Moron General Hospital
Ciego de Avila
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Department of Neurological Surgery

Early decompressive craniectomy in severe head injury with intracranial hypertension

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The 5th Annual International Neurosurgery Conference 27-30 December 2009

Introduction:

Severe traumatic brain injury (TBI) is one of the major causes of death in younger age groups in the world.

The incidence of head trauma in United State of America is 1.4 million / year, 235 000 are admitted and 50 000 die from head injury.

In Cuba traffic accidents are the fourth cause of death in adults and, the commonest cause in those under the 45 years old . Fifty percent of those suffering from traffic accident sustain a head injury.

The control of elevated intracranial pressure (ICP), is fundamental to the management of patients with severe head injury. Approximately 40% of patients suffering traumatic loss of consciousness will develop intracranial hypertension during the course of their treatment. Brain edema, increased ICP and reduced cerebral blood flow, are the main prognostic factors despite progress in the diagnosis and treatment of severe post-traumatic brain injury.

There is today enough evidence that the implementation of protocols to standardize therapy in patients with post-traumatic intracranial hypertension have, resulted in an improvement in neurological outcome. The steps of protocol driven include, medical measures such as maintaining blood pressure and oxygenation, prophylactic hypothermia, using anaesthetics, analgesics and sedatives, drainage of cerebrospinal fluid (CSF) by ventriculostomy, mild hyperventilation, administering mannitol, hypertonic saline and barbiturates.

Decompressive craniectomy (DC), is considered to be one of the "second tier therapies" in post-traumatic medically refractory intracranial hypertension. It is a kind of the urgent neurosurgical "cerebral rescue" procedures, to increase the volume of the cranial cavity and decrease the secondary damage in patients with severe traumatic brain injury.

The literature published to date does not reveal a definitive evidence regarding the effectiveness and indications of DC. In this article we present our analysis of the clinical data from a non-randomized control trial using early decompressive craniectomy in patients with severe head injuries with intracranial hypertension.

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Objectives:

The aims of this investigation were to know the effectiveness of early decompressive craniectomy in patients with severe head injury associated with refractory intracranial hypertension using this procedure as the initial second tier surgical therapy; also to describe CT findings and the effects over ICP, CPP, compliance, hemodynamic and other intracranial parameters in this kind of patients.

This study was carried out to examine with particular attention the relation between early decompressive craniectomy to long-term functional outcome.

Methods:

We have conducted a non-randomized controlled trial, in 68 patients admitted at intensive care unit of Moron General Hospital in Ciego de Avila, Cuba, with severe head injury (Glasgow coma scale (GCS) < 8) , in the period between January 2003 and December 2007.

Initial computarized tomography (CT) scans were obtained from all patients on admission; they were classified according to Marshall´s system. Sequentials CT scan were indicated to assess neurological deterioration in the ICU patients or every 72 hours.

According to initial CT scan results, the time span between admission and starting intracranial hypertension and the treatment modality, the patients were distributed in two groups.

Group I (Early DC): **Included patients with diffuse injury IV (midline shift > 5 mm, not high or mixed density lesion > 25 cc) or non-evacuated mass lesion (high or mixed density lesion > 25 cc not surgically evacuated). DC was performed in the first 12 hours post-trauma in patients with clinical, radiological and by continuous ICP monitoring evidence of refractory intracranial hypertension (ICP> 25 mmHg) as the first second tier therapy. DC was performed without ICP monitoring only in patients who require urgent surgery.**

Group II (Conventional treatment): Included patients with diffuse injury I - III, whom were admitted in intensive care unit to continuous ICP monitoring and medical treatment, showing clinical deterioration, worsening of GCS score and/or dilation of pupils unresponsive to light, with intracranial hypertension to more than 25 mmHg and or reduction of cerebral perfusion pressure to less than 55 mmHg longer than 12 hours after head trauma. If sequential CT scan showed worsening of images with appearance of diffuse injury IV or high/mixed density lesions > 25 cc and refractory intracranial hypertension appeared, surgical treatment was needed at this moment and it was considered as delayed DC.

Patients with CT scan imaging demonstration of severe brainstem injury, with initial GCS of 3, without improvement and bilateral dilated and fixed pupils were excluded.

