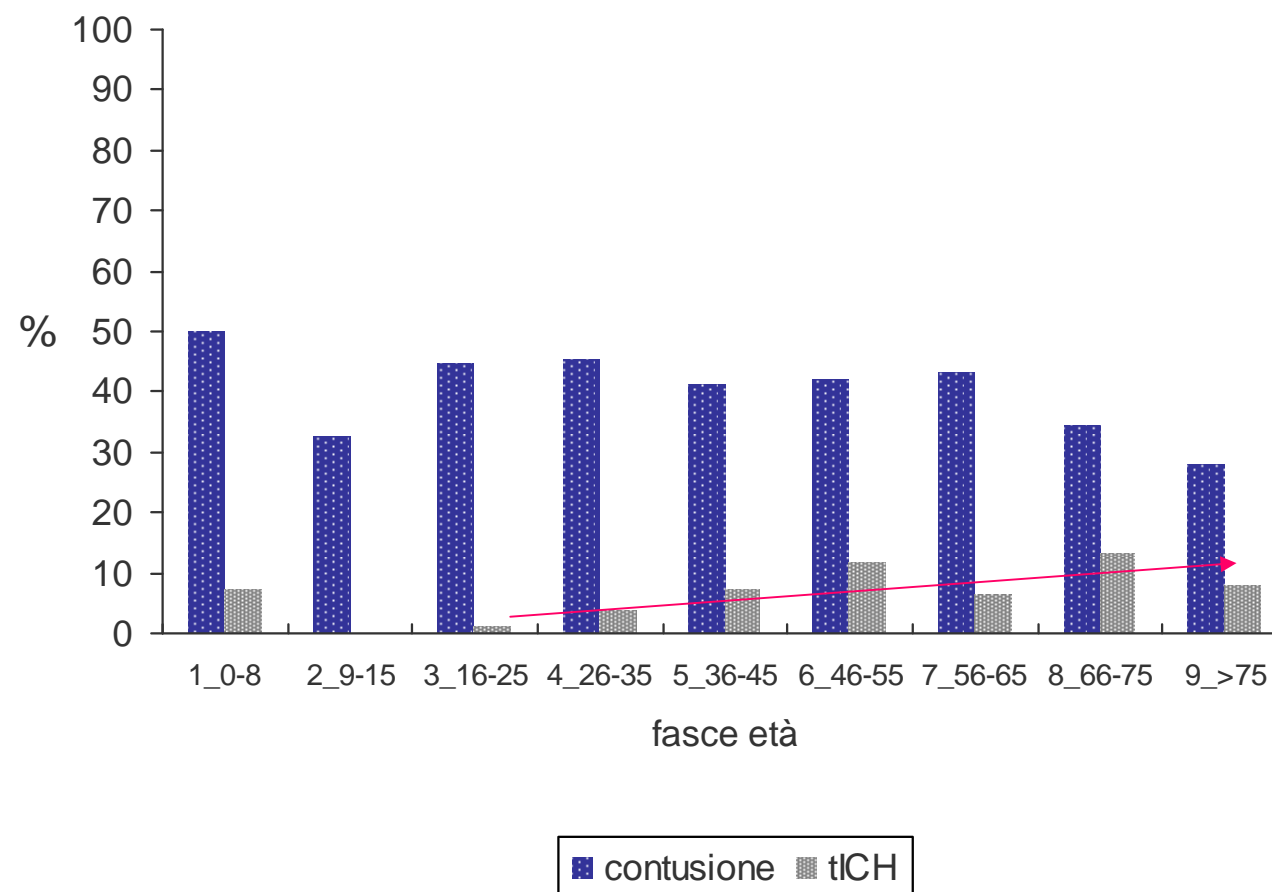
EDH and age  
834 patients with ICP monitoring  
Cesena 1997-2011



SDH and age  
834 patients with ICP monitoring  
Cesena 1997-2011

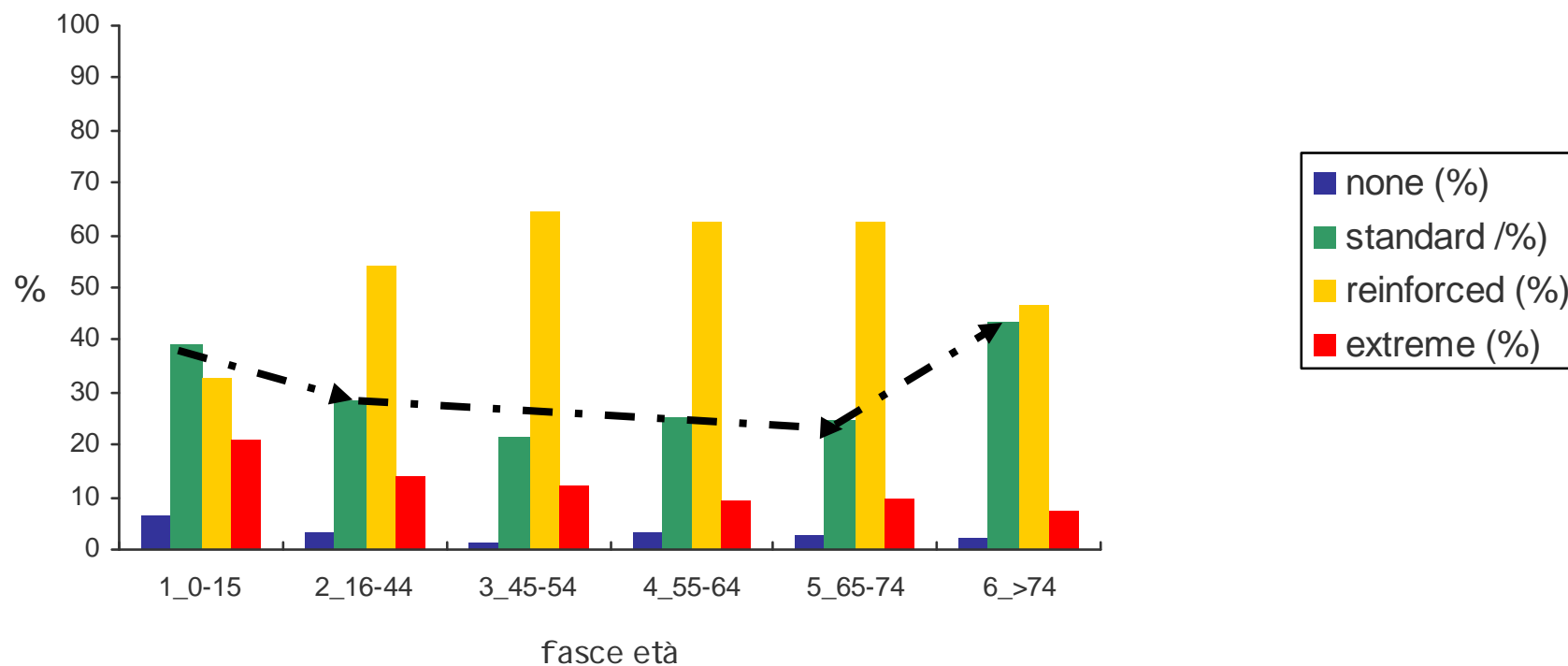


Contusions, tICH and age  
834 patients with ICP monitoring  
Cesena 1997-2011





Therapeutic intervention (TIL) score and age  
834 patients with ICP monitoring  
Cesena 1997-2011



# Clinical corner

## age

- ICP decline with ageing
  - compliance
- CPP increase with ageing
  - Physiological increase
- TIL reduces
  - Lower ICP
  - Management choice
    - Less biological reserve
    - withholding
- Differences in anatomical lesions
- Outcome
  - Young patients:
    - dichotomic
    - Children, performance
  - Middle age:
    - cognitive disturbance associated to diffuse injury
  - Older patient,
    - High rate of death after discharge
    - Few cases with good recovery

# Type of admission (core)

**Core**

- Dati personali del paziente
- Informazioni amministrative
  - Precedenti ricoveri in TI
  - Provenienza**
- Ammissione
  - Comorbidità
  - Tipologia paziente
  - Motivo di ammissione
- Condizioni cliniche all'ammissione
- Degenza in TI
  - Complicanze insorte durante la degenza
  - Procedure chirurgiche
  - Procedure non chirurgiche
  - Presidi e/o trattamenti
- Score di gravità
  - GCS all'ammissione in TI
  - AKIN / Metabolic
  - GCS peggiore nelle prime 24 h
  - SAPSII Score
  - SOFA Score
  - Pediatric Logistic Organ Dysfunction

**Provenienza**  
Core->Informazioni amministrative->Provenienza

Sala chirurgica

☐ Sì

☐ No

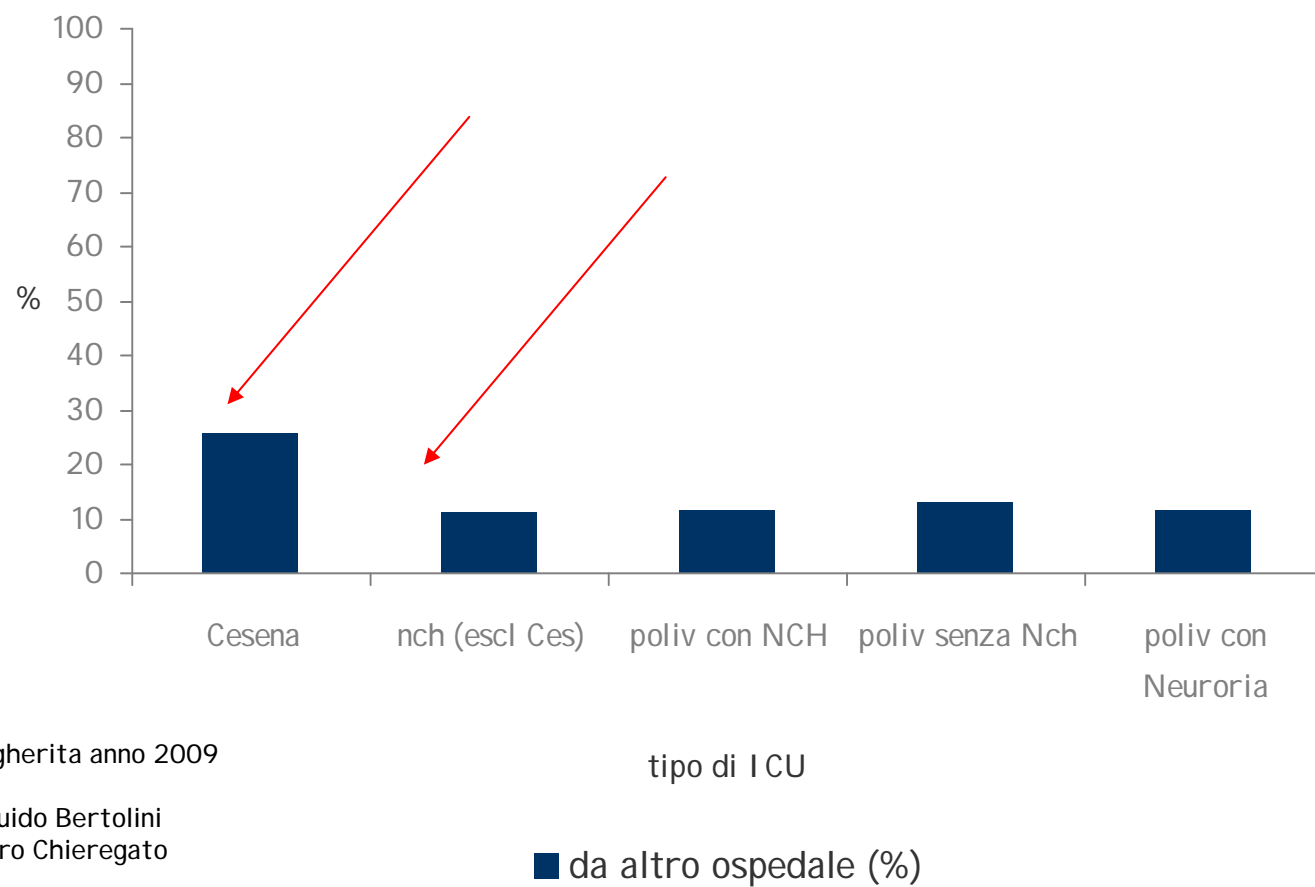
Provenienza

☐ Stesso ospedale

☐ Altro ospedale



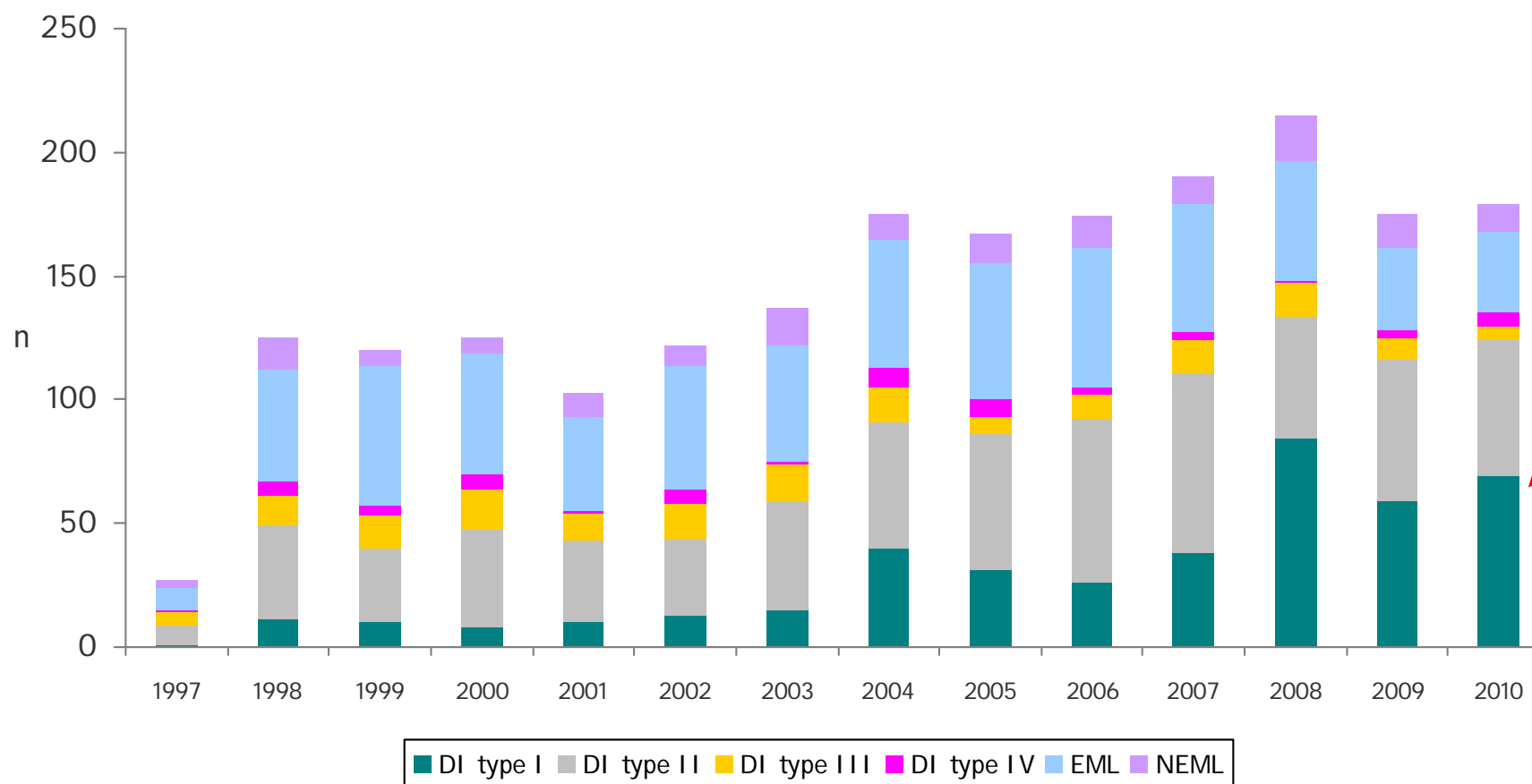
# Secondary referral



Fonte report Margherita anno 2009  
Gruppo GiViTi  
Carlotta Rossi e Guido Bertolini  
Elaborazione Arturo Chiaregato

Worst CT 1997-2010

more negative CT (diffuse injury type I)



# Clinical corner

## type of admission

- Monitor the kind of your admission
  - The TBI will be different
    - diffuse injury
    - extracranial injures
- Organize your dept

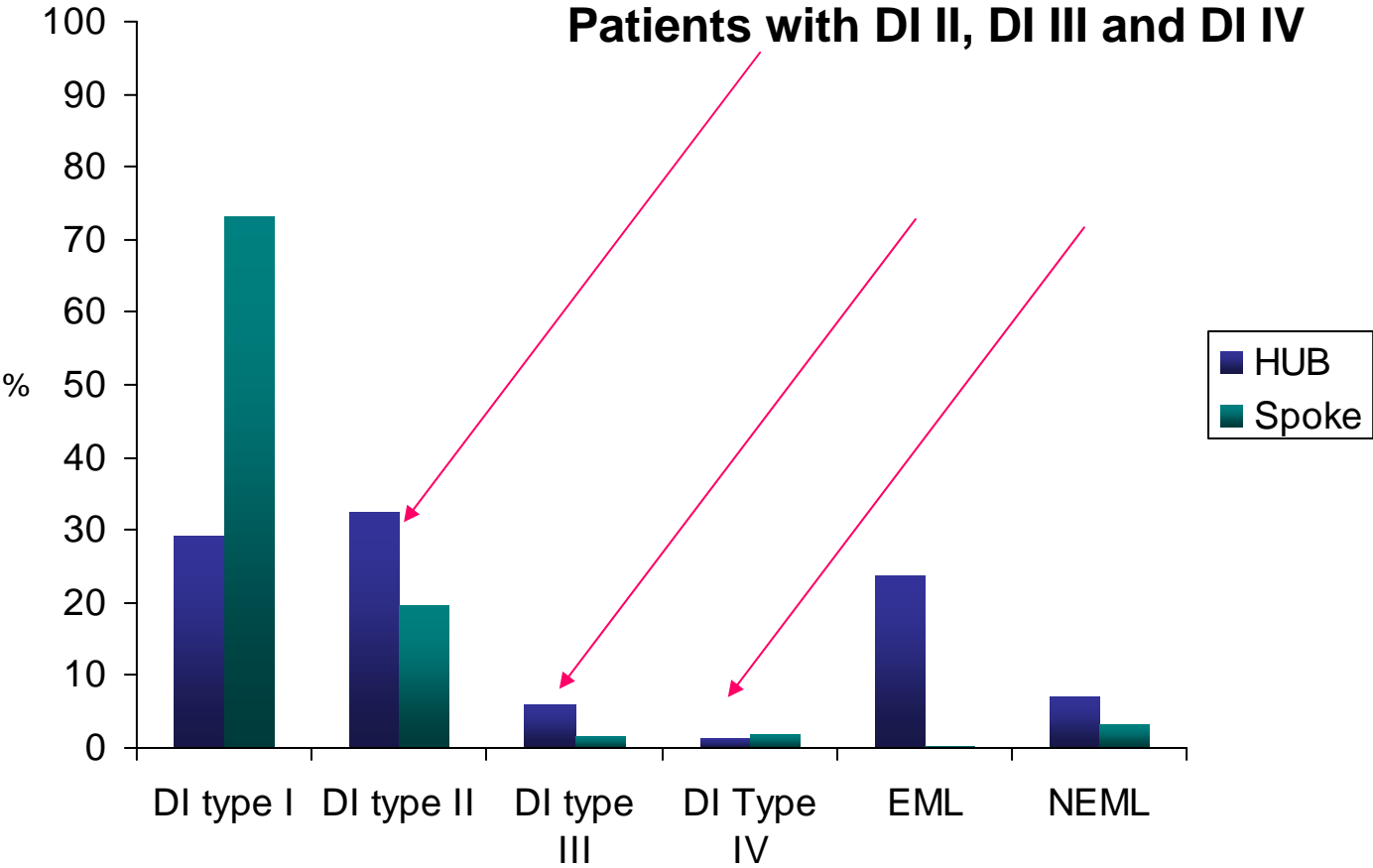
Data from TNet data base (Area Vasta Romagna) and db Neurosole (ICU Cesena) (september 1st 2006 to march 21 2010)

CT

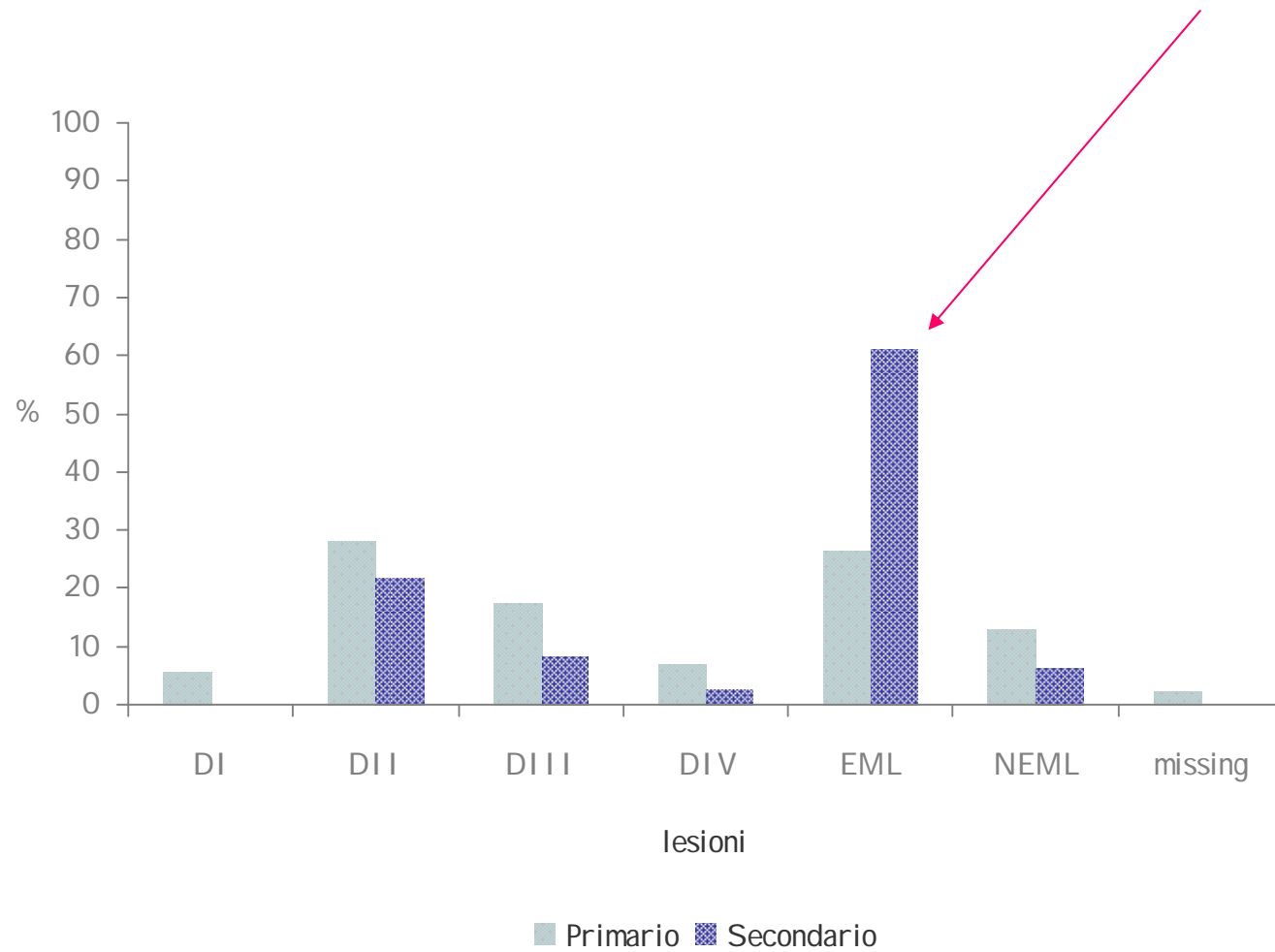
Rows are levels of  
Columns are levels of  
No Selector  
1270 total cases of which 190 are missing