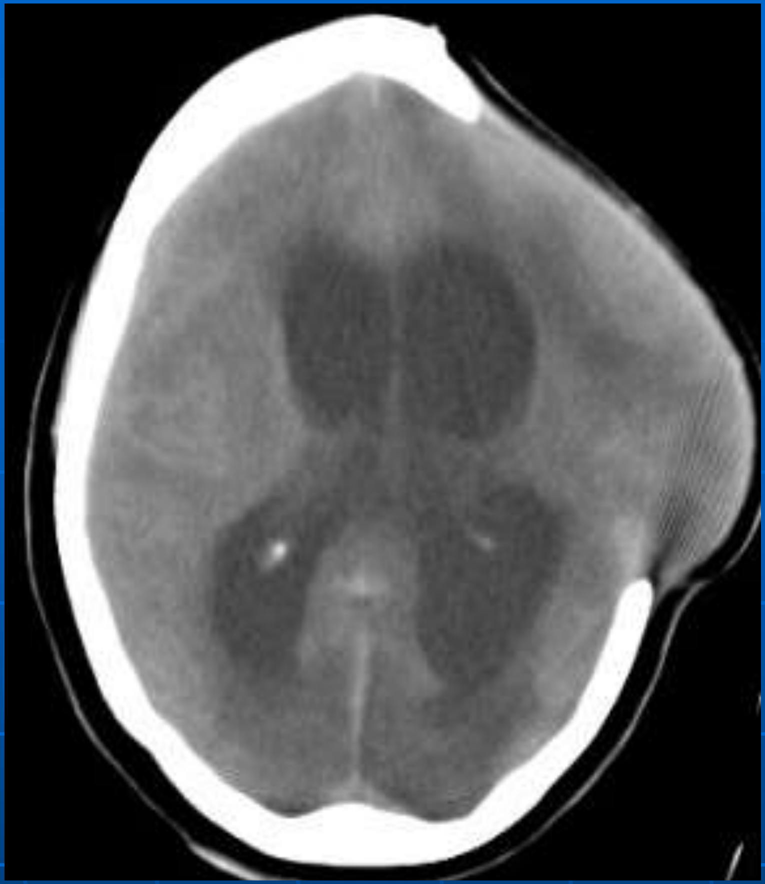
Moron´s train station

Surgical Technique:

The surgical procedure included a large unilateral or bilateral curvilinear incision in the fronto-temporal-parietal (F-T-P) area or a large bifrontal skin incision. After preparation of a myocutaneous flap, a craniectomy with a free F-T-P bone flap is performed (>12 cms), with expansive duroplasty starting at the temporal base. In bilateral frontal-temporal-parietal DC, only a rim of bone remains on the sagittal suture to avoid ligating the sagittal sinus.

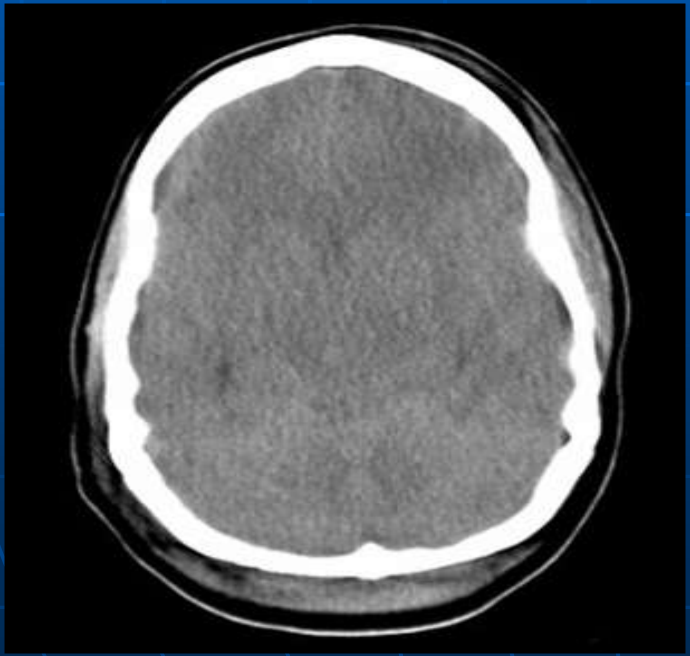
The extension of bifrontal DC with expansive duroplasty was from the floor of the anterior cranial base to the coronal suture posteriorly, and to the pterion laterally. A bridge of bone in the midline can be left over the superior sagittal sinus. We advocate to avoid the frontal air sinus an sagittal sinus. In both procedures the dura is enlarged with temporal fascia followed by watertight closure and the bone flap was preserved in anterior abdominal wall.

Bifrontal decompressive craniectomy with bone flap prepared to keep out in anterior abdominal wall.



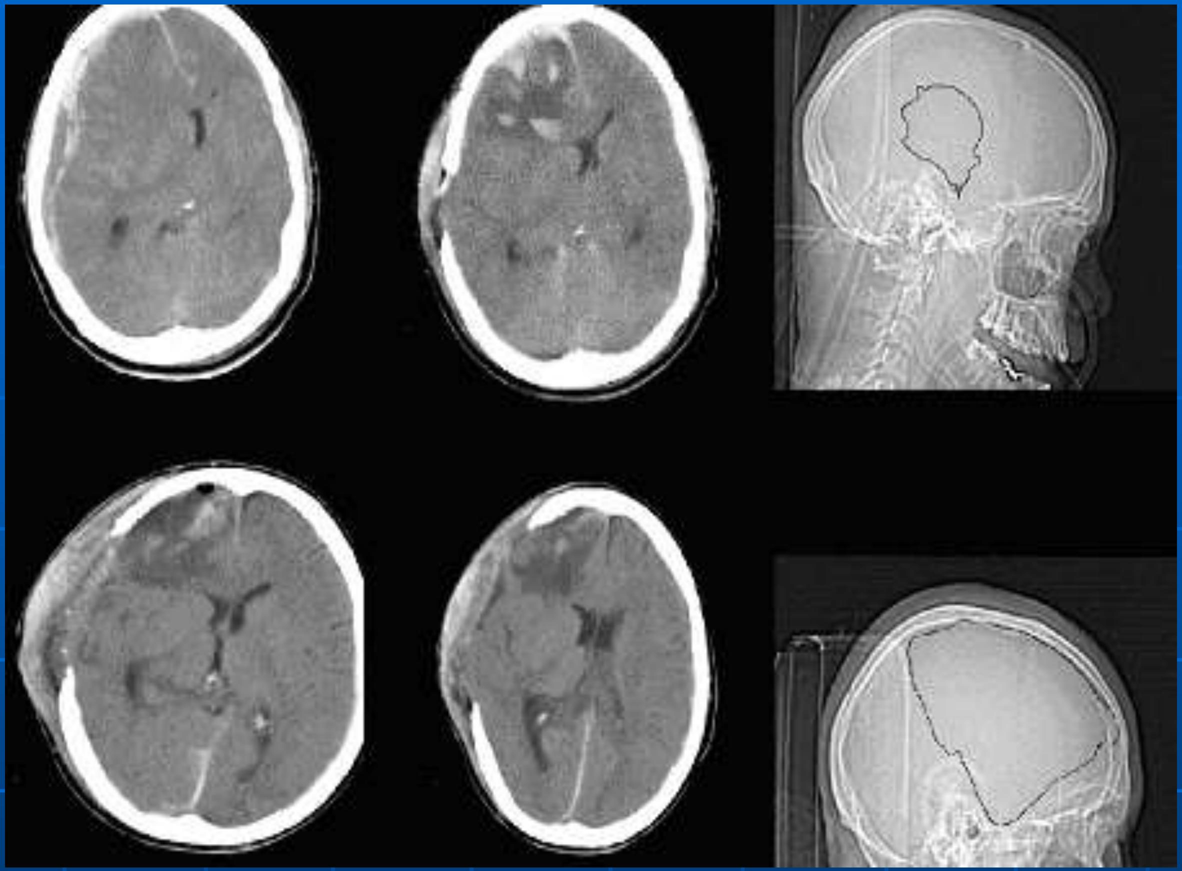
Hydrocephalus after decompressive craniectomy. VP CSF shunt

Petient with 58 years old, He was received in the emergency room 1 hour after head trauma, 7 points in GCS, initial CT scan is showed below. He was taken to operating room and ICP was monitored by external ventriculostomy showing values over 25 mmHg after manitol bolus administration. A bifrontal decompressive craniectomy was performed.



Initial CT Scan

Intraoperative images



A 30 year old patient operated on with intracranial hypertension after initial unenough decompressive FTP hemicraniectomy

ICP monitoring:

The ICP monitoring was performed by external strain gauge pressure transduction technology. External strain gauge transducer was coupled to the patient´s lateral ventriculostomy, where the catheter tip transducer was placed, via fluid-filled lines. The external transducer was maintained fixed at the ventricular level to avoid measurement error. The duration of ICP monitoring was 5 days on average and all patients received prophylactic antibiotics.