**4\_10 Marshall worst TAC  
Hub/Spoke**

	hub	spoke	total
<b>1.TC negativa</b>	191	312	503
	29.2	73.2	46.6
<b>2.Lesione diffusa tipo II</b>	212	84	296
	32.4	19.7	27.4
<b>3.Swelling</b>	40	7	47
	6.12	1.64	4.35
<b>4.Swelling e shift</b>	9	8	17
	1.38	1.88	1.57
<b>5.Massa evacuata</b>	155	1	156
	23.7	0.235	14.4
<b>6.Massa non evacuata</b>	47	14	61
	7.19	3.29	5.65
<b>total</b>	654	426	1080
	100	100	100

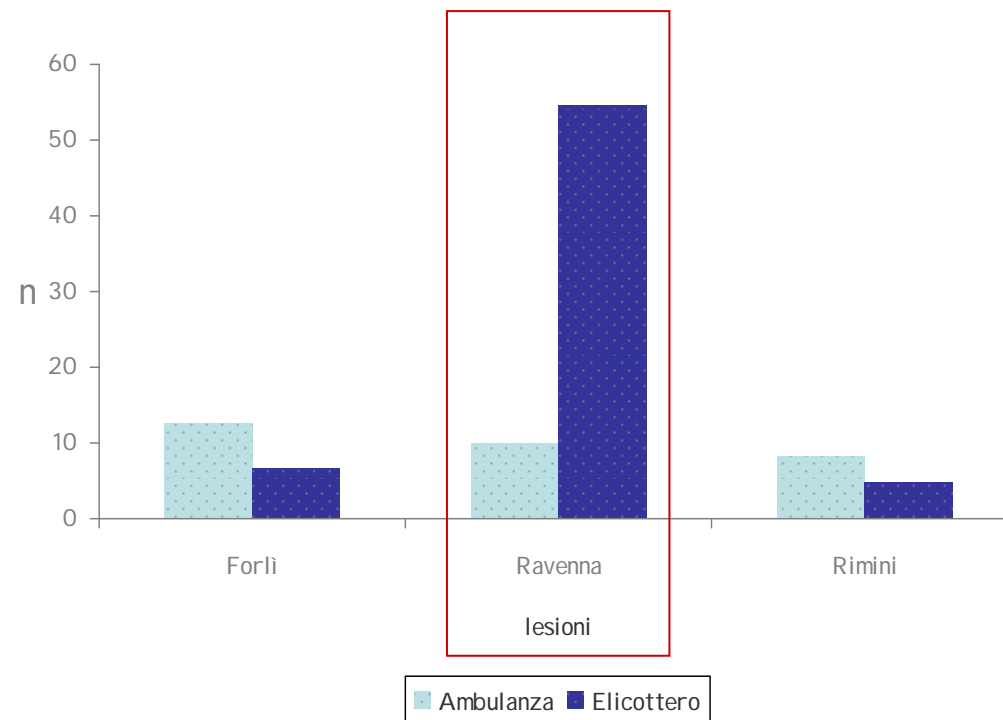


worst CT  
Cesena severe HI, 382 patients  
2003-2007

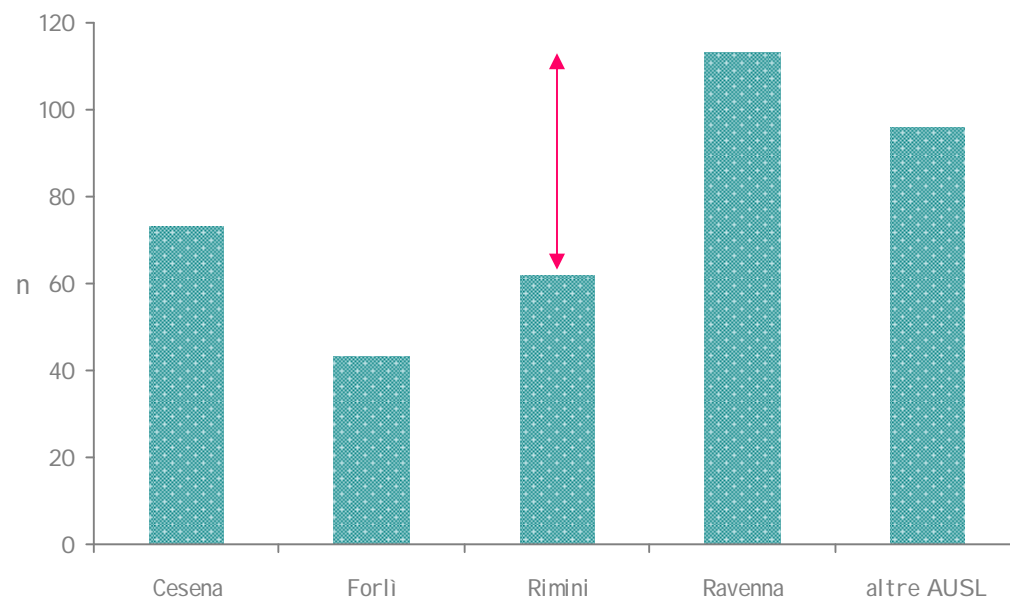




# Direct referral, type of transport Severe TBI 2003-2007 217 patients



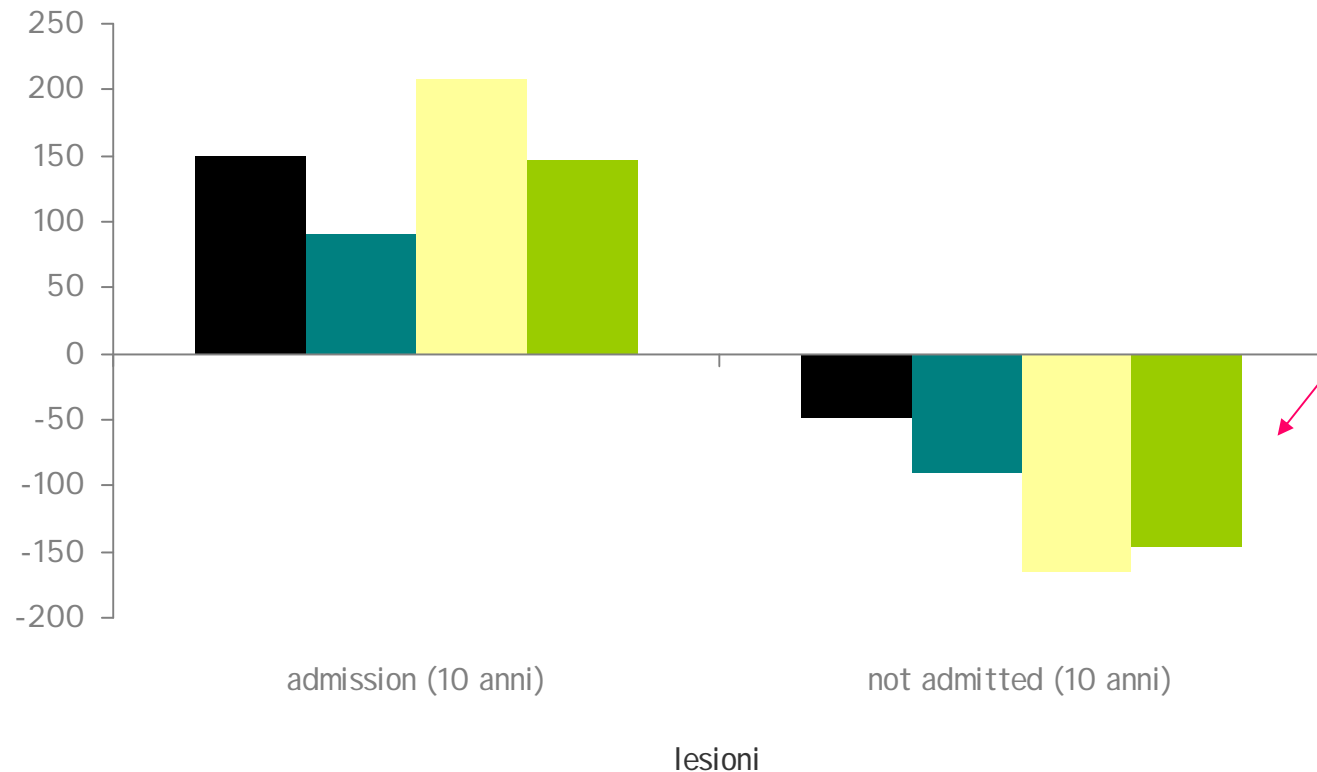
# Area Vasta Romagna admission per AUSL Severe TBI 2003-2007 217 patients



# Severe TBI 2003-2007

217 patients

admission indexed for AUSL and an estimate of patients  
not admitted



■ somma Cesena ■ somma Forlì ■ somma Ravenna ■ somma Rimini

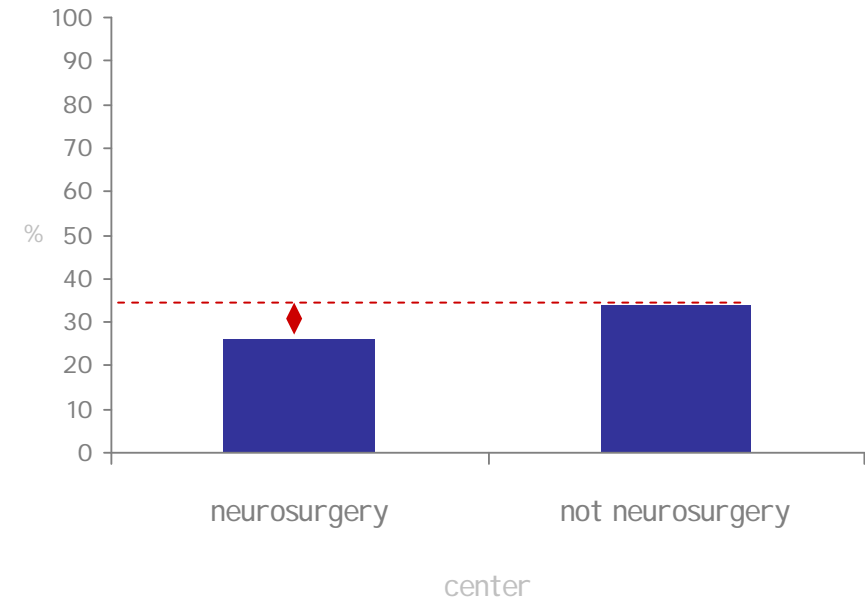
# Diffuse injury

## Mortality in specialized center seems lower

	All SHI patients n=6921 (age 16–65)	
	Neurosurgical centres	Non-neurosurgical centres
Number of patients	4616	2305
Age (years, median, IQR)	28 (16–48)	34 (20–58)
Male (% , 95% CI)	3448 (75%, 73–76)	1642 (71%, 69–73)
ISS (median, IQR)	25 (18–33)	26 (18–35)
GCS (median, IQR)	3 (3–6)	4 (3–6)
Isolated head injury (95% CI)	2054 (44%, 43–46)	899 (39%, 37–41)
SBP <90 mm Hg (95% CI)	383 (8%, 8–9)	434 (19%, 17–20)
Transferred (95% CI)	2665 (58%, 56–59)	302 (13%, 12–14)
Deaths (95% CI)	1624 (35%, 34–37)	1406 (61%, 59–63)
Isolated, non-surgical SHI n=894 (age 16–65)		
Number of patients	552	342
Age (years, median, IQR)	33 (23–47)	31 (22–46)
ISS (median, IQR)	16 (10–25)	16 (10–25)
GCS (median, IQR)	4 (3–7)	5 (3–7)
SBP <90 mm Hg (% , 95% CI)	21 (4%, 2–5)	29 (9%, 6–12)
Patients transferred (% , 95% CI)	311 (56%, 52–60)	23 (7%, 4–9)
Deaths (% , 95% CI)	147 (26%, 22–29)	118 (34%, 29–40)

SHI=severe head injury. GCS=Glasgow coma score. SBP=systolic blood pressure.

**Table 2: Patient characteristics after severe head injury according to treatment centre**



Trends in head injury outcome from 1989 to 2003 and the effect of neurosurgical care: an observational study

H C Patel, O Boscarro, M Woodford, A T King, D W Yates, F E Ledy, on behalf of the Trauma Audit and Research Network

Lancet 2005; 366: 1538–44 Background Case fatality rates after all types of blunt injury have not improved since 1994 in England and Wales.

# Extracranial injury and centralization patients with AISc and AISmax extracranial >3

Rows are levels of  
Columns are levels of  
No Selector  
1270 total cases of which 99 are missing

	hub	spoke	total
<b>no</b>	522 67.4	318 80.3	840 71.7
<b>si</b>	253 32.6	78 19.7	331 28.3
<b>total</b>	775 100	396 100	1171 100

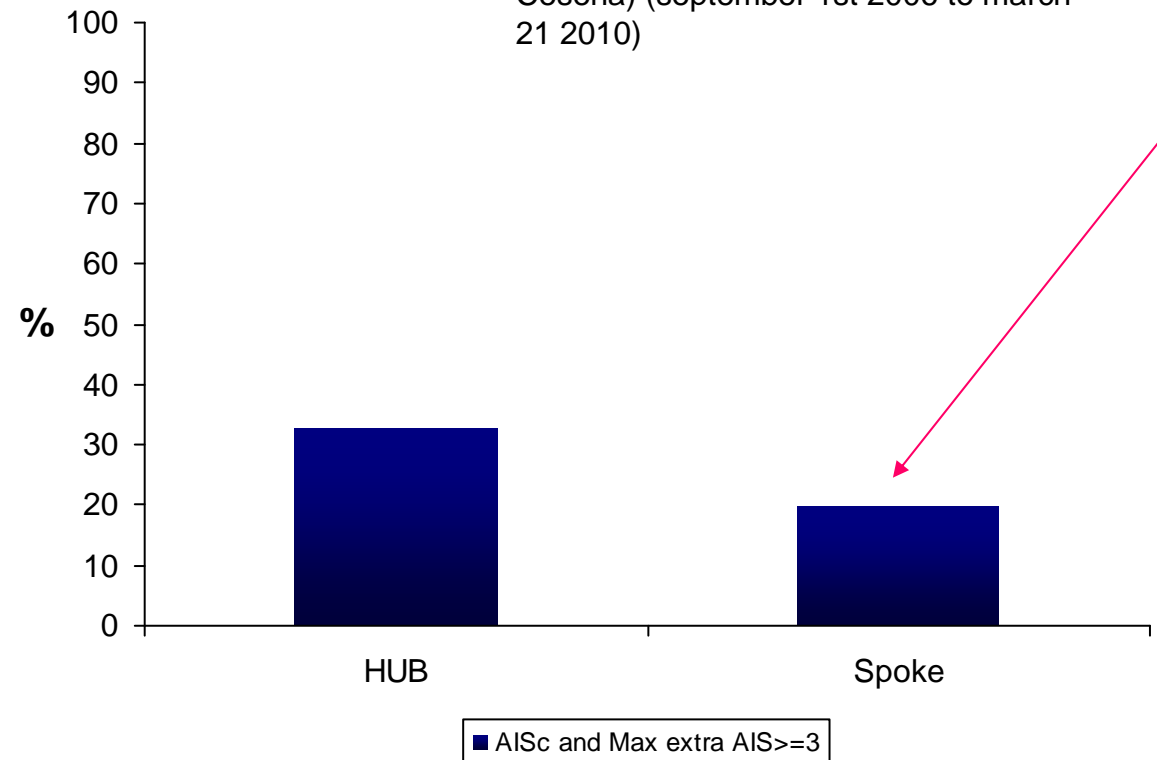
## table contents:

Count  
Percent of Column Total

Chi-square = 21.67 with 1 df  
p ≤ 0.0001

Fisher Exact Test:  
≤ 0.0001

**maxExtraeAISc>=3**  
**Hub/Spoke**



Data from TNet data base  
(Area Vasta Romagna)  
and db Neurosole (ICU  
Cesena) (september 1st  
2006 to march 21 2010)

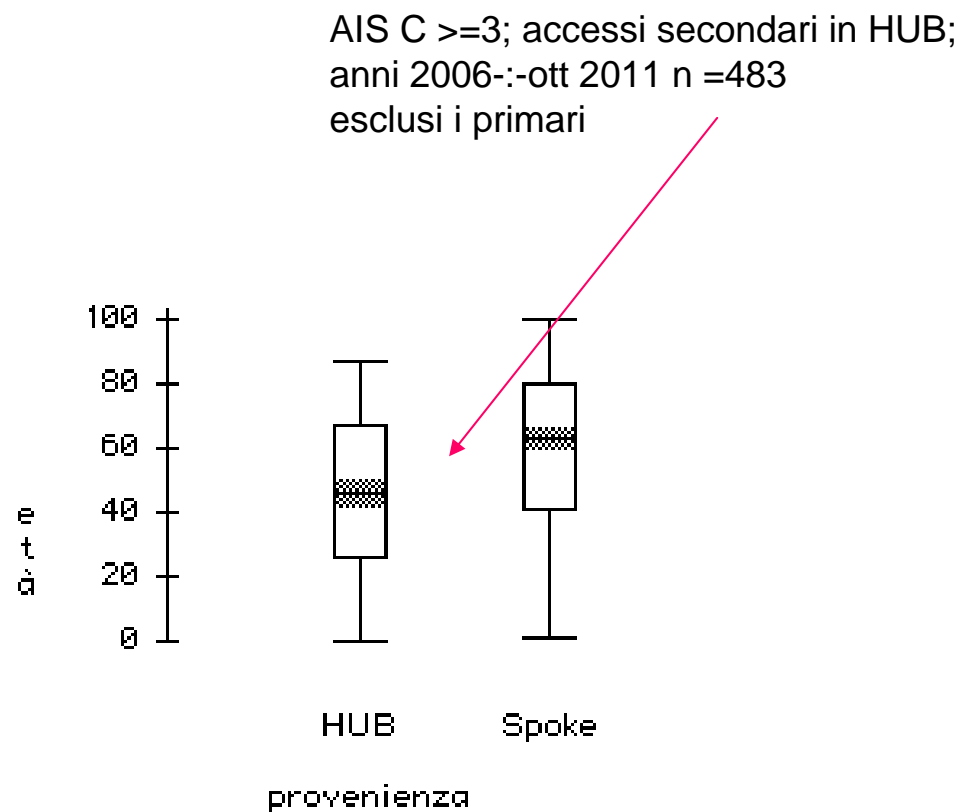
# Age and trauma system

## AI<sub>Sc</sub> ≥ 3

Summary of  
For categories in  
No Selector  
482 total cases of which 1 is missing

Group	Count	Mean	Median	StdDev	Int QRange
HUB	191	46.9162	46	23.269	40.75
Spoke	290	59.5655	63	23.055	39

età  
provenienza



Data from TNet data base  
(Area Vasta Romagna) and  
db Neurosole (ICU Cesena)  
(september 1st 2006 to  
march 21 2010)

# Comorbidities and admission

Rows are levels of  
Columns are levels of  
No Selector

Apache  
provenienza

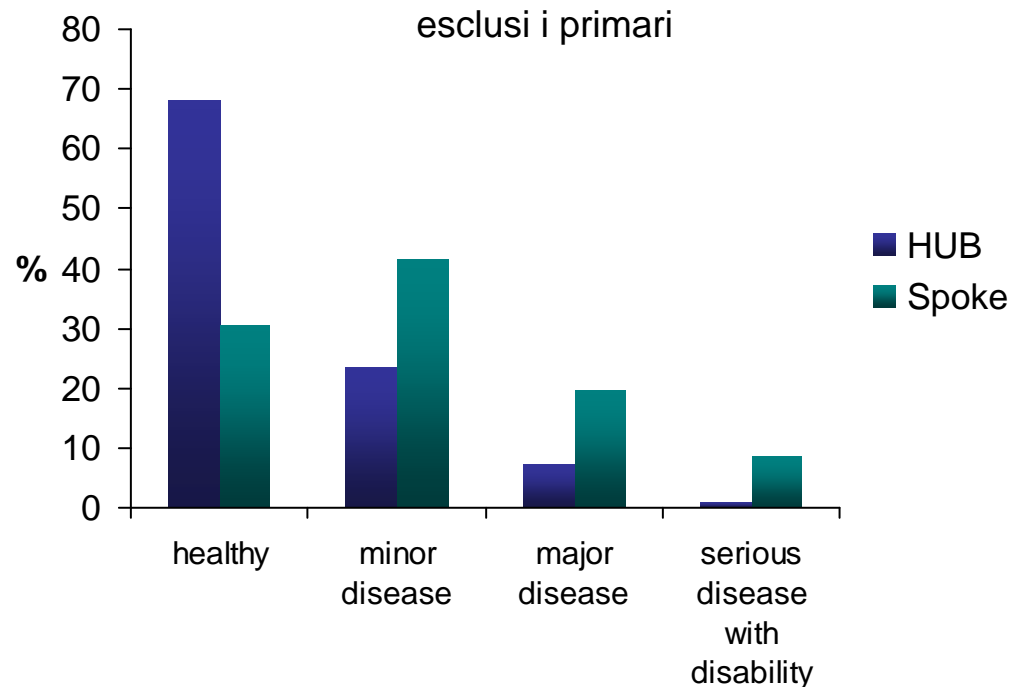
482 total cases of which 173 are missing

	HUB	Spoke	total
<b>1.Sano</b>	130 68.1	36 30.5	166 53.7
<b>2.Patologia minore</b>	45 23.6	49 41.5	94 30.4
<b>3.Patologia seria</b>	14 7.33	23 19.5	37 12
<b>4.Patologia invalidante</b>	2 1.05	10 8.47	12 3.88
<b>total</b>	191 100	118 100	309 100

table contents:

Count  
Percent of Column Total

AIS C  $\geq 3$ ; accessi secondari in HUB;  
anni 2006:-ott 2011 n =483  
esclusi i primari





# Clinical corner provenienza

- Monitor your trauma system
  - Telemedicine
  - elicotter
- Consider the patients not admitted
  - They should be with diffuse TBI
    - Sec damage/rehabilitation plan
  - Or with multiple injuries
    - Survival/sec damage
  - Aged patients or with comorbidities



# Comorbidities (core)



## Comorbidità

Core->Ammissione->Comorbidità

Comorbidità

☐ Nessuno

**Respiratorie**

☐ Asma

☐ Broncodisplasia

☐ Malattie polmonari restrittive

☐ Anomalie alte vie respiratorie

☐ Anomalie basse vie respiratorie

☐ Malformazioni polmonari

**Cardiovascolari**

☐ Ipertensione sistemica

☐ Infarto miocardico

☐ Aritmia

☐ Miocardite

☐ Miocardiopatia

☐ Valvulopatia non congenita

☐ Cardiopatia congenita

☐ Ipertensione polmonare

☐ Malattia vascolare periferica

**Neurologiche**

☐ Encefalopatia

☐ Vasculopatia cerebrale

☐ Emiplegia o paraplegia o tetraplegia

☐ Malattia neuromuscolare/neurodegenerativa

☐ Idrocefalo

☐ Malformazioni cerebrali o della teca cranica

**Gastroenteriche**

☐ Ulcera peptica

☐ Enterocolite necrotizzante

☐ Malformazioni gastroenteriche

☐ Malformazioni gastroenteriche operate

☐ Epatopatia lieve

☐ Epatopatia moderata o grave

**Renali**

☐ Insufficienza Renale moderata o grave

☐ Insufficienza renale terminale

**Endocrine**

☐ Diabete Tipo I

☐ Diabete Tipo II senza terapia insulinica

☐ Diabete Tipo II con terapia insulinica

**Neoplastiche**

☐ Tumore senza metastasi

☐ Tumore metastatizzato

☐ Malattie ematologiche maligne

**Altro**

☐ Coagulopatie da farmaci

☐ Disturbo della coagulazione

☐ Malattie autoimmuni

☐ Immunosoppressione

☐ Immunodeficienza congenita

☐ AIDS

☐ Malnutrizione grave

☐ Aplasia midollare

☐ Retinopatia

☐ Malattie endocrino-metaboliche

☐ Miopatia

☐ Malformazioni/disturbi scheletrici

☐ Malattie genetiche

☐ Anomalia cromosomica

Note sulle comorbidità

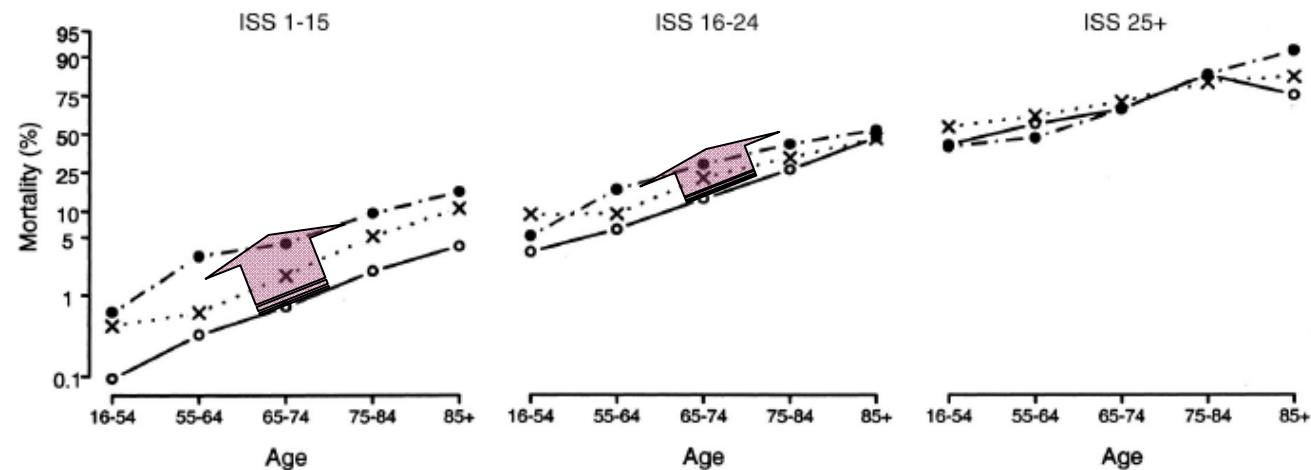
# Comorbidity in Injury and mortality

The Journal of TRAUMA® Injury, Infection, and Critical Care

## The Effect of Pre-Existing Medical Conditions and Age on Mortality After Injury

Sally Hollis, MSc, Fiona Lecky, MD, David W. Yates, MD, and Maralyn Woodford, BSc

*J Trauma.* 2006;61:1255–1260.




**Fig. 1.** The effect of age, and pre-existing medical conditions on mortality, by anatomical injury severity (ISS). PMC status is indicated by symbol and line type (no PMCs, open circle with solid line; unrecorded PMC status, x with dotted line; PMC present, closed circle with dotted line). Mortality is plotted on a log-odds scale so change in the vertical direction is proportional to the log-odds ratio for mortality.

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# Clinical corner comorbidities

- Admission criteria
  - Cross linked with age
- Influence the case mix of patients admitted

# Anticoagulants (core)



## Comorbidità

Core->Ammissione->Comorbidità

Comorbidità

☐ Nessuno

**Respiratorie**

☐ Asma

☐ Broncodisplasia

☐ Malattie polmonari restrittive

☐ Anomalie alte vie respiratorie

☐ Anomalie basse vie respiratorie

☐ Malformazioni polmonari

**Cardiovascolari**

☐ Ipertensione sistemica

☐ Infarto miocardico

☐ Aritmia

☐ Miocardite

☐ Miocardiopatia

☐ Valvulopatia non congenita

☐ Cardiopatia congenita

☐ Ipertensione polmonare

☐ Malattia vascolare periferica

**Neurologiche**

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**Gastroenteriche**

☐ Ulcera peptica

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☐ Malformazioni gastroenteriche

☐ Malformazioni gastroenteriche operate

☐ Epatopatia lieve

☐ Epatopatia moderata o grave

**Renali**

☐ Insufficienza Renale moderata o grave

☐ Insufficienza renale terminale

**Endocrine**

☐ Diabete Tipo I

☐ Diabete Tipo II senza terapia insulinica

☐ Diabete Tipo II con terapia insulinica

**Neoplastiche**

☐ Tumore senza metastasi

☐ Tumore metastatizzato

☐ Malattie ematologiche maligne

**Altro**

☐ Coagulopatie da farmaci

☐ Disturbo della coagulazione

☐ Malattie autoimmuni

☐ Immunosoppressione

☐ Immunodeficienza congenita

☐ AIDS

☐ Malnutrizione grave

☐ Aplasia midollare

☐ Retinopatia

☐ Malattie endocrino-metaboliche

☐ Miopatia

☐ Malformazioni/disturbi scheletrici

☐ Malattie genetiche

☐ Anomalia cromosomica

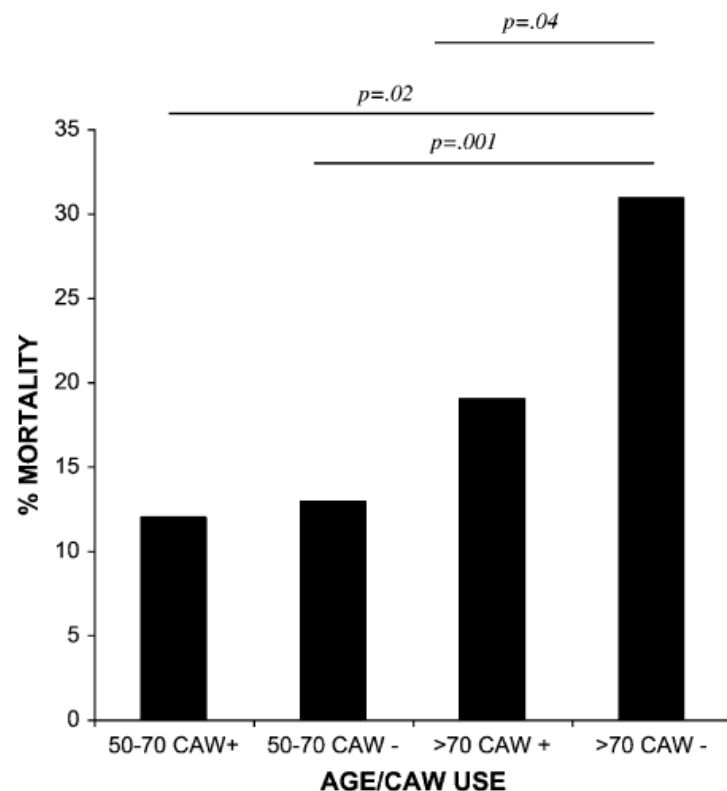
Note sulle comorbidità

The impact of preinjury antiplatelet and anticoagulant pharmacotherapy on outcomes in elderly patients with hemorrhagic brain injury

Gerald R. Fortuna, MD,\* Eric W. Mueller, PharmD,<sup>b</sup> Laura E. James, MS,\* Lori A. Shutter, MD,\* and Karyn L. Butler, MD,<sup>a,d,e</sup> Cincinnati, Ohio

(*Surgery* 2008;144:598-605.)

# Antiplatelets (proSafe core since 2012)



**Fig 1.** Percent mortality was significantly higher in older patients compared with younger patients irrespective of CAW use.

**Table IV.** Multivariate logistic regression for effect on mortality

Variable	Odds Ratio	95% Wald confidence limits	
Age	1.07	1.03	1.10
Gender	0.74	0.38	1.46
ISS	1.04	1.01	1.08
GCS	0.75	0.69	0.81
CAW	0.56	0.28	1.14

Hosmer–Lemeshow goodness-of-fit statistic:  $P = .70$ .

CAW, Clopidogrel, aspirin, warfarin; GCS, Glasgow Coma Score; ISS, Injury Severity Score.

# Clinical corner

## anticoagulant/antiplatelets

- Anticoagulants
  - Revert with prothrombin complex
    - Multiple injury, revert with fresh frozen plasma
- Antiplateletes
  - unclear

# Type of trauma

# Type of TBI (petalo)



## Caratteristiche del Trauma

Neurologia->Trauma cranico->Caratteristiche del Trauma

### Tipologia di trauma cranico

- ☐ Chiuso
- ☐ Penetrante
- ☐ Blast
- ☐ Crash

### Dinamica del Trauma

- ☐ Accidentale
- ☐ Autoaggressione
- ☐ Autolesione
- ☐ Violenza
- ☐ Altro

### Luogo

- ☐ Luogo pubblico
- ☐ Ambiente domestico
- ☐ Incidente sul lavoro
- ☐ Sport/Ricreazione



# Dynamic of trauma (petalo)



## Caratteristiche del Trauma

Neurologia->Trauma cranico->Caratteristiche del Trauma

### Tipologia di trauma cranico

- ☐ Chiuso
- ☐ Penetrante
- ☐ Blast
- ☐ Crash

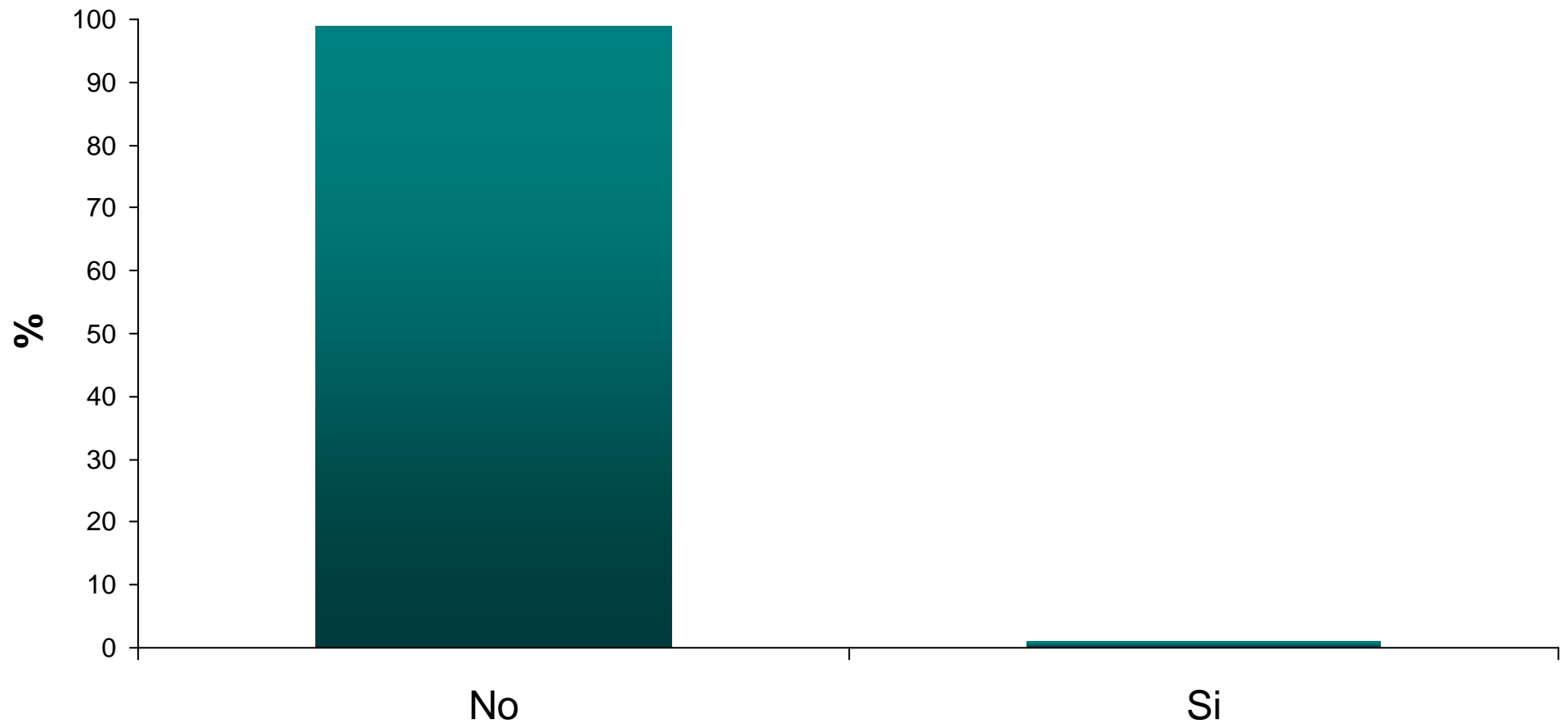
### Dinamica del Trauma

- ☐ Accidentale
- ☐ Autoaggressione
- ☐ Autolesione
- ☐ Violenza
- ☐ Altro

### Luogo

- ☐ Luogo pubblico
- ☐ Ambiente domestico
- ☐ Incidente sul lavoro
- ☐ Sport/Ricreazione

# Penetrating TBI Cesena 1997-2011 1975 TBI patients



# Site (petalo)



## Caratteristiche del Trauma

Neurologia->Trauma cranico->Caratteristiche del Trauma

### Tipologia di trauma cranico

- ☐ Chiuso
- ☐ Penetrante
- ☐ Blast
- ☐ Crash

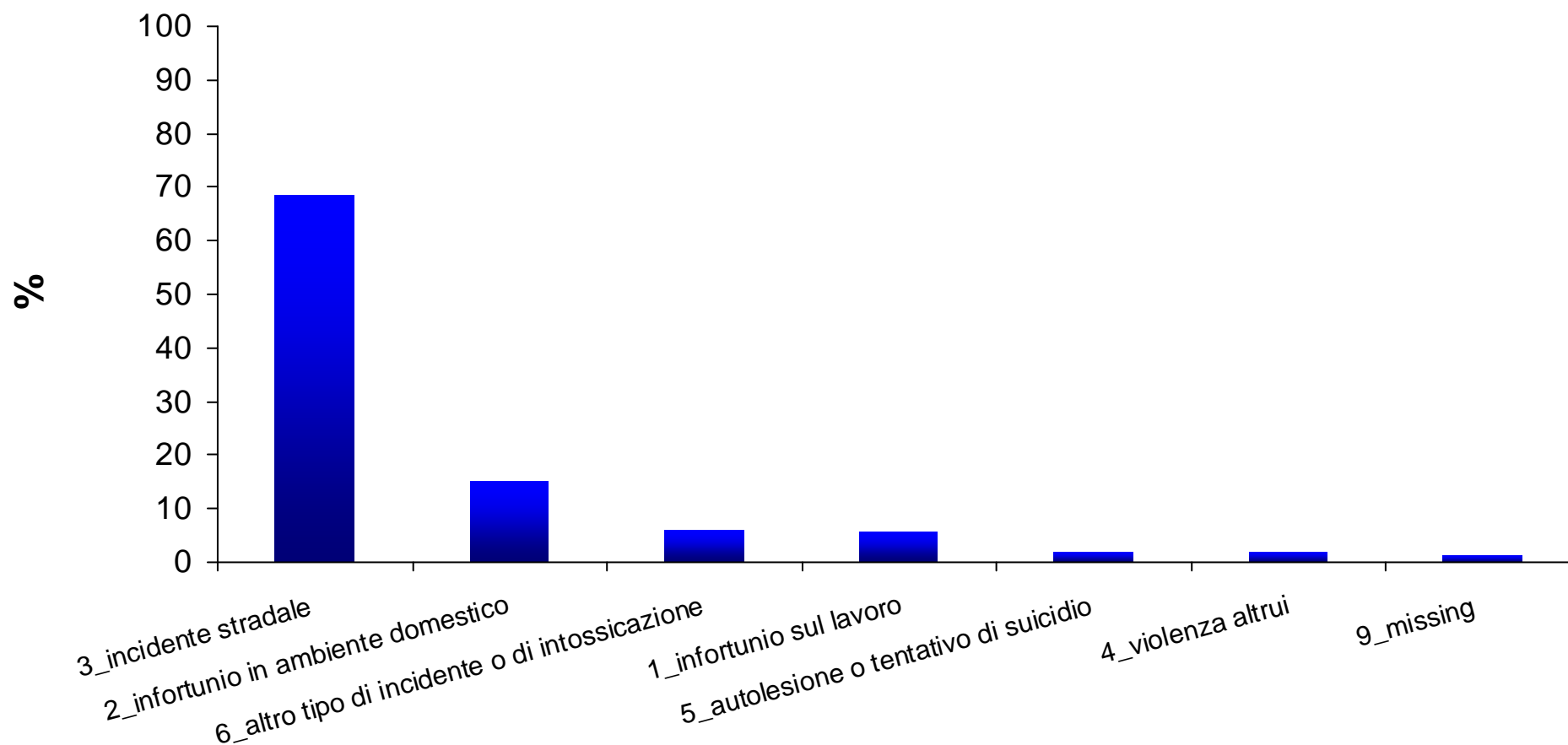
### Dinamica del Trauma

- ☐ Accidentale
- ☐ Autoaggressione
- ☐ Autolesione
- ☐ Violenza
- ☐ Altro

### Luogo

- ☐ Luogo pubblico
- ☐ Ambiente domestico
- ☐ Incidente sul lavoro
- ☐ Sport/Ricreazione

# Circostanze trauma 1952 TBI Cesena 1997-2011



# Fall is associated with ageing

JOURNAL OF NEUROTRAUMA  
Volume 24, Number 2, 2007  
© Mary Ann Liebert, Inc.  
Pp. 281–286  
DOI: 10.1089/neu.2006.0030

## Prognostic Value of Cause of Injury in Traumatic Brain Injury: Results from the IMPACT Study

ISABELLA BUTCHER,<sup>1</sup> GILLIAN S. McHUGH,<sup>1</sup> JUAN LU,<sup>2</sup> EWOUT W. STEYERBERG,<sup>3</sup>  
ADRIÁN V. HERNÁNDEZ,<sup>3</sup> NINO MUSHKUDIANI,<sup>3</sup> ANDREW L.R. MAAS,<sup>4</sup>  
ANTHONY MARMAROU,<sup>2</sup> and GORDON D. MURRAY<sup>1</sup>

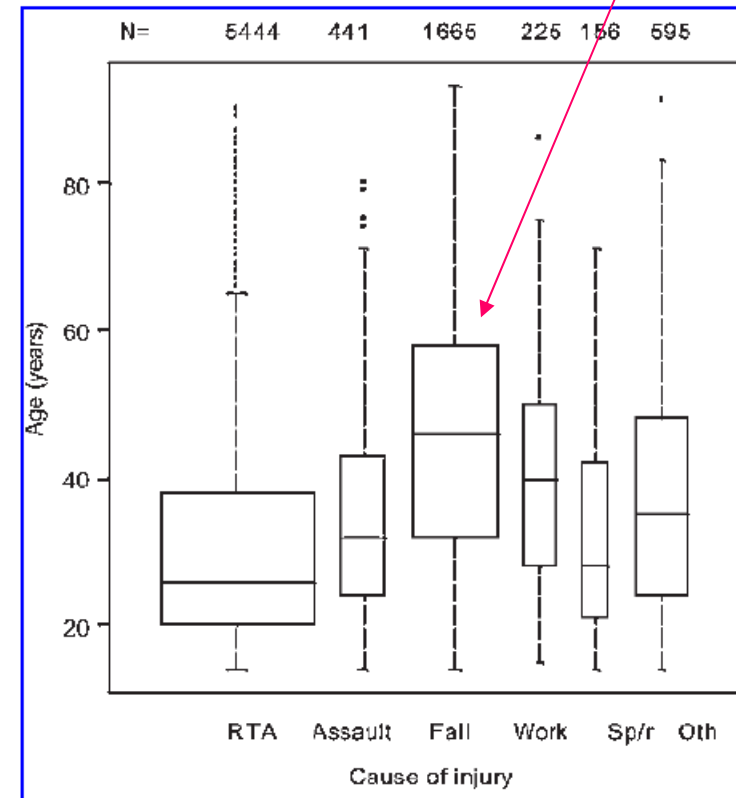


FIG. 2. Box plot of patient age by cause of injury category for cases with age of  $\geq 14$  years and non-missing outcome ( $n = 8526$ ).