Standardized protocol for medical therapy:

Medical management of intracranial hypertension included the following measures: elevation of the head 20º, hemodynamic stabilization, sedation with analgesics and sedative, CSF drainage, intravenous administration of manitol in intermittent boluses (0,25g / kg / dosis / 4 hours), controlled mild hyperventilation (PaCO2: 30-35 mmHg) and muscle relaxation if indicated. Barbiturate medication was not used.

Data collection:

The following patient data were prospectively collected: date of the accident, mechanism of injury, age of the patient, neurological status at admission (GCS score), pupillary response, initial and sequential CT scan results, data of medical ICP therapy, surgical procedures and complications. Outcome was scored using the Glasgow Outcome Scale (GOS). A GOS score of good recovery (grade 5) and with moderate disability (grade 4) was considered to be a satisfactory outcome. A GOS score with severe disability (grade III), vegetative state (grade II) or dead (grade I), was considered to be unsatisfactory outcome.

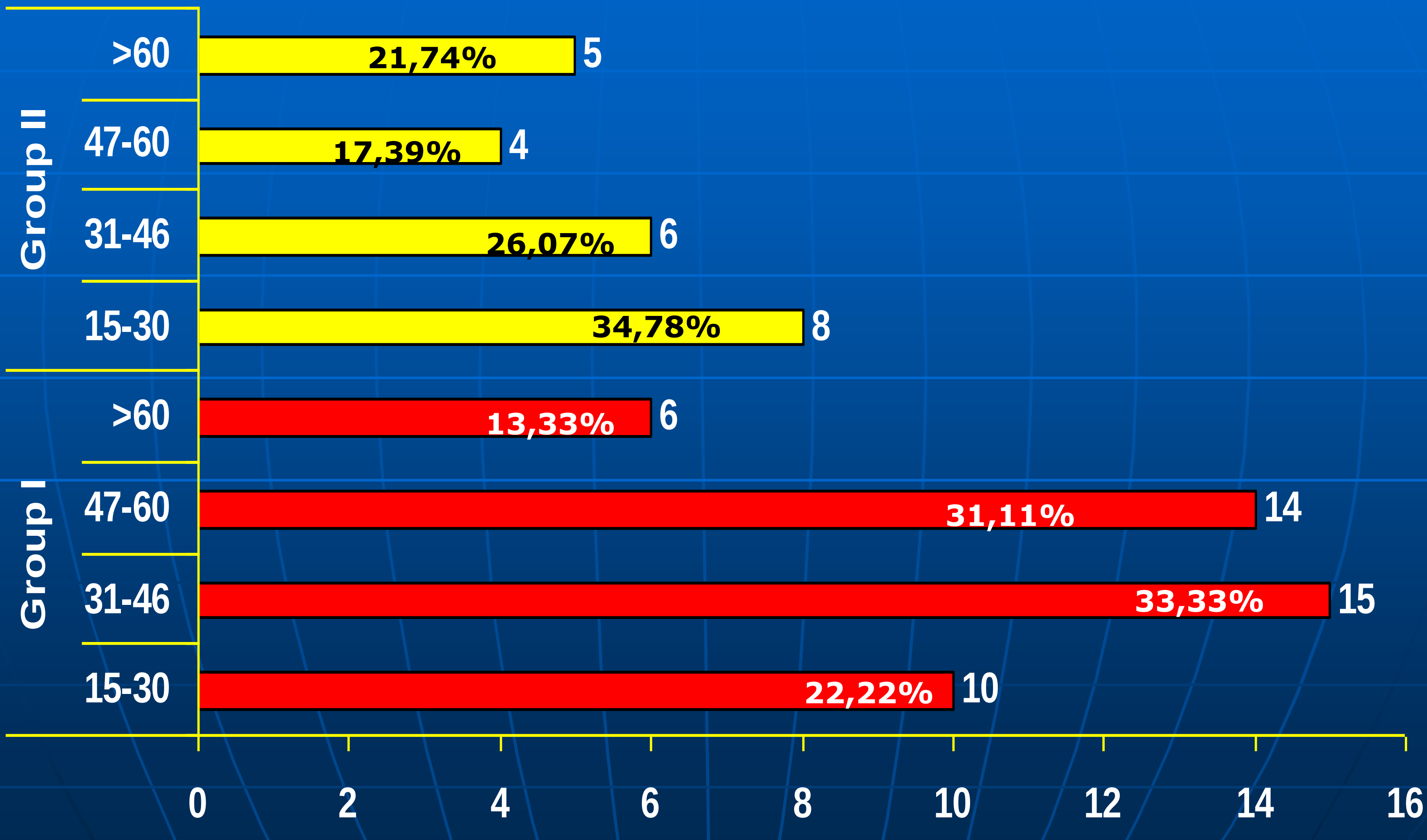
Statistical analysis:

A data base was created using SPSS system, version 11.5. The Chi-Square test was used to tabulates the variables into categories and compares the observed and expected frequencies in each category. p-value of less than 0.05 was deemed significant.

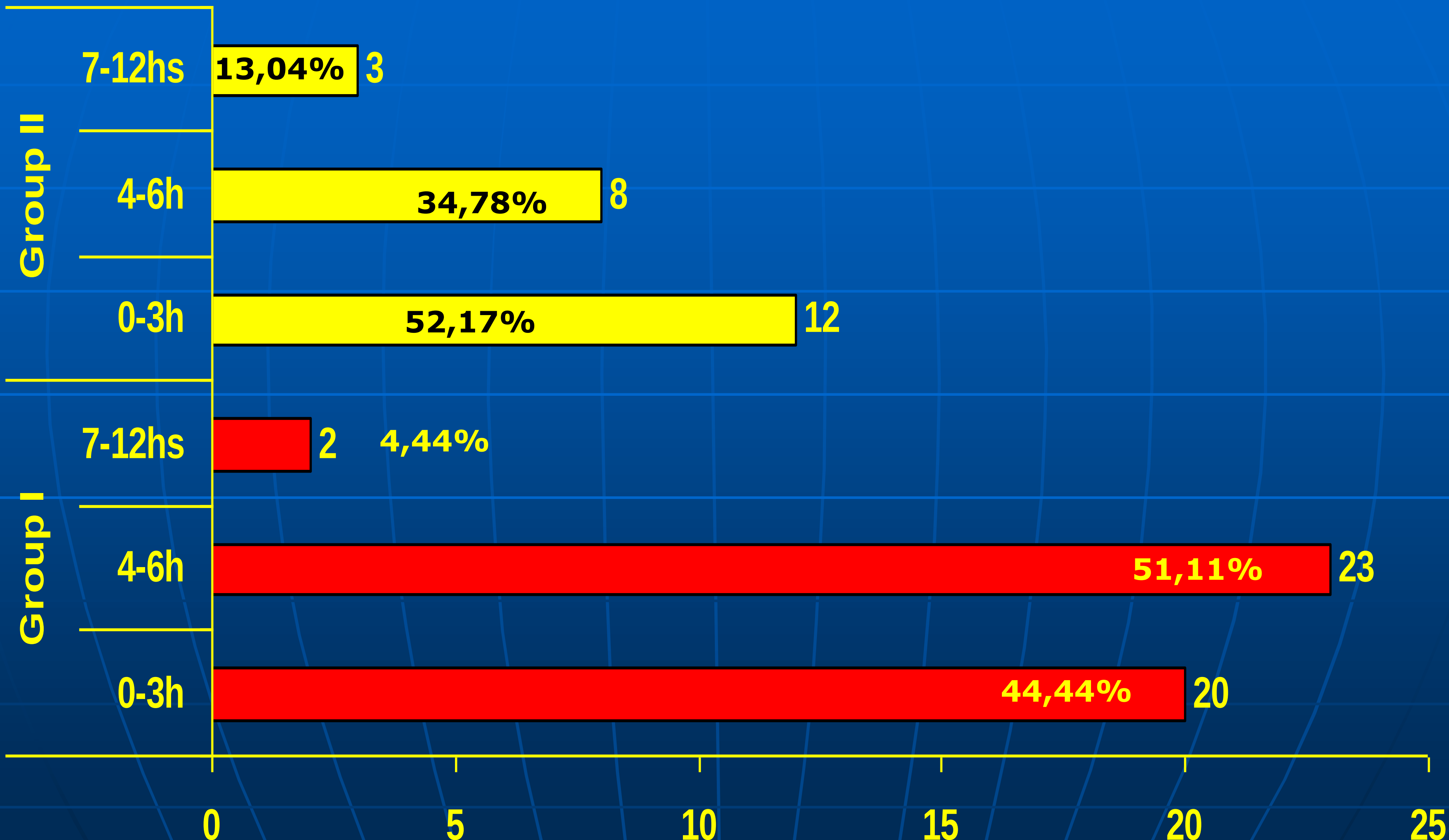
The bivariate Pearson’s correlation coefficient, was used to measure how variables were related in linear association with GOS.