# Fall is not and independent predictor

## Prognostic Value of Cause of Injury in Traumatic Brain Injury: Results from the IMPACT Study

ISABELLA BUTCHER,<sup>1</sup> GILLIAN S. McHUGH,<sup>1</sup> JUAN LU,<sup>2</sup> EWOUT W. STEYERBERG,<sup>3</sup>  
ADRIÁN V. HERNÁNDEZ,<sup>3</sup> NINO MUSHKUDIANI,<sup>3</sup> ANDREW I.R. MAAS,<sup>4</sup>  
ANTHONY MARMAROU,<sup>2</sup> and GORDON D. MURRAY<sup>1</sup>

### CONCLUSION

Patients sustaining TBI from falls are more likely to have poorer outcomes than from other external causes, but this relationship can be explained by associations with age. We conclude that from a prognostic perspective, cause of injury is not an independent predictor and should not be included in prognostic models. From a clinical perspective, however, falls as the cause of injury should alert clinicians to an increased risk of mass lesions.

TABLE 2. STRENGTH OF RELATIONSHIP BETWEEN CAUSE OF INJURY AND OUTCOME

	<i>RTA</i>	<i>Assault</i>	<i>Work-related</i>	<i>Sports/recreation</i>	<i>Other</i>
Dichotomous OR					
Less than good vs. good recovery	0.71 (0.63–0.81)	0.71 (0.54–0.93)	1.06 (0.71–1.60)	0.41 (0.25–0.66)	0.97 (0.76–1.23)
Unfavorable vs. favorable outcome	0.68 (0.60–0.76)	0.65 (0.46–0.92)	0.73 (0.54–1.00)	0.45 (0.29–0.71)	0.95 (0.77–1.16)
Dead/vegetative vs. conscious survival	0.60 (0.53–0.68)	0.57 (0.45–0.72)	0.84 (0.62–1.15)	0.42 (0.25–0.71)	0.81 (0.66–1.01)
Dead vs. alive	0.54 (0.48–0.61)	0.56 (0.44–0.71)	0.84 (0.61–1.16)	0.40 (0.23–0.71)	0.78 (0.63–0.98)
Proportional OR					
Unadjusted	0.66 (0.60–0.73)	0.66 (0.52–0.84)	0.88 (0.68–1.14)	0.45 (0.28–0.71)	0.91 (0.76–1.09)
Adjusted for age	1.08 (0.96–1.21)	1.03 (0.76–1.40)	1.21 (0.91–1.63)	0.74 (0.51–1.09)	1.06 (0.87–1.29)

RTA, road traffic accident.

Odds ratios (OR) are calculated for Glasgow Outcome Scale (GOS) categorized as less than good recovery (D/V/SD/MD vs. GR), unfavorable outcome (D/V/SD vs. MD/GR), death/vegetative state versus conscious survival (D/V vs. SD/MD/GR), mortality (D vs. V/SD/MD/GR), as well as with a proportional odds model (unadjusted and adjusted for age), with their 95% confidence intervals. Odds ratios refer to the comparison of causes of injury relative to the reference category “fall.”



## Clinical corner type of trauma

- Consider dynamic of injury
  - Association elderly/fall/focal lesion
  - Association young age/diffuse injury

# Prehospital phase



# Date and hour of operating room call (petalo)



## Fase preospedaliera

Neurologia->Trauma cranico->Fase preospedaliera

Soccorso da 118 ? ☒ SI ☐ NO

Data chiamata centrale  ☐ Dato non disponibile

Ore chiamata centrale  ☐ Dato non disponibile

☐ Valore normale:

GCS Occhi aperti (GCS <sub>e</sub> preH)	GCS Miglior risposta verbale (GCS <sub>v</sub> preH)	GCS Migliore risposta motoria (GCS <sub>m</sub> preH)
<input type="checkbox"/> Dato non disponibile	<input type="checkbox"/> Dato non disponibile	<input type="checkbox"/> Dato non disponibile
<input type="radio"/> Apertura spontanea (4)	<input type="radio"/> Appropriata (5)	<input type="radio"/> Al comando verbale obbedisce (6)
<input type="radio"/> Apertura a comando (3)	<input type="radio"/> Confusa (4)	<input type="radio"/> Allo stimolo doloroso localizza la sede del dolore (5)
<input type="radio"/> Apertura al dolore (2)	<input type="radio"/> Parole inappropriate (3)	<input type="radio"/> Allo stimolo doloroso flette-si ritra (4)
<input type="radio"/> Nessuna risposta (1)	<input type="radio"/> Suoni incomprensibili (2)	<input type="radio"/> Allo stimolo doloroso flette in modo anormale (3)
	<input checked="" type="radio"/> Nessuna risposta (1)	<input type="radio"/> Allo stimolo doloroso estende (2)
		<input type="radio"/> Nessuna risposta (1)

# Date and hour of operating room call (petalo)

Injury, Int. J. Care Injured (2007) 38, 305–311



**INJURY**  
INTERNATIONAL JOURNAL OF THE CARE OF THE INJURED

www.elsevier.com/locate/injury

## Are pre-hospital time and emergency department disposition time useful process indicators for trauma care in Italy?

Stefano Di Bartolomeo<sup>a,\*</sup>, Francesca Valent<sup>a</sup>, Valentina Rosolen<sup>a</sup>,  
Gianfranco Sanson<sup>b</sup>, Giuseppe Nardi<sup>c</sup>, Francesco Cancellieri<sup>d</sup>,  
Fabio Barbone<sup>a</sup>

**Conclusion:** Although PT and EDt were significantly shorter in the hospital with best outcome performances, we could not confirm at the patient level their expected independent association with outcome. More evidence is needed before these indicators can be validated as standard tools for system analysis in our setting.

Table 3 Adjusted effects of the PI variables on mortality, GOS, and EQ5D

	Point estimate	95% CI
Logistic regression (dependent variable: mortality)		
Pre-hospital interval. OR for 10-min increase	1.03	0.90–1.17
ED disposition time. OR for 20-min increase	0.94	0.87–1.02
Logistic regression (dependent variable: GOS = bad)		
Pre-hospital interval. OR for 10-minute increase	0.95	0.80–1.14
ED disposition time. OR for 20-minute increase	0.95	0.86–1.05
Linear regression (dependent variable: EQ5D)		
Regression coefficient Pre-hospital interval	0.00004	–0.00026 to 0.00034
Regression coefficient ED disposition time	0.00003	–0.00017 to 0.00023

GOS: Glasgow Outcome Score; EQ5D: Euroqol 5-D; ED: Emergency Department; Adjusted for age, gender, Injury Severity Score, Abbreviated Injury Scale of the head, Revised Trauma Score, type of trauma, mechanism of injury, co-morbidity, provenience, hospital.

## Clinical corner time (indicator)

- Difficult to find process indicators concerning timing

# Pre hospital GCS total (petalo)

☐ Valore normale:

## GCS Occhi aperti (GCSe preH)

- ☐ Dato non disponibile
- ☐ Apertura spontanea (4)
  - ☐ Apertura a comando (3)
  - ☐ Apertura al dolore (2)
  - ☐ Nessuna risposta (1)

## GCS Miglior risposta verbale(GCSv preH)

- ☐ Dato non disponibile
- ☐ Appropriata (5)
  - ☐ Confusa (4)
  - ☐ Parole inappropriate (3)
  - ☐ Suoni incomprensibili (2)
  - ☐ Nessuna risposta (1)

## GCS Migliore risposta motoria (GCSm preH)

- ☐ Dato non disponibile
- ☐ Al comando verbale obbedisce (6)
  - ☐ Allo stimolo doloroso localizza la sede del dolore (5)
  - ☐ Allo stimolo doloroso flette-si ritra (4)
  - ☐ Allo stimolo doloroso flette in modo anormale (3)
  - ☐ Allo stimolo doloroso estende(2)
  - ☐ Nessuna risposta (1)

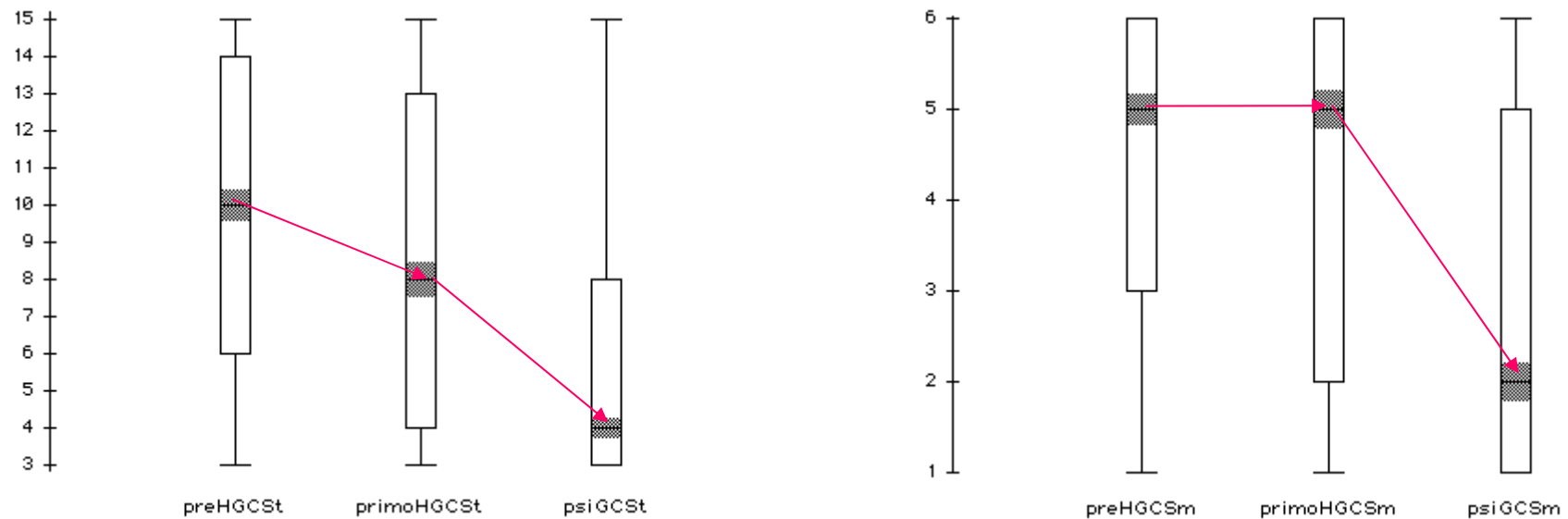
# Pre hospital GCS motor (petalo)

GCS Occhi aperti (GCS <sub>e</sub> preH)	GCS Miglior risposta verbale(GCS <sub>v</sub> preH)	GCS Migliore risposta motoria (GCS <sub>m</sub> preH)
<input checked="" type="checkbox"/> Dato non disponibile	<input checked="" type="checkbox"/> Dato non disponibile	<input type="checkbox"/> Dato non disponibile
		<input type="radio"/> Al comando verbale obbedisce (6)
		<input type="radio"/> Allo stimolo doloroso localizza la sede del dolore (5)
		<input type="radio"/> Allo stimolo doloroso flette-si ritra (4)
		<input type="radio"/> Allo stimolo doloroso flette in modo anormale (3)
		<input type="radio"/> Allo stimolo doloroso estende(2)
		<input type="radio"/> Nessuna risposta (1)
GCS totale (se i parziali non fossero disponibili): <input type="text"/>		

# Total GCS and motor GCS

## 1952 TBI

### Cesena 1997-2011

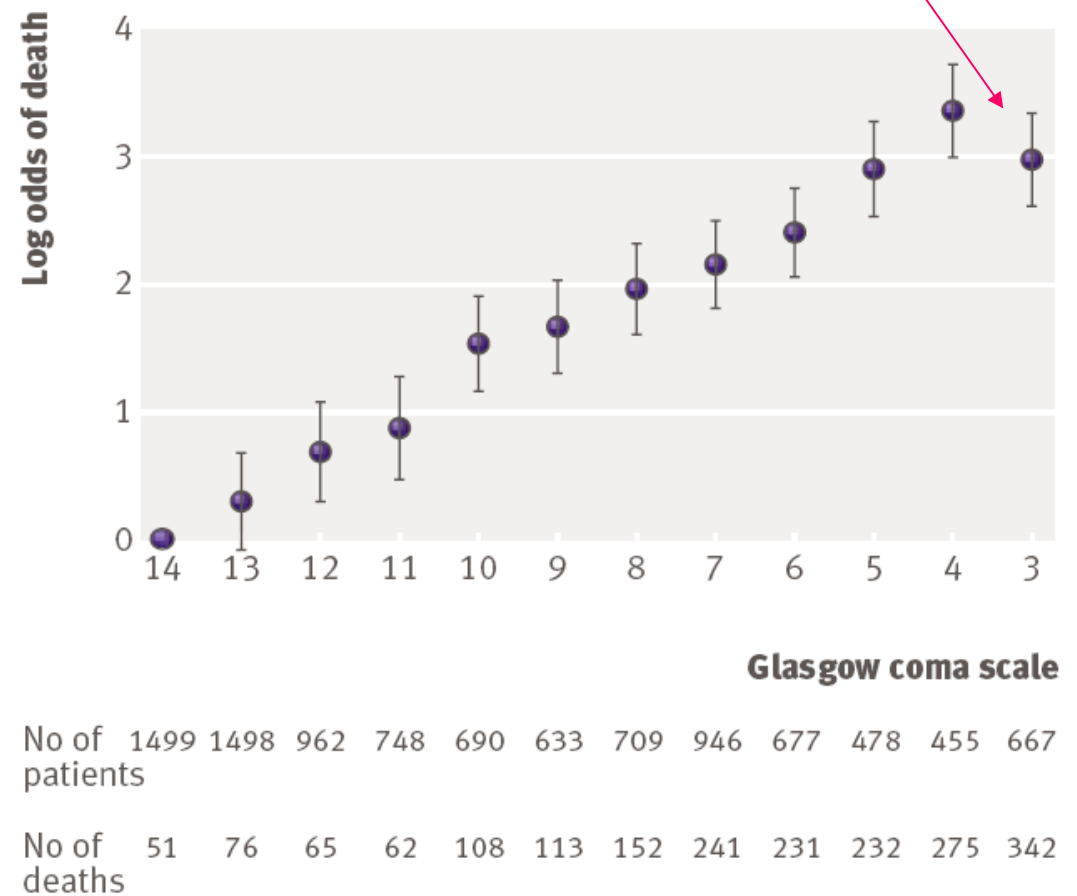


RESEARCH

Predicting outcome after traumatic brain injury: practical prognostic models based on large cohort of international patients

MRC CRASH Trial Collaborators

# GCS 3



**Fig 2** | Relation between Glasgow coma scale and mortality at 14 days

# Diagnostic Value of the Glasgow Coma Scale for Traumatic Brain Injury in 18,002 Patients with Severe Multiple Injuries

Stefan Grote<sup>1</sup>, Wolfgang Böcker<sup>1</sup>, Wolf Mutschler<sup>1</sup>, Bertil Bouillon<sup>2</sup> and Rolf Lefering<sup>3</sup>

# In multiple injuries patients, GCS and anatomical severity may be not correlated

TABLE 2. CHARACTERISTIC OF PRE-HOSPITAL  
UNCONSCIOUSNESS (GCS ≤ 8) TO PREDICT SEVERE TBI

Characteristic	No. of patients	Value [%]	95% CI
Sensitivity	4903/8746	56.1%	[55.0–57.1]
Specificity	7613/9256	82.2%	[81.5–83.0]
Positive PV	4903/6546	74.9%	[73.9–76.0]
Negative PV	7613/11456	66.5%	[65.6–67.3]

Prediction with 95% confidence intervals [95%CI]; PV, predictive value.



# Several years ago “pure” “poststab” GCS reflected damage

J Neurosurg 61:241-253, 1984

Cerebral blood flow and metabolism in comatose patients with acute head injury

Relationship to intracranial hypertension

WALTER D. ORRIST, PH.D., THOMAS W. LANGFITT, M.D., JURG L. JAGGI, M.S., JULIO CRUZ, M.D., AND THOMAS A. GENNARELLI, M.D.

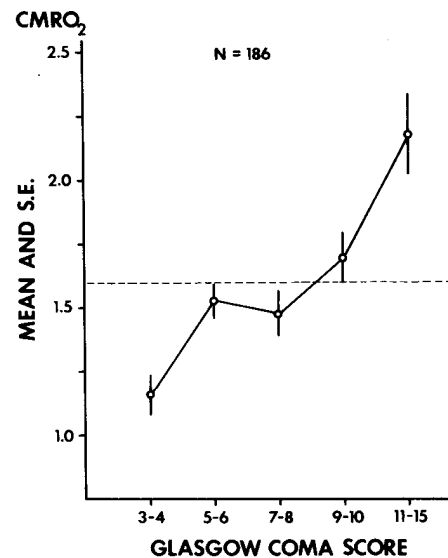


FIG. 1. Mean and standard error (SE) of cerebral metabolic rate (CMRO<sub>2</sub>) plotted against the Glasgow Coma Scale (GCS) score.<sup>70,71</sup> The CMRO<sub>2</sub> is expressed in ml/100 gm/min. The findings are based on 186 studies in 65 patients. The number of observations at each GCS score level is: 36, 74, 34, 30, and 12, respectively, from left to right. Patients with GCS scores of 8 or less had CMRO<sub>2</sub>'s below 1.6 (dashed line), which is less than half of the normal mean value of 3.3 ml/100 gm/min.<sup>28</sup>

28

The Open Neurosurgery Journal, 2010, 3, 28-58

Open Access

A Practical Approach to Interpretation of CBF Measured by Mean of Xenon-CT in Patients with Traumatic Brain Injury

Arturo Chiericato<sup>\*1</sup>, Alessandra Tanfani<sup>1</sup> and Enrico Fainardi<sup>2</sup>

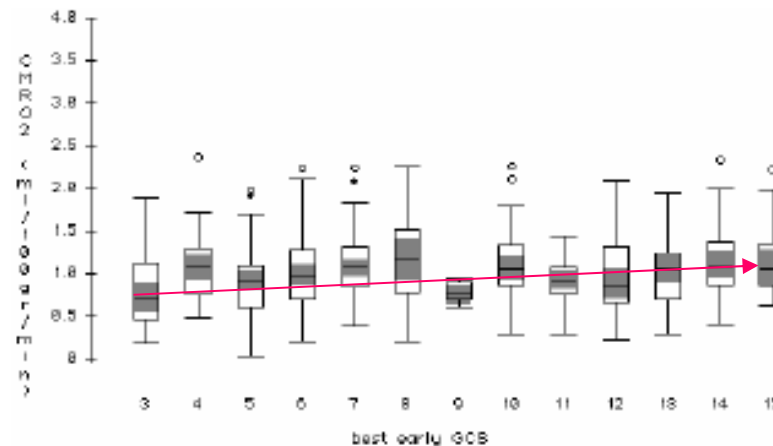


Fig. (27). A slight association has been found among best Glasgow Coma Scale score (GCS) values observed the first day post injury and lower cerebral metabolic rate of oxygen (CMRO<sub>2</sub>) values. Data from 393 Xe-CT studies (unpublished data). Grey rectangles represent the 95% confidence interval for comparing median values.

# GCS 3

## SHORT REPORT

### Predictive value of Glasgow coma scale after brain trauma: change in trend over the past ten years

M Balestreri, M Czosnyka, D A Chatfield, L A Steiner, E A Schmidt, P Smielewski, B Matta,  
J D Pickard

*J Neurol Neurosurg Psychiatry* 2004;75:161-162

**Table 1** Distribution of GCS, GOS, age and correlation between GCS and GOS in the period 1992-2001

Year	Number of patients	GCS median (range)	GOS median (range)	Age mean (SD)	GCS and GOS correlation	p Value
1992	29	4 (3-11)	3 (1-5)	30 (17)	0.55	0.019*
1993	39	6 (3-15)	4 (1-5)	32(15)	0.39	0.015*
1994	40	5 (3-15)	4 (1-5)	30 (13)	0.43	0.006*
1995	33	6 (3-12)	4 (1-5)	34 (16)	0.42	0.016*
1996	43	5 (3-14)	3 (1-5)	33 (17)	0.39	0.011*
1997	31	6 (3-14)	4 (1-5)	37 (17)	0.01	0.978
1998	52	7 (3-14)	4 (1-5)	36 (16)	0.21	0.131
1999	30	7 (3-14)	4 (1-5)	30 (15)	-0.16	0.932
2000	27	7 (3-13)	3 (1-5)	38 (18)	0.00	1.000
2001	36	6 (3-12)	4 (1-5)	39 (16)	0.29	0.087

GCS, Glasgow Coma Scale; GOS, Glasgow Outcome Score.

\*significant correlation.

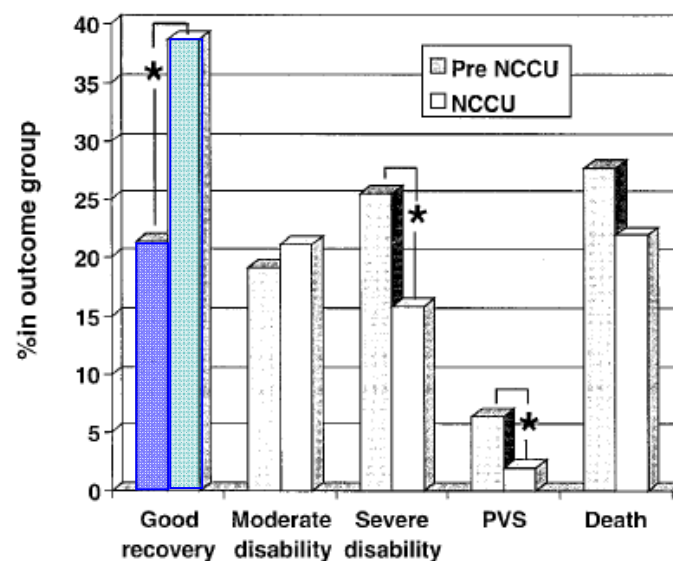


Intensive Care Med (2002) 28:547–553  
DOI 10.1007/s00134-002-1235-4

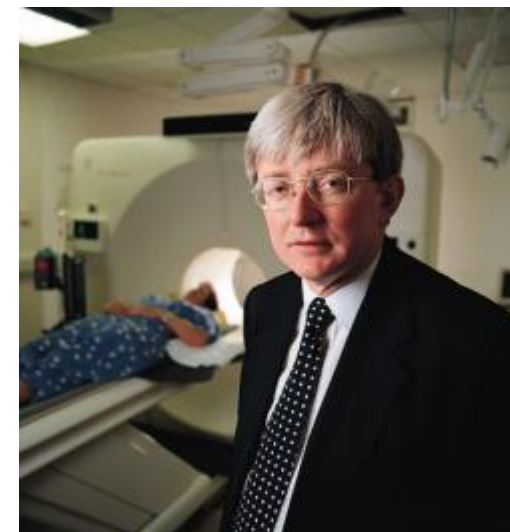
ORIGINAL

Hiren C. Patel  
David K. Menon  
Susan Tebbis  
Rebecca Hawker  
Peter J. Hutchinson  
Peter J. Kirkpatrick

### Specialist neurocritical care and outcome from head injury



**Fig. 3** Outcome in patients with severe head injury (post-resuscitation GCS  $\leq 8$ ); 53 patients were admitted during the pre-NCCU epoch and 129 were treated on NCCU. The median GCS was 5 for both epochs. Patients were also matched for average age ( $33.8 \pm 13.5$  vs.  $33.8 \pm 13.6$ ) ISS (median ISS 25 in both epochs). Outcomes (pre-NCCU vs. post-NCCU): good recovery 21.3% vs. 38.6% ( $p=0.0432$ ); moderate disability 19.1% vs. 21.1%; severe disability/persistent vegetative state 31.9% vs. 21% ( $p=0.014$ ); death 27.7% vs. 21.9% ( $p=0.54$ ); favourable outcomes 40.4% vs. 59.6% ( $p=0.036$ )



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# Clinical corner

## GCS

- Selected preH GCS being considered that more likely to be unaffected by therapy
- However
  - GCS might be underestimated
    - Alcohol, drugs
    - Hypotension
    - Hypoxia
    - Pain/agitation
    - Hypothermia
  - GCS might be overestimated
    - Evolving lesions

preICU phase

# PreICU admission Systolic Arterial Pressure (petalo)

## Pressione arteriosa sistolica pre ICU

- ☐ Ipotensione certa <90 mmHg
- ☐ Ipotensione clinica
- ☐ Nessuna ipotensione

## Ipossia pre ICU

- ☐ Ipossia certa
- ☐ Ipossia clinica
- ☐ Nessuna ipossia

## Pupille in pronto soccorso

- ☐ Areattive bilateralmente
- ☐ Unilateralmente dilatata e areattiva
- ☐ Bilateralmente dilatate e areattive
- ☐ Non rilevabili
- ☐ Dato non disponibile

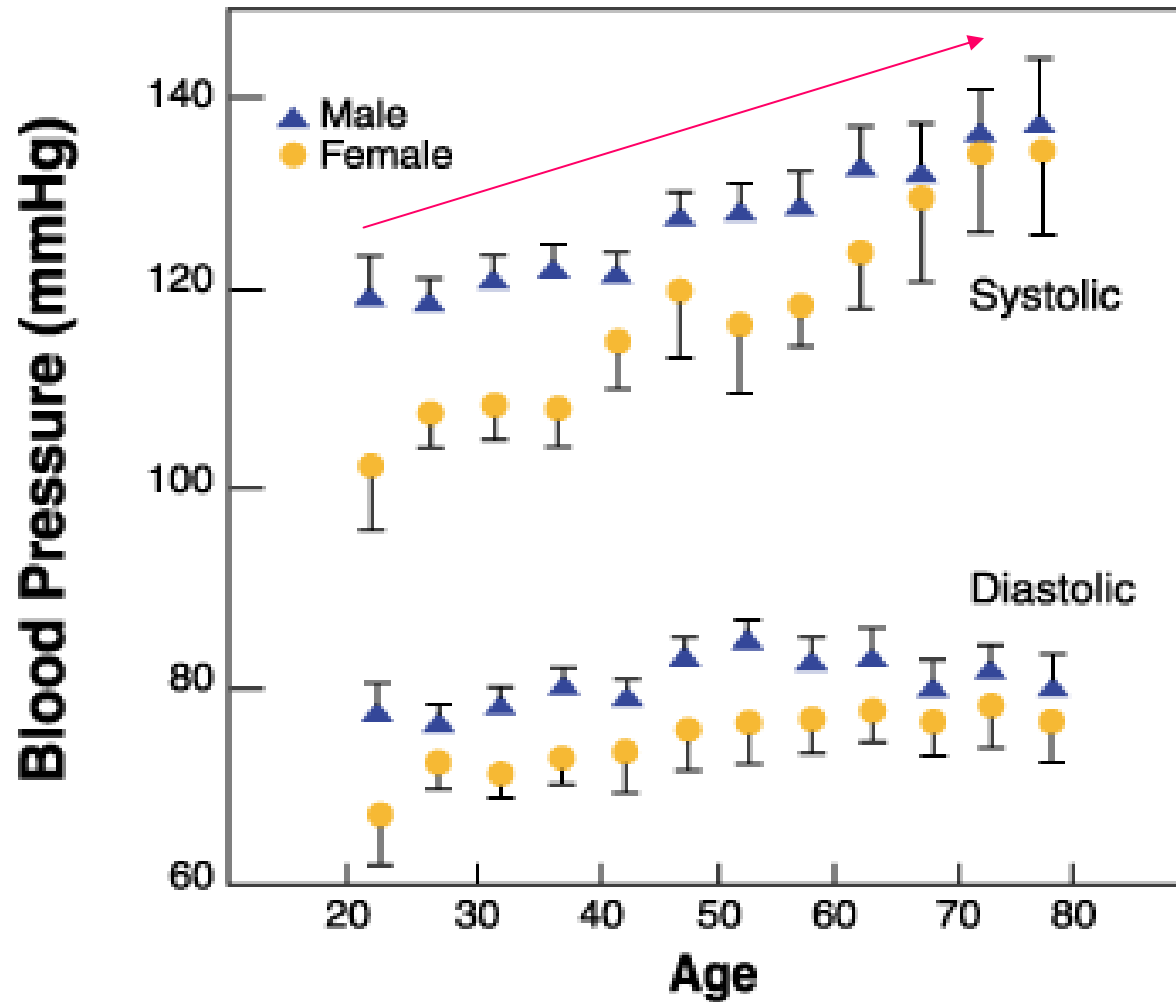
Emoglobina PS (gr/L)

☐ Dato non disponibile

Glicemia PS (gr/dl)

☐ Dato non disponibile

# Age Changes in Systolic and Diastolic Blood Pressure



# Clinical corner

## systolic arterial pressure

- SAP<90mmhg
  - Epidemiological threshold
- Closed trauma
  - Age>50 years, >130 mmHg
  - Age 20-50 years, >110 mmHg
  - Age<10 years, >70mmHg
- Multiple trauma (active bleeding)
  - 20 mmHg lower



# PreICU admission hypoxia (petalo)

## Pressione arteriosa sistolica pre ICU

- ☐ Ipotensione certa <90 mmHg
- ☐ Ipotensione clinica
- ☐ Nessuna ipotensione

## Ipossia pre ICU

- ☐ Ipossia certa
- ☐ Ipossia clinica
- ☐ Nessuna ipossia

## Pupille in pronto soccorso

- ☐ Areattive bilateralmente
- ☐ Unilateralmente dilatata e areattiva
- ☐ Bilateralmente dilatate e areattive
- ☐ Non rilevabili
- ☐ Dato non disponibile

Emoglobina PS (gr/L)

☐ Dato non disponibile

Glicemia PS (gr/dl)

☐ Dato non disponibile

# Emergency room pupils dilatation and reactivity to light (petalo)

## Pressione arteriosa sistolica pre ICU

- ☐ Ipotensione certa <90 mmHg
- ☐ Ipotensione clinica
- ☐ Nessuna ipotensione

## Ipossia pre ICU

- ☐ Ipossia certa
- ☐ Ipossia clinica
- ☐ Nessuna ipossia

## Pupille in pronto soccorso

- ☐ Areattive bilateralmente
- ☐ Unilateralmente dilatata e areattiva
- ☐ Bilateralmente dilatate e areattive
- ☐ Non rilevabili
- ☐ Dato non disponibile

Emoglobina PS (gr/L)

☐ Dato non disponibile

Glicemia PS (gr/dl)

☐ Dato non disponibile

# IMPACT db

## Multivariable Prognostic Analysis in Traumatic Brain Injury: Results from the IMPACT Study

GORDON D. MURRAY,<sup>1</sup> ISABELLA BUTCHER,<sup>1</sup> GILLIAN S. MCHUGH,<sup>1</sup>  
JUAN LU,<sup>2</sup> NINO A. MUSHKUDIANI,<sup>3</sup> ANDREW I.R. MAAS,<sup>4</sup>  
ANTHONY MARMAROU,<sup>2</sup> and EWOUT W. STEYERBERG<sup>3</sup>

OPEN ACCESS Freely available online

PLOS MEDICINE

## Predicting Outcome after Traumatic Brain Injury: Development and International Validation of Prognostic Scores Based on Admission Characteristics

Ewout W. Steyerberg<sup>1\*</sup>, Nino Mushkudiani<sup>1</sup>, Pablo Perel<sup>2</sup>, Isabella Butcher<sup>3</sup>, Juan Lu<sup>4</sup>, Gillian S. McHugh<sup>3</sup>,  
Gordon D. Murray<sup>5</sup>, Anthony Marmarou<sup>4</sup>, Ian Roberts<sup>2</sup>, J. Dik F. Habbema<sup>1</sup>, Andrew I. R. Maas<sup>5</sup>

<sup>1</sup> Center for Medical Decision Sciences, Department of Public Health, Erasmus MC, Rotterdam, The Netherlands, <sup>2</sup> London School of Hygiene and Tropical Medicine, Nutrition and Public Health Intervention Research Unit, London, United Kingdom, <sup>3</sup> Division of Community Health Sciences, University of Edinburgh, Scotland, <sup>4</sup> Department of Neurosurgery, Virginia Commonwealth University, Richmond, Virginia, United States of America, <sup>5</sup> Department of Neurosurgery, Erasmus MC, Rotterdam, The Netherlands

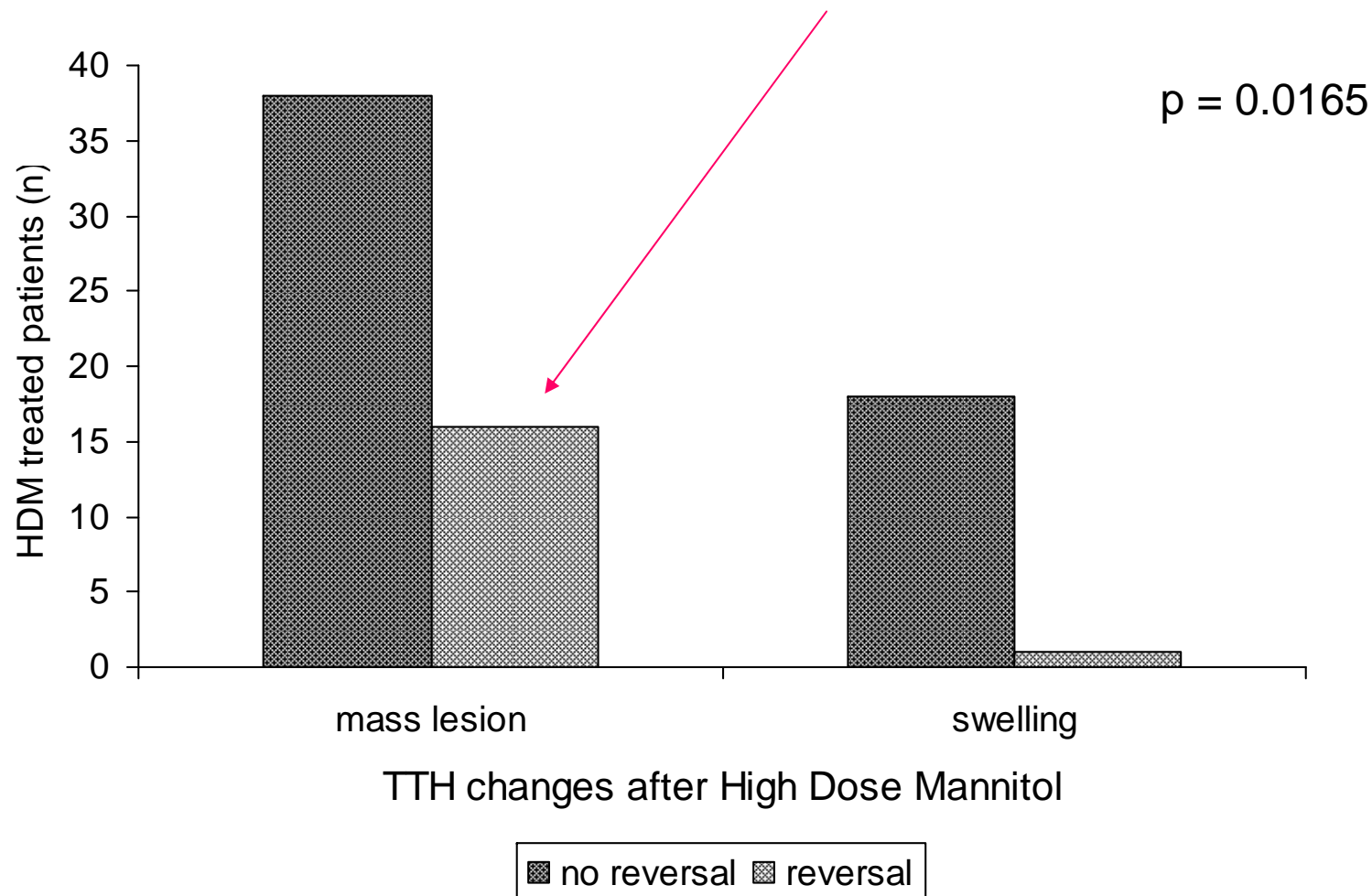
Characteristics	Value	Score	Sum
Age (years)	≤ 30	0	
	30 – 39	1	
	40 – 49	2	
	50 – 59	3	
	60 – 69	4	
	70 +	5	
Motor score	None/extension	6	
	Abnormal flexion	4	
	Normal flexion	2	
	Localizes/obeys	0	
	Untestable/missing	3	
Pupillary reactivity	Both pupils reacted	0	
	One pupil reacted	2	
	No pupil reacted	4	
<b>Sum score core model</b>			
Hypoxia	Yes or suspected	1	
	No	0	
Hypotension	Yes or suspected	2	
	No	0	
CT classification	I	–2	
	II	0	
	III/IV	2	
	V/VI	2	
Traumatic subarachnoid Hemorrhage	Yes	2	
Epidural hematoma	No	0	
	Yes	–2	
<b>Subscore CT</b>			
<b>Sum score extended model</b>			
Glucose (mmol/l)	< 6	0	
	6–8.9	1	
	9–11.9	2	
	12–14.9	3	
	15 +	4	
Hb (g/dl)	< 9	3	
	9–11.9	2	
	12–14.9	1	
	15 +	0	
<b>Subscore lab</b>			
<b>Sum score lab model</b>			

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# Rate of pupil reversal after high dose mannitol

## Cesena

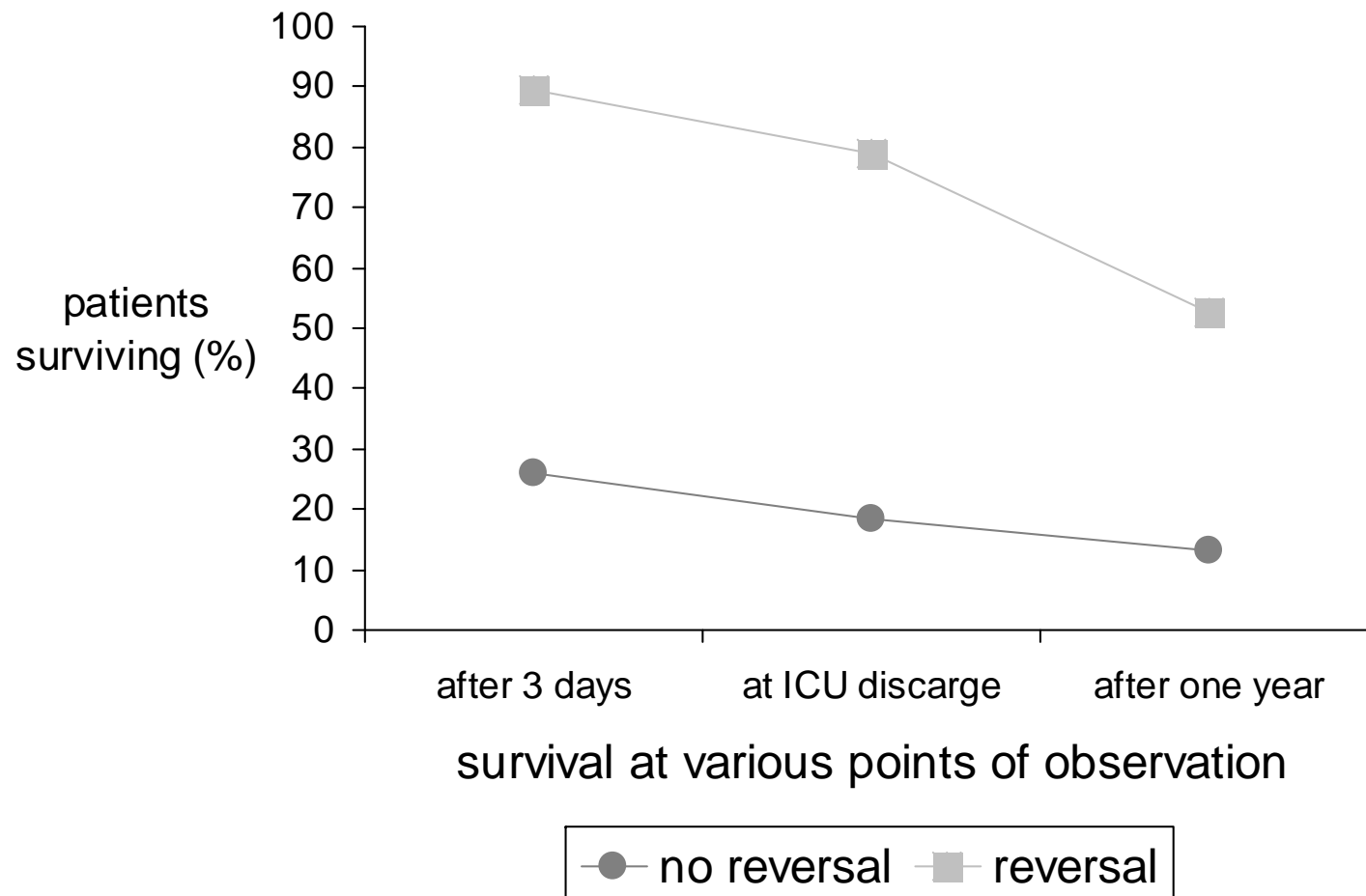
### 73 TBI patients



# Rate of pupil reversal after high dose mannitol

## Cesena

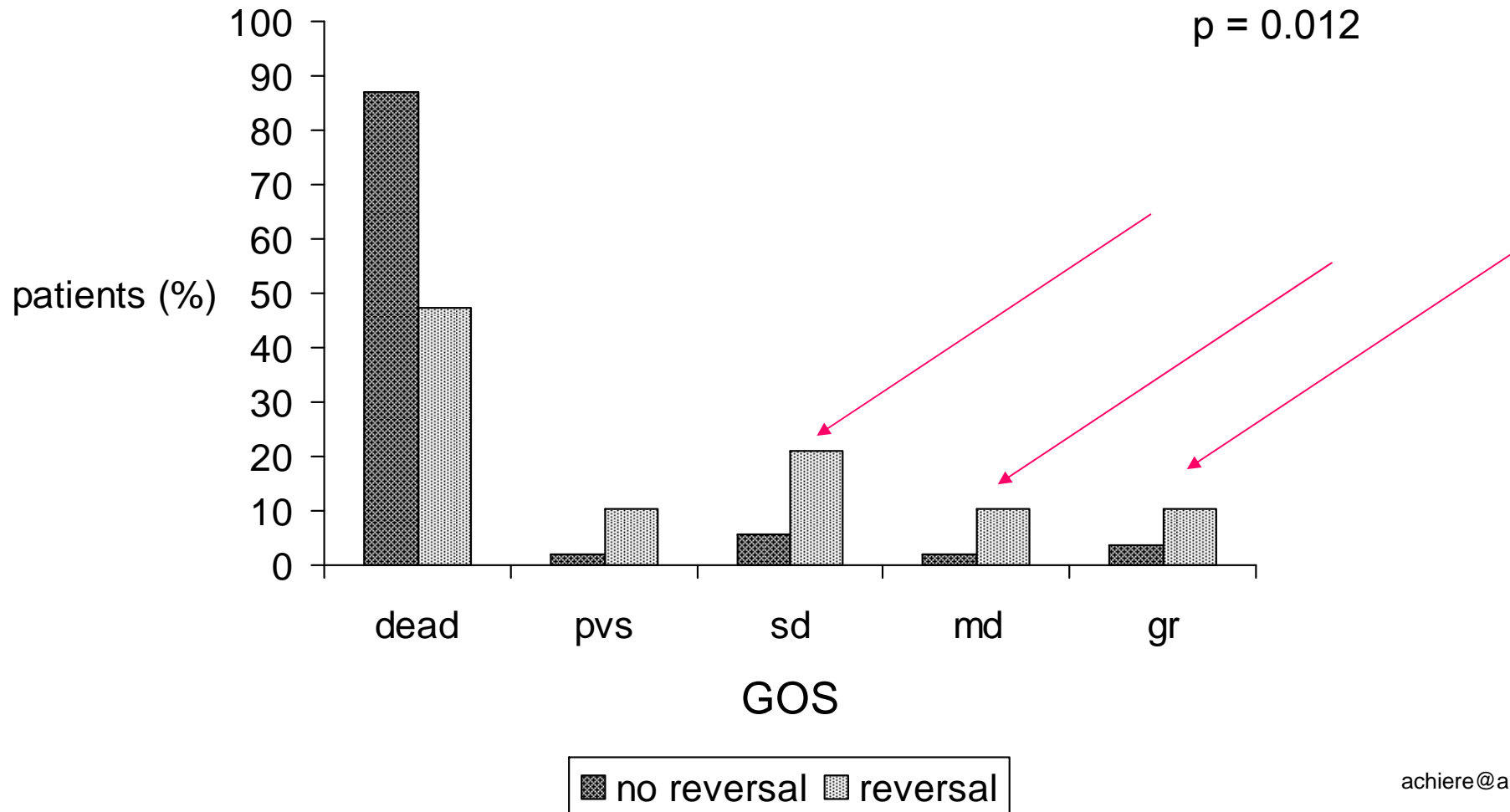
### 73 TBI patients



# Rate of pupil reversal after high dose mannitol

## Cesena

### 73 TBI patients



# Clinical corner

## pupils reactivity to light

- Anisocoria
- midriasis
- High dose mannitol (300-500 ml/5 min, injection)
- Hyperventilation
- Barbiturate (avoid in unstable multiple injury)



# Worst Emergency Room hemoglobin (proSAFE admitting hospital)

Pressione arteriosa sistolica pre ICU

☐ Ipotensione certa <90 mmHg

☐ Ipotensione clinica

☐ Nessuna ipotensione

Ipossia pre ICU

☐ Ipossia certa

☐ Ipossia clinica

☐ Nessuna ipossia

Pupille in pronto soccorso

☐ Areattive bilateralmente

☐ Unilateralmente dilatata e areattiva

☐ Bilateralmente dilatate e areattive

☐ Non rilevabili

☐ Dato non disponibile

Emoglobina PS (gr/L)  ☐ Dato non disponibile

Glicemia PS (gr/dl)  ☐ Dato non disponibile



Multivariable Prognostic Analysis in Traumatic Brain Injury:  
Results from the IMPACT Study

GORDON D. MURRAY,<sup>1</sup> ISABELLA BUTCHER,<sup>1</sup> GILLIAN S. McHUGH,<sup>1</sup>  
JUAN LI,<sup>2</sup> NINO A. MUSHKUDIAN,<sup>2</sup> ANDREW LR. MAAS,<sup>4</sup>  
ANTHONY MARMAROU,<sup>2</sup> and EWOUT W. STEYERBERG<sup>3</sup>

TABLE 1. POOLED COMMON ODDS RATIOS DERIVED FROM PROPORTIONAL ODDS MODELS ADJUSTING FOR A RANGE OF COVARIATES (CONT'D)

Variable	Number of studies	Sample size	Adjusted sample size <sup>a</sup>	Reference category	Category	Common odds ratio from proportional odds model				
						Univariate	Model A	Model B	Model C	Model D
Pupil response	9	7282	7126	Both reacting	One reacting	<b>2.71</b>	—	—	—	—
					Neither reacting	<b>7.31</b>	—	—	—	—
Systolic BP	9	6801	6797	120–150 mm Hg	<120 mm Hg	<b>1.53</b>	<b>1.28</b>	<b>1.27</b>	1.18	1.09
					>150 mm Hg	<b>1.42</b>	<b>1.30</b>	1.28	<b>1.33</b>	<b>1.33</b>
Mean arterial BP	9	6647	6643	85–110 mm Hg	<85 mm Hg	<b>1.30</b>	1.14	1.14	1.06	1.00
					>110 mm Hg	<b>1.45</b>	1.27	1.26	1.29	1.30
Sodium	7	5270	5266	137–142 mmol/L	<137 mmol/L	<b>1.40</b>	1.14	1.09	1.07	1.03
					>142 mmol/L	1.14	1.11	1.10	1.05	1.12
Age	11	8509	8509			<b>2.14</b>	—	—	—	—
pH	5	3398	3394			<b>0.80</b>	<b>0.84</b>	<b>0.83</b>	0.89	0.93
Hemoglobin	6	3875	3871			<b>0.69</b>	<b>0.76</b>	<b>0.76</b>	<b>0.76</b>	—
Glucose	6	4834	4830			<b>1.68</b>	<b>1.45</b>	<b>1.42</b>	<b>1.35</b>	—
Platelets	4	1629	1629			<b>0.70</b>	<b>0.79</b>	<b>0.80</b>	<b>0.81</b>	<b>0.80</b>
Prothrombin time	3	840	840			1.41	<b>1.63</b>	<b>1.60</b>	<b>1.55</b>	<b>1.46</b>

<sup>a</sup>The adjusted analyses (Models A–D) are restricted to patients aged  $\geq 14$  years.

Figures in bold correspond to  $p < 0.01$ .

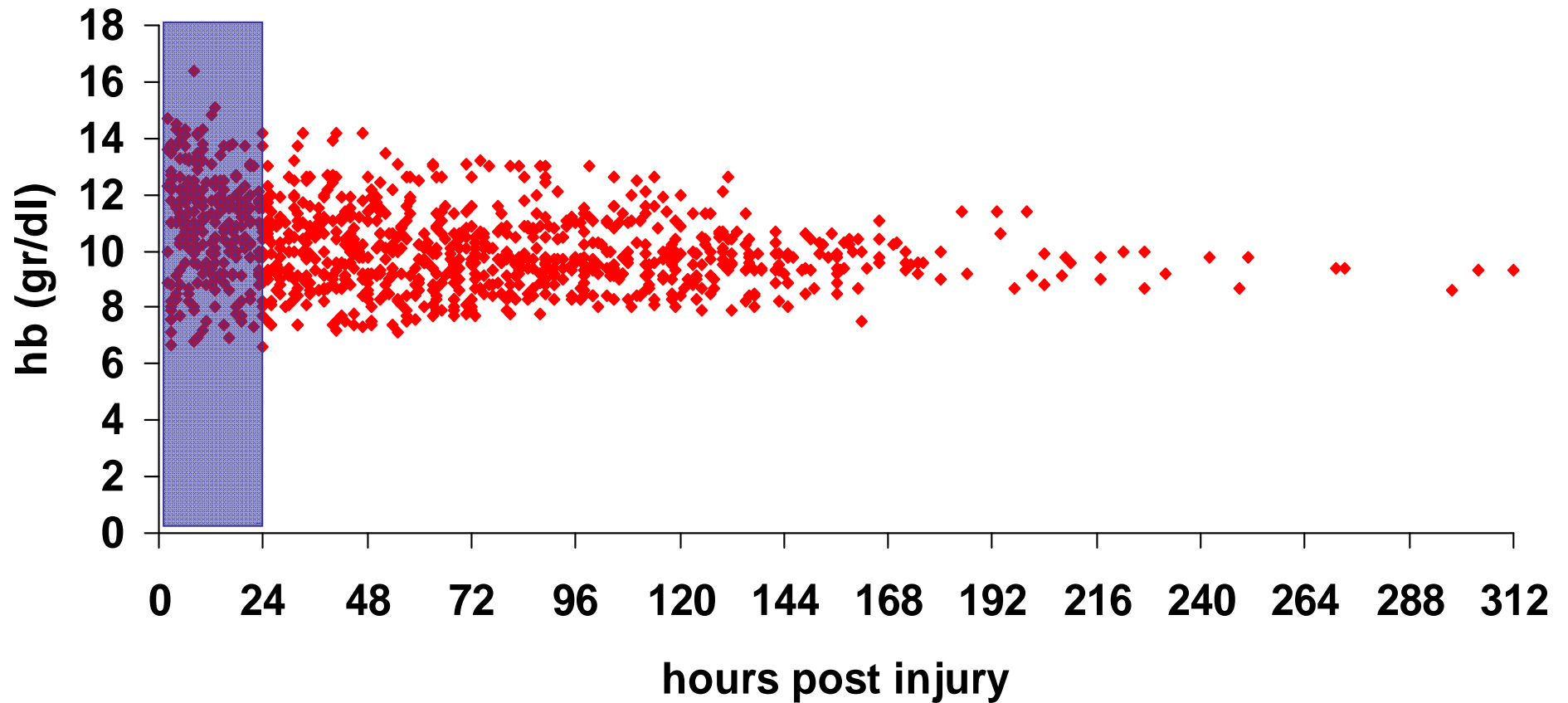
Model A: Adjusted for age, GCS motor score, and pupils. Model B: Model A plus CT class. Model C: Model B plus hypoxia, hypotension, and tSAH. Model D: Model C plus Hb and glucose

The odds ratios for age through prothrombin time are scaled to reflect the effect of an increase from the lower quartile of each variable to the upper quartile

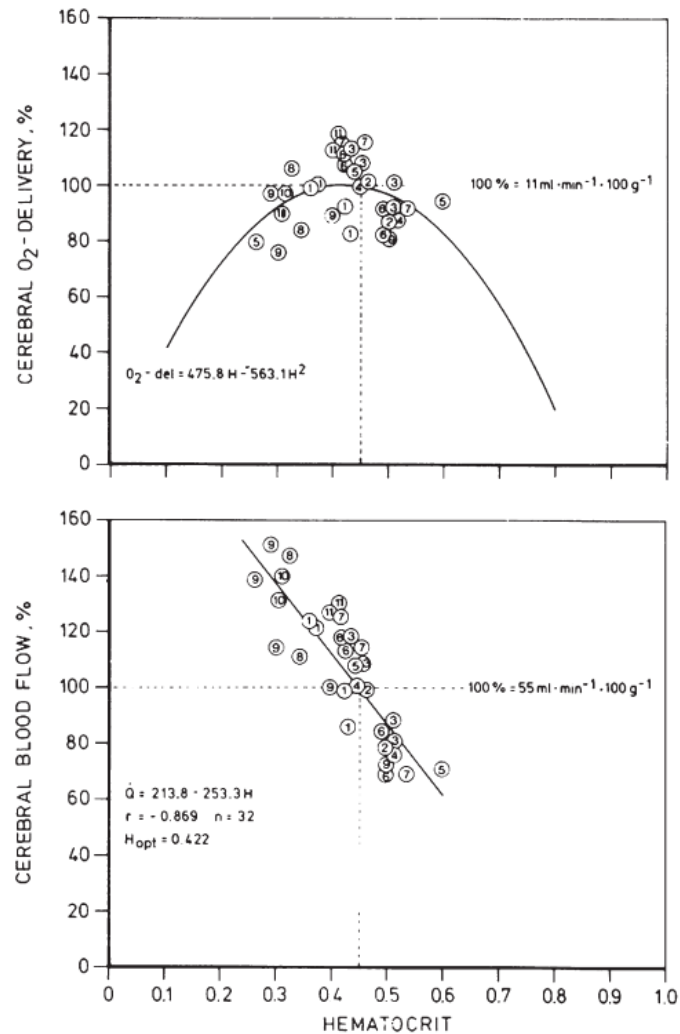
CT, computerized tomography; tSAH, traumatic subarachnoid hemorrhage; EDH, epidural hematoma; SDH, subdural hematoma; GCS, Glasgow Coma Scale; BP, blood pressure.

# Hb over time 1017 spls

Chiericato 1994-199  
unpublished data



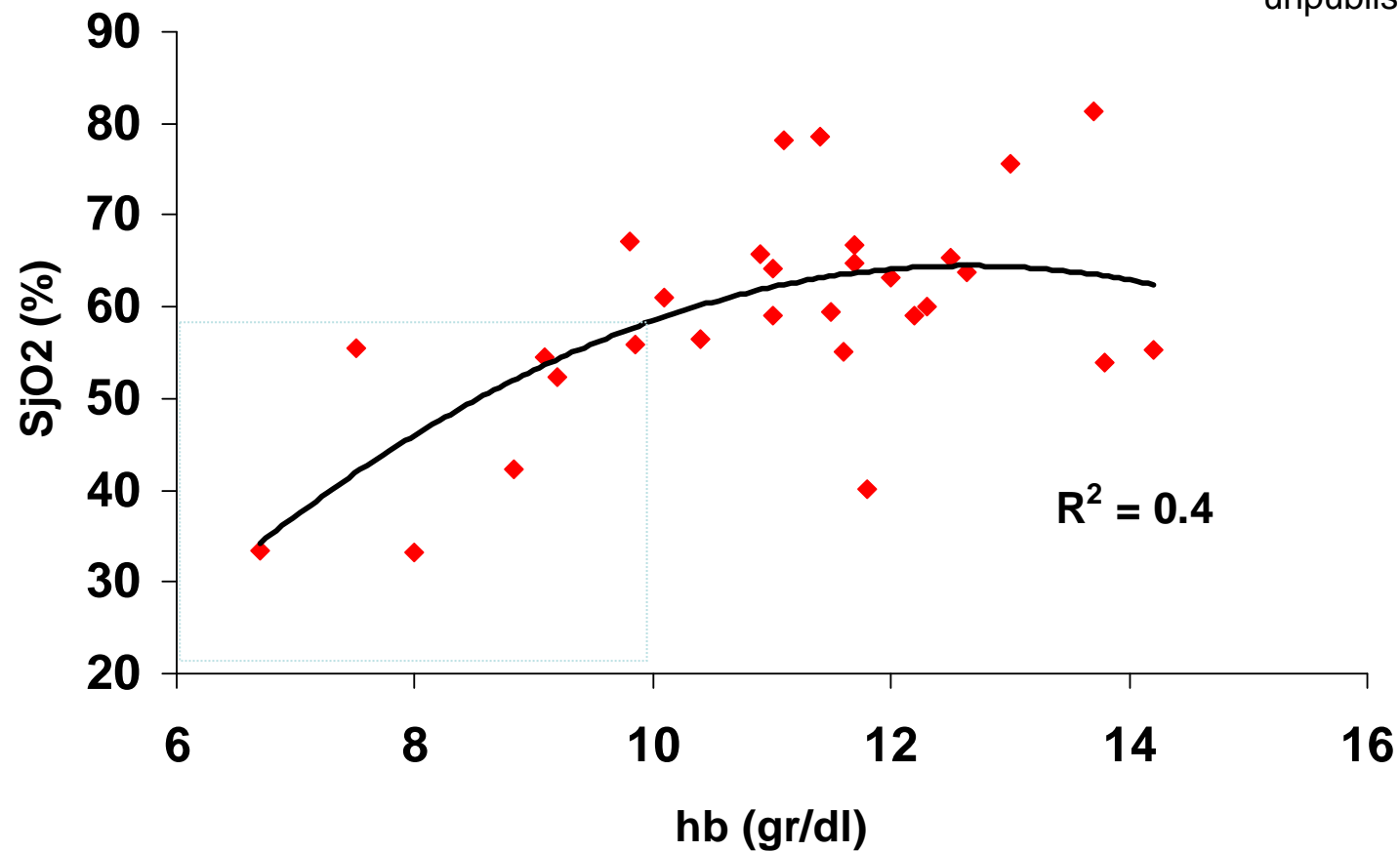
Gaethens JCBFM 1987



**Fig. 2. Top:** Effect of hematocrit on cerebral O<sub>2</sub> delivery, calculated on the basis of the data in the bottom. Calculation assumes constant arterial O<sub>2</sub> saturation and proportionality between hematocrit and hemoglobin concentration in the blood. The relationship shown indicates an optimal hematocrit ( $H_{opt}$ ) at 0.422. **Bottom:** Changes of cerebral blood flow as a function of systemic hematocrit. Data from measurements in human patients by various authors (indicated by numbers). Blood flow data are expressed relative to a control value (100% = 55 mL · minute<sup>-1</sup> · 100 g<sup>-1</sup>) at a hematocrit of 0.45. (From ref. 47, with permission.)

causes  
**SjO2 is hb dependent**  
hb threshold for abnormal SjO2 is 10 gr/dl

Chieregato 1994-1999  
unpublished data



# Why is hypotension the worst damage?

$$\frac{(\text{CaO}_2)}{(\text{hb} \times 1.39 \times \text{SaO}_2)} \times \frac{(\text{CBF})}{(\text{CPP/CVR})}$$

$$\frac{(\text{hb} \times 1.39 \times \text{SaO}_2)}{(\text{hb} \times 1.39 \times \text{SaO}_2)} \times \frac{(\text{CBF})}{(\text{CPP/CVR})}$$

$$\frac{(\text{hb} \times 1.39 \times \text{SaO}_2)}{(\text{hb} \times 1.39 \times \text{SaO}_2)} \times \frac{(\text{CBF})}{(\text{CPP/CVR})}$$

$$\frac{(\text{hb} \times 1.39 \times \text{SaO}_2)}{(\text{hb} \times 1.39 \times \text{SaO}_2)} \times \frac{(\text{CBF})}{(\text{CPP/CVR})}$$

# Clinical corner

## pupils reactivity to light

- Keep Hb above 10gr/dl
- Balanced transfusion
  - Fresh frozen plasma
  - platelets

# Glycemia in Emergency Room (proSAFE admitting hospital)

Pressione arteriosa sistolica pre ICU

☐ Ipotensione certa <90 mmHg

☐ Ipotensione clinica

☐ Nessuna ipotensione

Ipossia pre ICU

☐ Ipossia certa

☐ Ipossia clinica

☐ Nessuna ipossia

Pupille in pronto soccorso

☐ Areattive bilateralmente

☐ Unilateralmente dilatata e areattiva

☐ Bilateralmente dilatate e areattive

☐ Non rilevabili

☐ Dato non disponibile

Emoglobina PS (gr/L)  ☐ Dato non disponibile

Glicemia PS (gr/dl)  ☐ Dato non disponibile

## Assessment of nutritional requirements of head-injured patients

GUY L. CLIFTON, M.D., CLAUDIA S. ROBERTSON, M.D., AND SUNG C. CHOI, Ph.D.

Department of Neurological Surgery, Baylor College of Medicine, Houston, Texas, and Department of Biostatistics, Medical College of Virginia, Virginia Commonwealth University, Richmond, Virginia

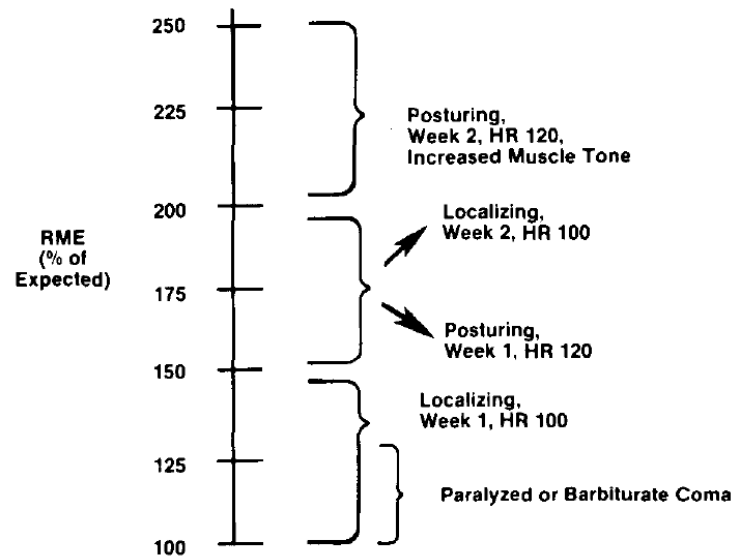


FIG. 2. A nomogram for estimation of caloric expenditure with an assumed heart rate (HR, per min) is shown. Movement and stimulation during half the day increase these values by approximately 20% in posturing patients but has a negligible effect unless extreme in patients who do not posture or who are not in coma. Resting metabolic expenditure (RME) values of 200% of expected levels or greater are found in patients who posture to stimulation and have increased muscle tone, sweating, and fever.

## Effects of Glucose and $P_{aO_2}$ Modulation on Cortical Intracellular Acidosis, NADH Redox State, and Infarction in the Ischemic Penumbra

Robert E. Anderson, BS; William K. Tan, PhD; Heidi S. Martin; Fredric B. Meyer, MD

*(Stroke. 1999;30:160-170.)*

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### EDITORIAL

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## Permissive mild to moderate hyperglycemia is safer for damaged brains

A. CHIEREGATO



# Clinical corner

- Please ... observe
  - Association is not causation
- Treat only very abnormal values  $>300$  gr/dl

# Anatomical severity (CT)

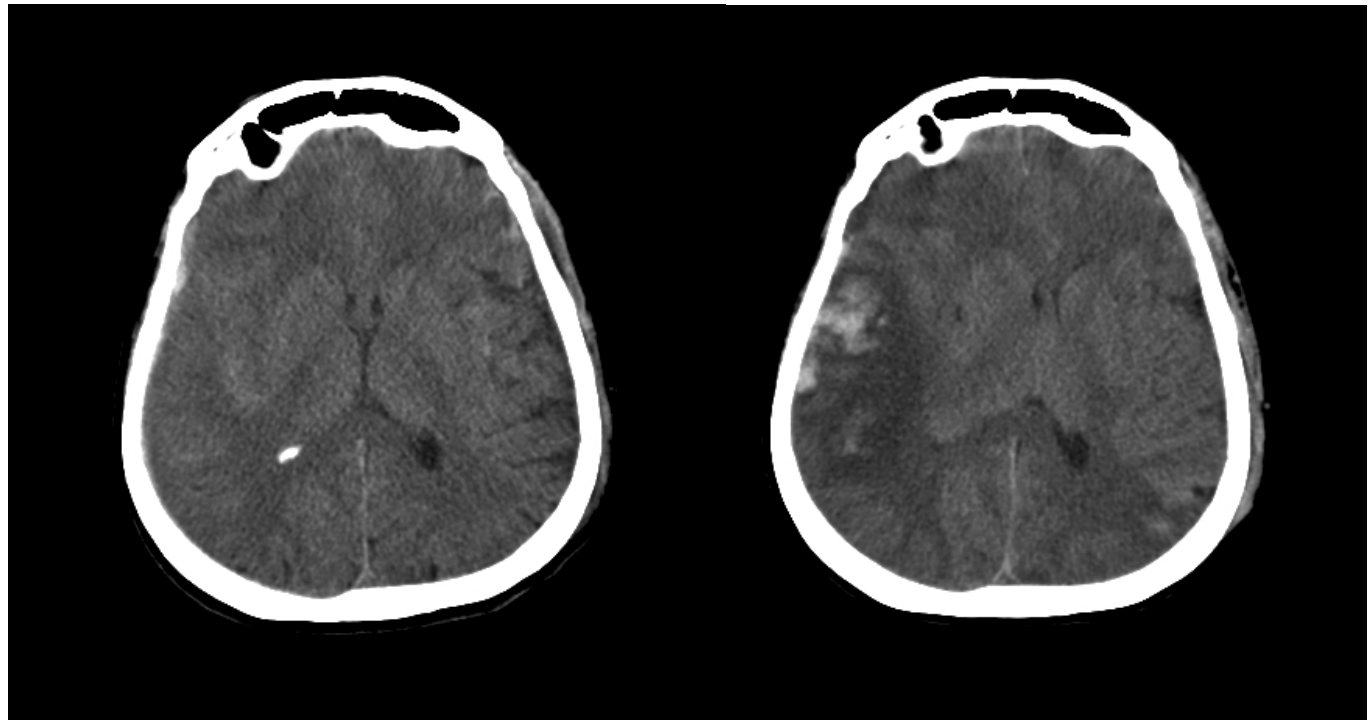
brain

# Clinical corner first and worst CT

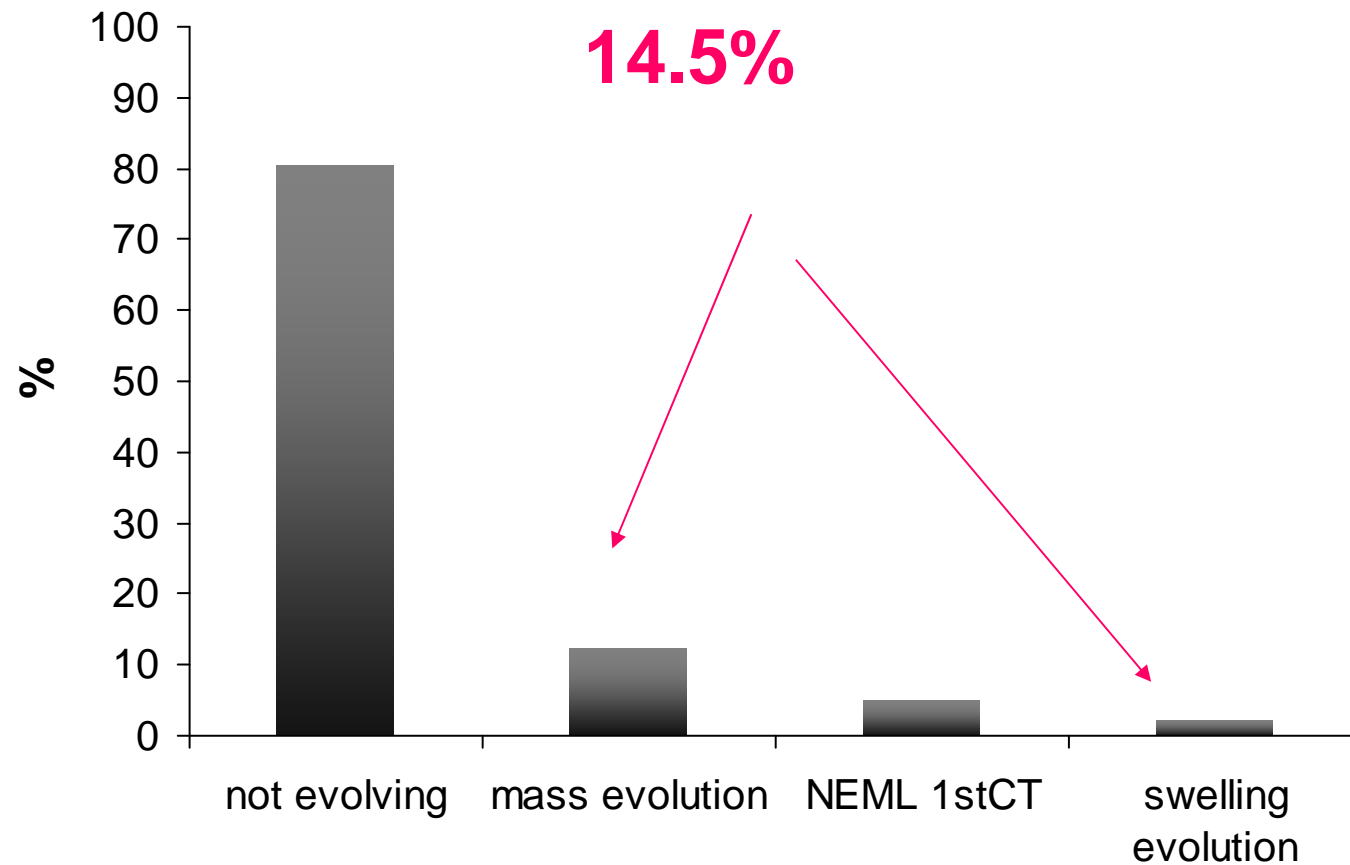
- The first? Decisional process, organization, centralization
- The worst? The final outcome

# CT evolution

- predictors of neuroworsening
  - Evolving CT
    - tSAH
      - Antiplt, anticoag
    - Contusion
    - Fractures
      - EDH



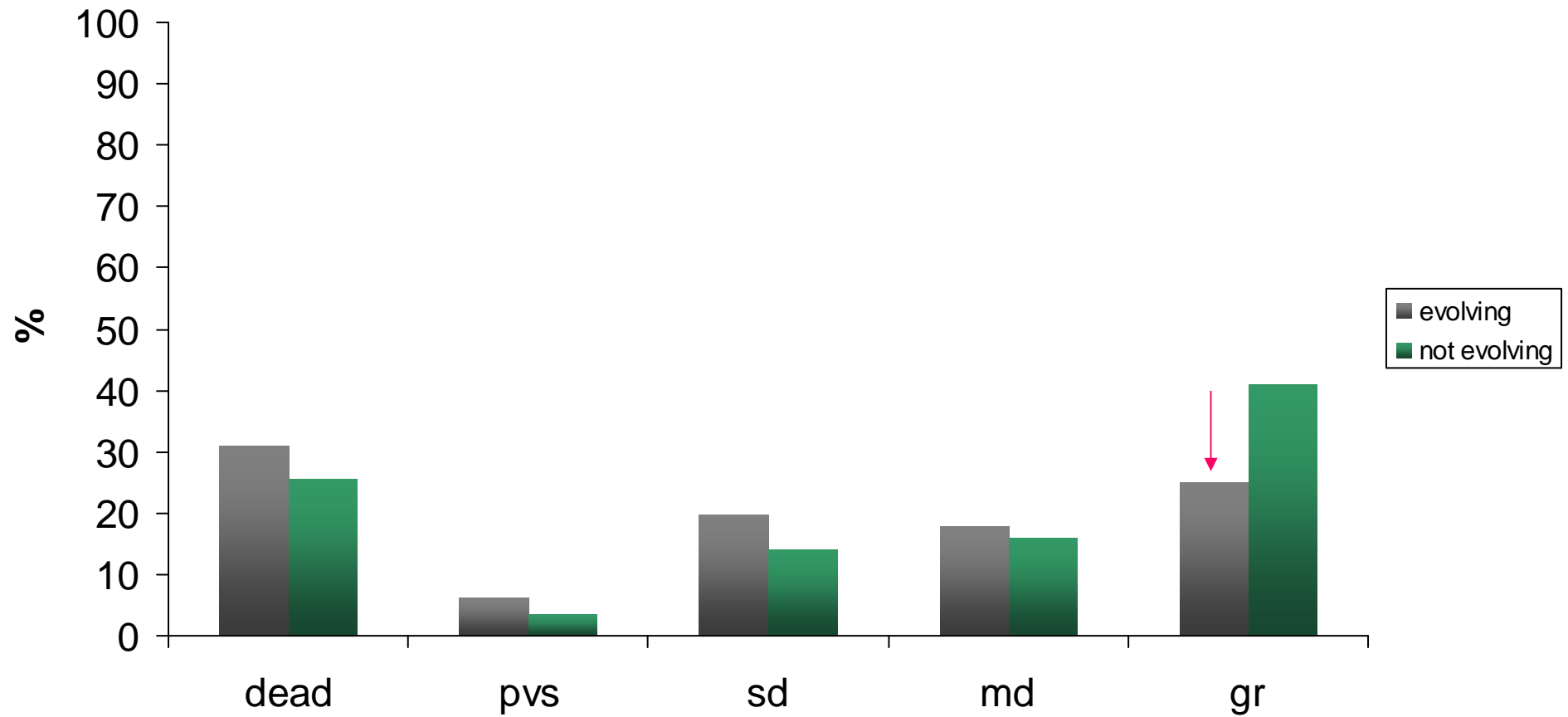
# Rate of evolution? 1465 TBI patients Cesena 1997-2010



# CT evolution and outcome

## 1465 TBI patients

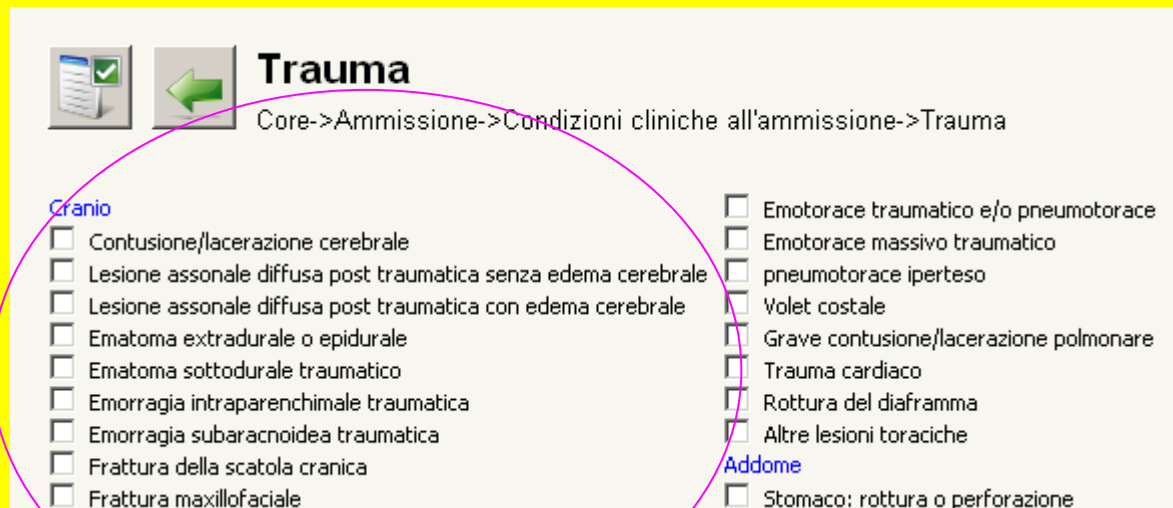
### Cesena 1997-2010





# Clinical corner

- CT evolution
  - It is “per se” negative
- CT evolution
  - Is much more negative if undetected
  - Consider warning signals
    - tSAH

# Anatomical severity cranial lesions



  **Trauma**

Core->Ammissione->Condizioni cliniche all'ammissione->Trauma

**Cranio**

- ☐ Contusione/lacerazione cerebrale
- ☐ Lesione assonale diffusa post traumatica senza edema cerebrale
- ☐ Lesione assonale diffusa post traumatica con edema cerebrale
- ☐ Ematoma extradurale o epidurale
- ☐ Ematoma sottodurale traumatico
- ☐ Emorragia intraparenchimale traumatica
- ☐ Emorragia subaracnoidea traumatica
- ☐ Frattura della scatola cranica
- ☐ Frattura maxillofaciale

- ☐ Emotorace traumatico e/o pneumotorace
- ☐ Emotorace massivo traumatico
- ☐ pneumotorace iperteso
- ☐ Volet costale
- ☐ Grave contusione/lacerazione polmonare
- ☐ Trauma cardiaco
- ☐ Rottura del diaframma
- ☐ Altre lesioni toraciche

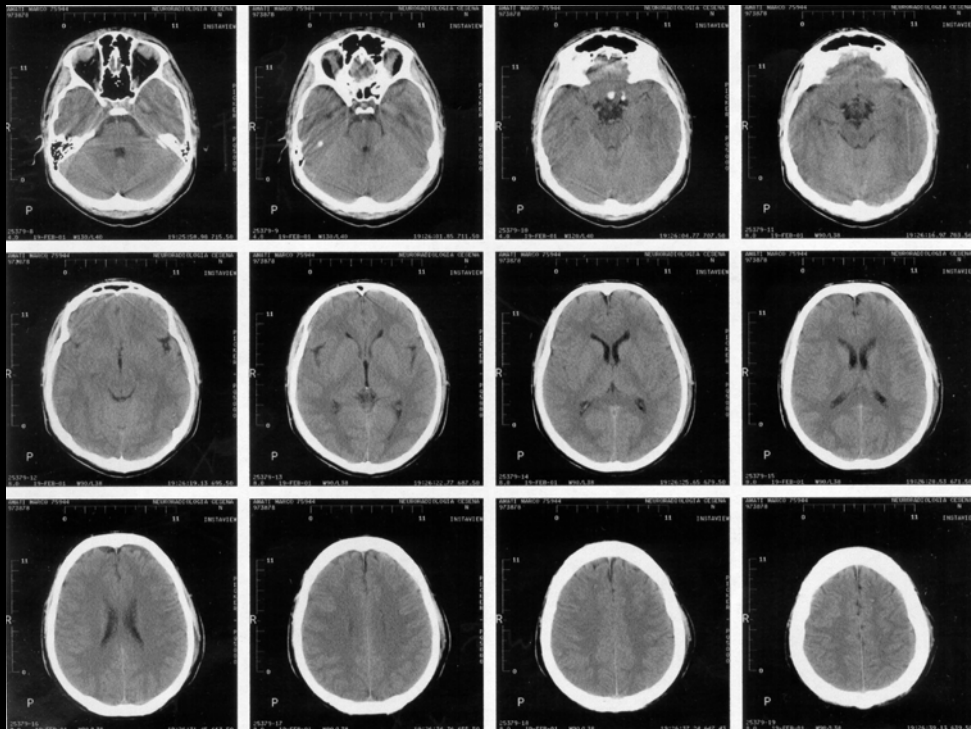
**Addome**

- ☐ Stomaco: rottura o perforazione

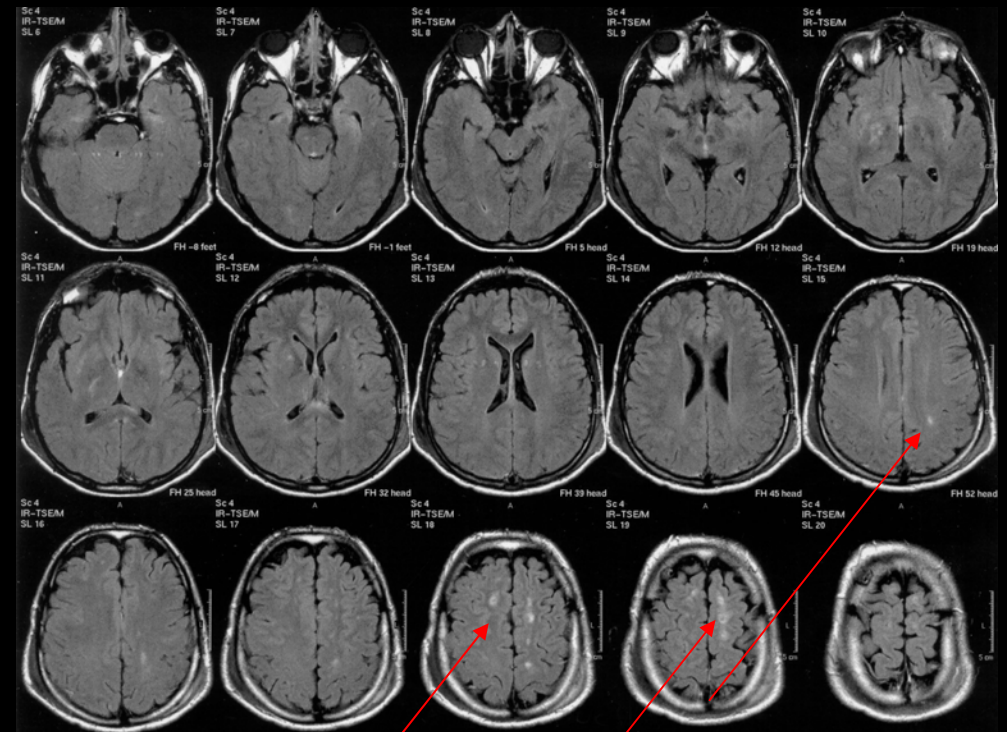


# Lesione assonale diffusa post-traumatica **senza** edema cerebrale (post-traumatic diffuse injury **without** swelling)

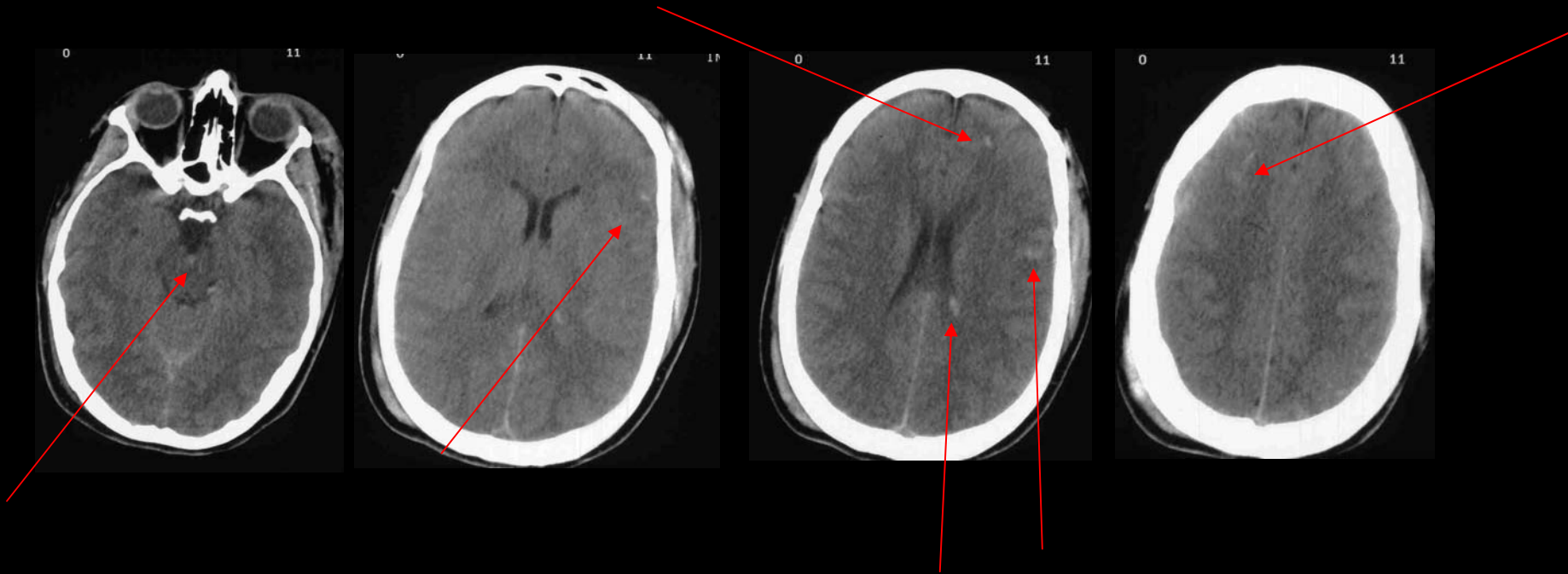
CT



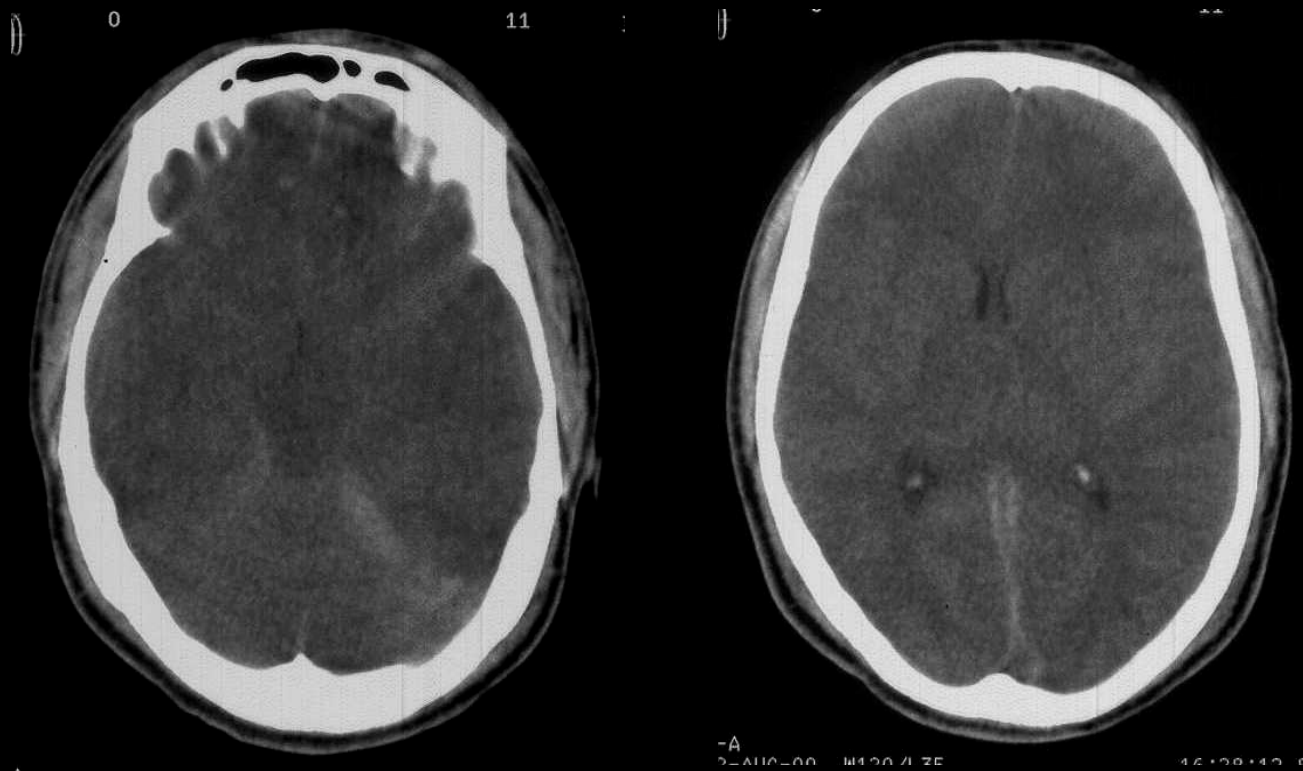
MRI



# Lesione diffusa post-traumatica **senza** edema cerebrale (post-traumatic diffuse injury **without** swelling)



# Lesione assonale diffusa post-traumatica **con** edema cerebrale (post-traumatic diffuse injury **with** swelling)



A  
Domenico H

...how to give a look to brain CT

# Due metodi

fotografico-nosografico-  
qualitativo

Ematoma tipo: SDH, EDH ...

Ematoma volume: "piccolo", "sottile", "grosso", "enorme"

Edema: "scomparsa spazi liquorali", "spianamento solchi corticali", edema

Linea mediana: "enorme sbandamento" .....

Analitico

Scompone la TAC utilizzando indicatori

Ricostruisce una nosografia

Permette una comunicazione

esperto

# Anatomical severity cranial lesions



## Gravità anatomica (peggior TAC)

Neurologia->Trauma cranico->Gravità anatomica (peggior TAC)

La peggior TAC è quella nella quale che manifestano le lesioni di maggior rilievo per la prognosi del paziente, prima di un eventuale trattamento chirurgico. Nel caso di danno diffuso, la TAC con maggior rigonfiamento nelle prime 24 ore dal trauma.

Condizioni cliniche all'ammissione

Lesione assonale diffusa post-traumatica con edema cerebrale

DI with swelling

Presenza anche un danno focale?

Classificazione di Marshall: (5-NEML) Not Evacuated mass lesion

- ☒ SI  
☐ NO

Che tipo di lesione focale?

Lesioni

- ☐ Contusione e/o lacerazione cerebrale  
☐ Ematoma extradurale o epidurale  
☒ Emorragia intraparenchimale traumatica  
☐ Ematoma sottodurale traumatico

evacuata masse

- ☐ SI  
☒ NO

Volume della lesione >25 ml

- ☒ SI  
☐ NO

Volume

Shift > 5 mm

Shift > 5 mm

- ☒ SI  
☐ NO

Cisterne

- ☒ Compresse o distorte  
☐ Normale  
☐ Assenti

Cisterne

Petecchie

Petecchie

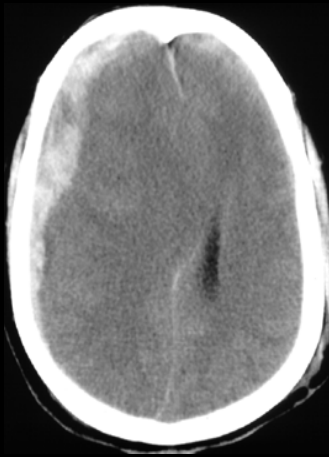
- ☒ SI  
☐ NO

achiere@ausl-cesena.emr.it

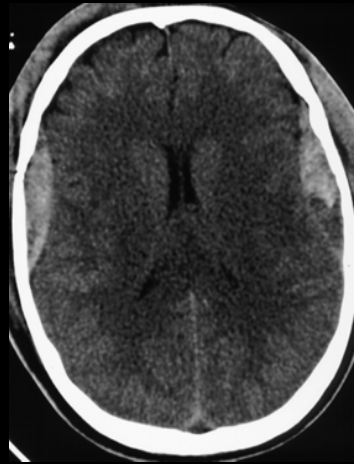
...is there a lesion?

A hyperintense lesion

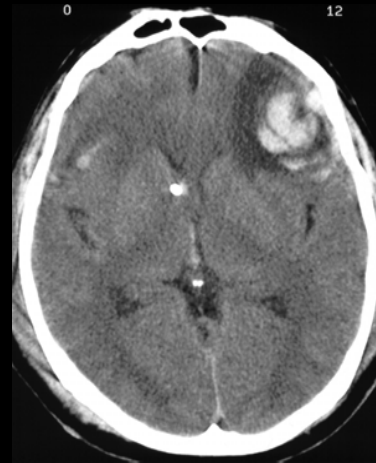
# lesions



ematoma  
sottodurale



ematoma extradurale



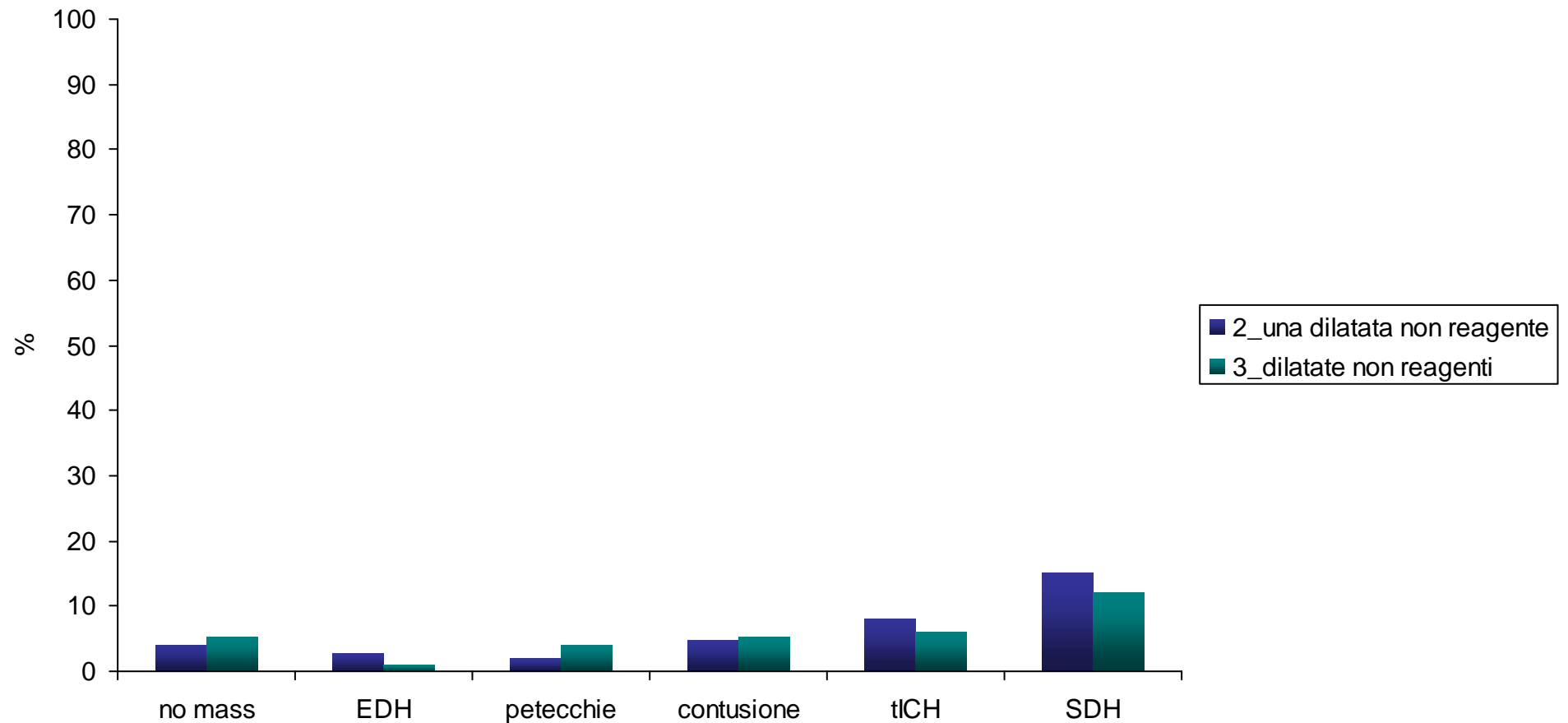
contusione



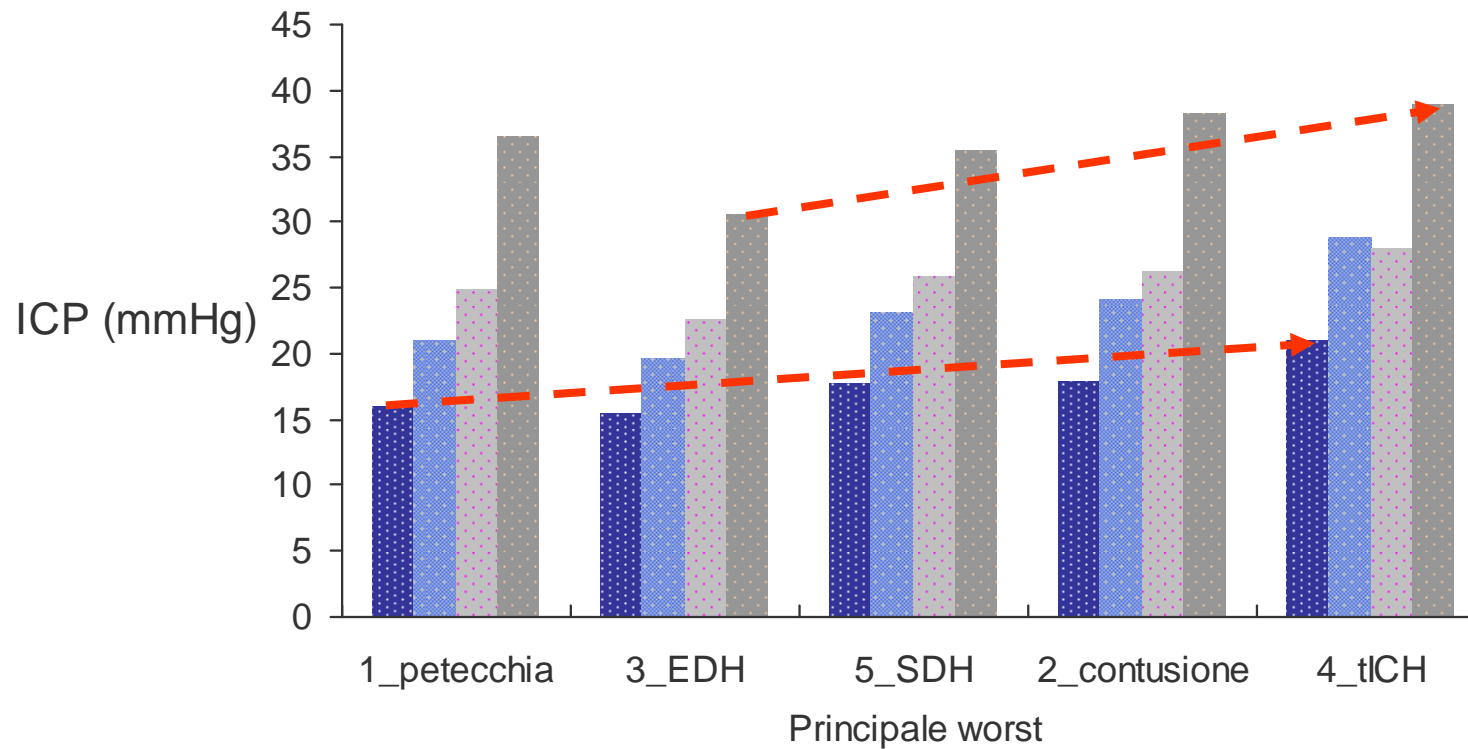
ematoma  
intraparenchimale



# First CT (lesions) and preH pupils Cesena 1997-2011 1975 patients



# ICP and type of lesion 834 patients with ICP monitoring Cesena 1997-2011

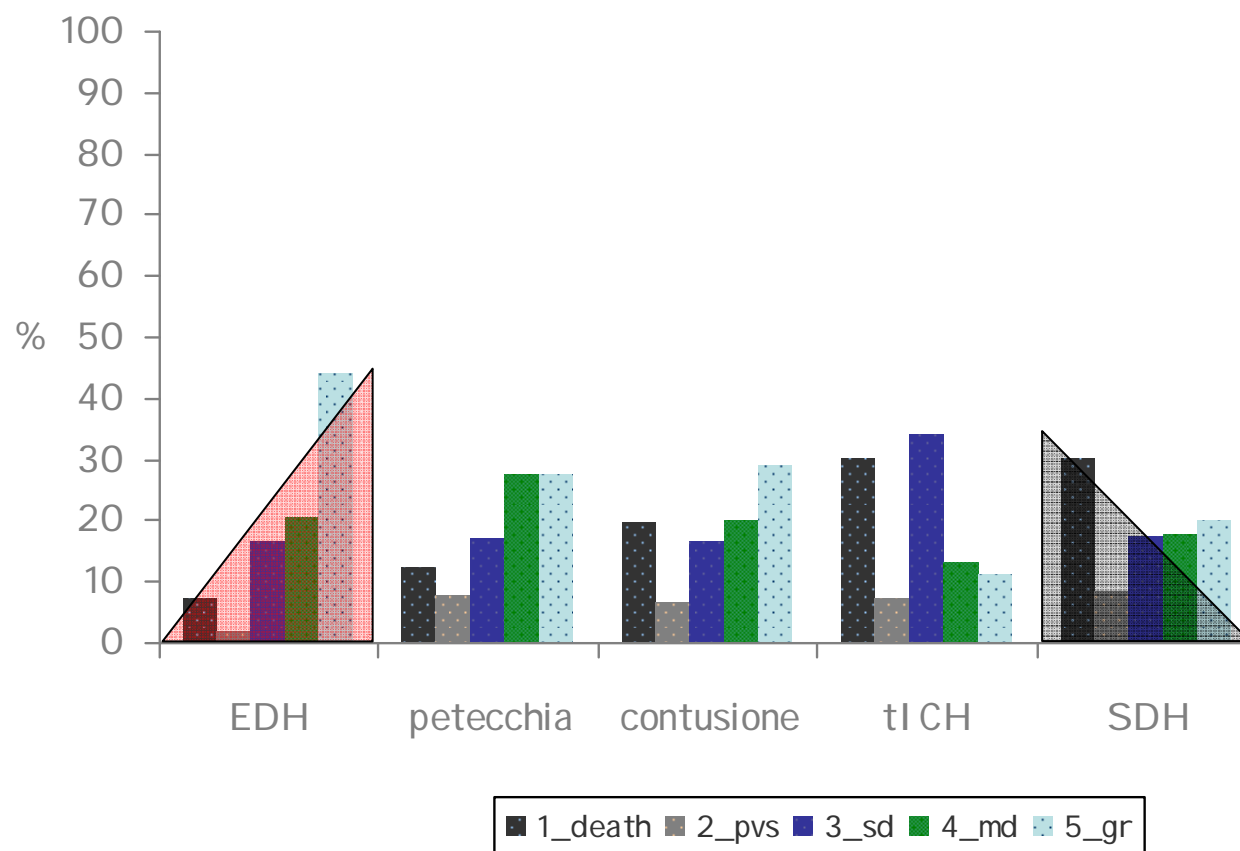


■ ICP mean\_the mean ■ ICP mean\_the max ■ ICP max\_the mean ■ ICP max\_the max

# Principal lesion in worst CT and outcome

## 834 pazienti with ICP monitoring



### Cesena 1997-2011



...how much is it large?

# The measure of brain lesions (petalo)

- Volume (>25 ml)

  **Gravità anatomica (peggior TAC)**  
Neurologia->Trauma cranico->Gravità anatomica (peggior TAC)

La peggior TAC è quella nella quale che manifestano le lesioni di maggior rilievo per la prognosi del paziente, prima di un eventuale trattamento chirurgico. Nel caso di danno diffuso, la TAC con maggior rigonfiamento nelle prime 24 ore dal trauma.

[Condizioni cliniche all'ammissione](#)

Lesione assonale diffusa post-traumatica con edema cerebrale DI with swelling

[Presenza anche un danno focale?](#) Classificazione di Marshall: (5-NEML) Not Evacuated mass lesion

☒ SI  
☐ NO

[Che tipo di lesione focale?](#) Lesioni

☐ Contusione e/o lacerazione cerebrale  
☐ Ematoma extradurale o epidurale  
☒ Emorragia intraparenchimale traumatica  
☐ Ematoma sottodurale traumatico

[evacuata masse](#)

☐ SI  
☒ NO

[Shift>5 mm](#) Shift>5 mm

☒ SI  
☐ NO

[Petecchie](#) Petecchie

☒ SI  
☐ NO

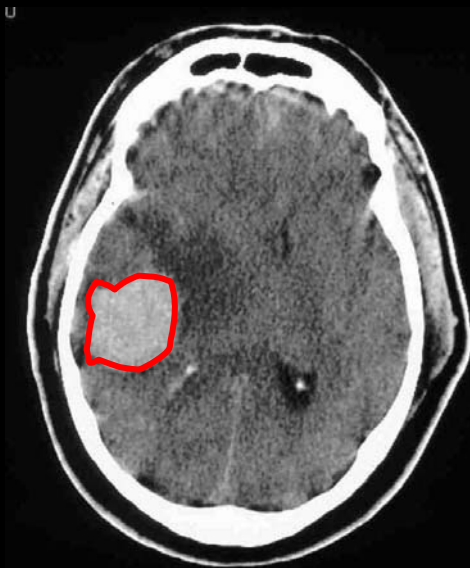
[Volume della lesione >25 ml](#) Volume

☒ SI  
☐ NO

[Cisterne](#) Cisterne

☒ Compresse o distorte  
☐ Normale  
☐ Assenti

# lesion volum (escluding perilesional edema)



Contusione core  
<25 ml



Contusione core  
<25 ml



Contusione core  
~ 25 ml



Contusione core  
> 25 ml



...does it exert a mass effect?

Or

is there a mass effect independent from a mass?

# The effect of mass lesions (petalo)

- Shift > 5 mm



## Gravità anatomica (peggior TAC)

Neurologia->Trauma cranico->Gravità anatomica (peggior TAC)

La peggior TAC è quella nella quale che manifestano le lesioni di maggior rilievo per la prognosi del paziente, prima di un eventuale trattamento chirurgico. Nel caso di danno diffuso, la TAC con maggior rigonfiamento nelle prime 24 ore dal trauma.

Condizioni cliniche all'ammissione

Lesione assonale diffusa post-traumatica con edema cerebrale DI with swelling

Presenza anche un danno focale? Classificazione di Marshall: (5-NEML) Not Evacuated mass lesion

☒ SI  
☐ NO

Che tipo di lesione focale? Lesioni

☐ Contusione e/o lacerazione cerebrale  
☐ Ematoma extradurale o epidurale  
☒ Emorragia intraparenchimale traumatica  
☐ Ematoma sottodurale traumatico

evacuata masse Volume della lesione > 25 ml Volume

☐ SI  
☒ NO

Shift > 5 mm Shift > 5 mm

☒ SI  
☐ NO

Petecchie Petecchie

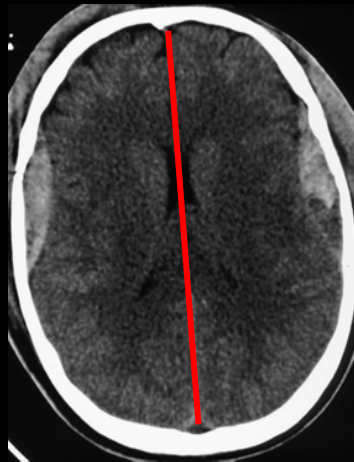
☒ SI  
☐ NO

Cisterne Cisterne

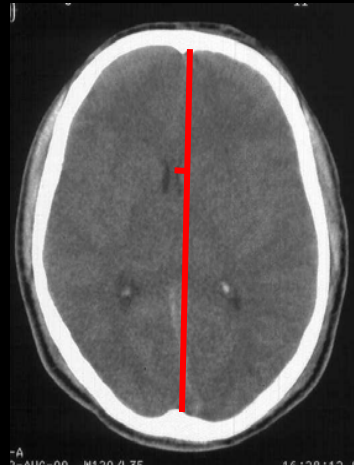
☒ Compresse o distorte  
☐ Normale  
☐ Assenti



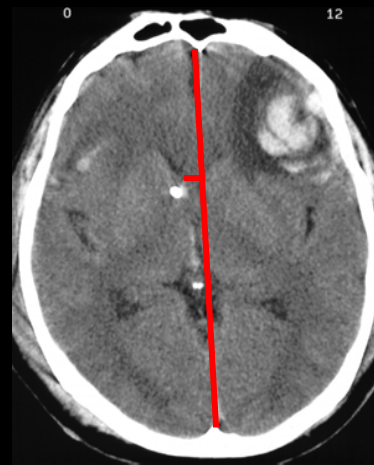
shift



0 mm



2 mm



4 mm



18 mm



...does the mass effect exert reduce even the  
liquoral space?

Or

Is there a diffuse reduction of liquoral space  
indipendent from a mass?

# The measure of diffuse lesions (petalo)

- Basal cisternes



## Gravità anatomica (peggior TAC)

Neurologia->Trauma cranico->Gravità anatomica (peggior TAC)

La peggior TAC è quella nella quale che manifestano le lesioni di maggior rilievo per la prognosi del paziente, prima di un eventuale trattamento chirurgico. Nel caso di danno diffuso, la TAC con maggior rigonfiamento nelle prime 24 ore dal trauma.

Condizioni cliniche all'ammissione

Lesione assonale diffusa post-traumatica con edema cerebrale DI with swelling

Presenza anche un danno focale? Classificazione di Marshall: (5-NEML) Not Evacuated mass lesion

☒ SI  
☐ NO

Che tipo di lesione focale? Lesioni

☐ Contusione e/o lacerazione cerebrale  
☐ Ematoma extradurale o epidurale  
☒ Emorragia intraparenchimale traumatica  
☐ Ematoma sottodurale traumatico

evacuata masse Volume della lesione > 25 ml

☐ SI  
☒ NO Volume

Shift > 5 mm Shift > 5 mm

☒ SI  
☐ NO

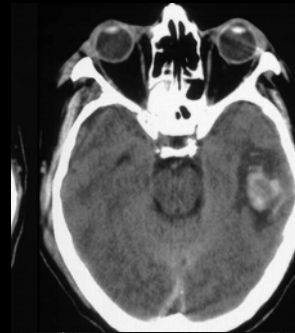
Petecchie Petecchie

☒ SI  
☐ NO

Cisterne Cisterne

☒ Compresse o distorte  
☐ Normale  
☐ Assenti

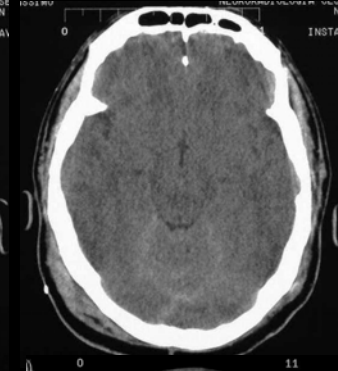
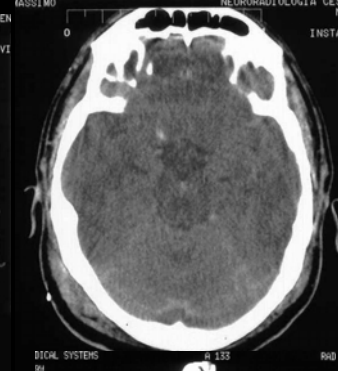
**normal**



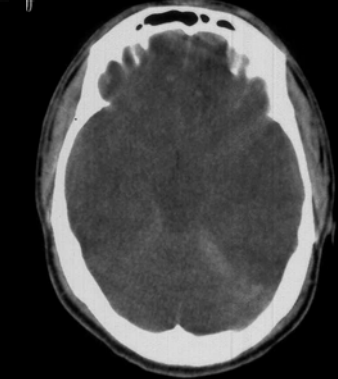
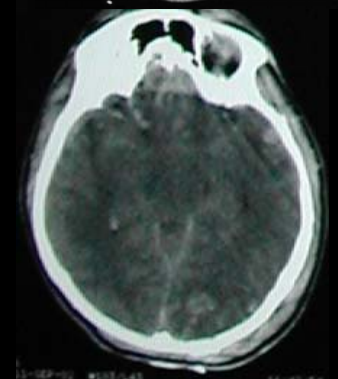
**distorted:**  
asymmetric  
compression



**compressed:**  
uniform reduction  
of the caliber



**absent:** no visible  
liquoral space



# Basal cisterns

...is it mandatory to remove the mass?