RESULTS

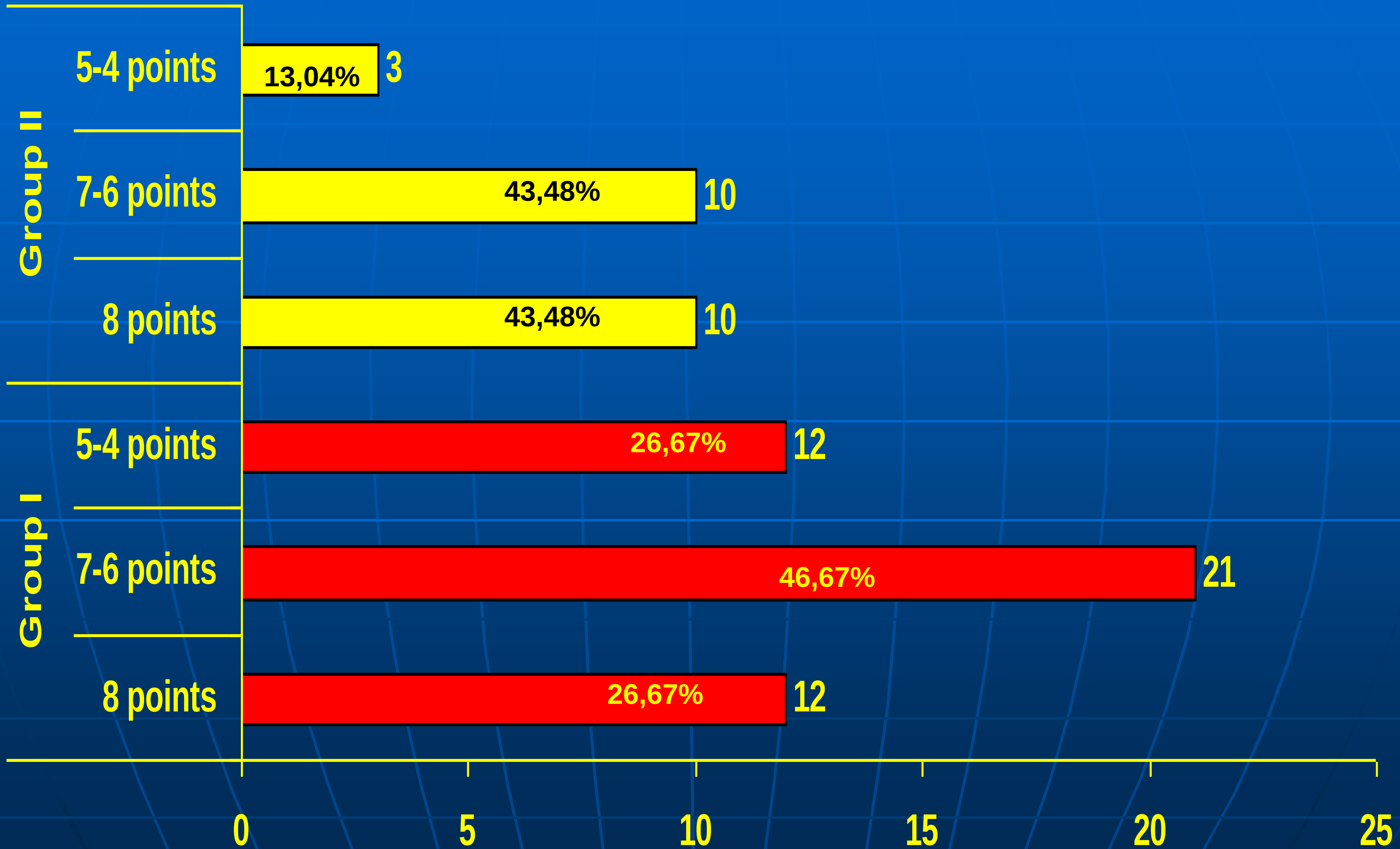
Age distribution



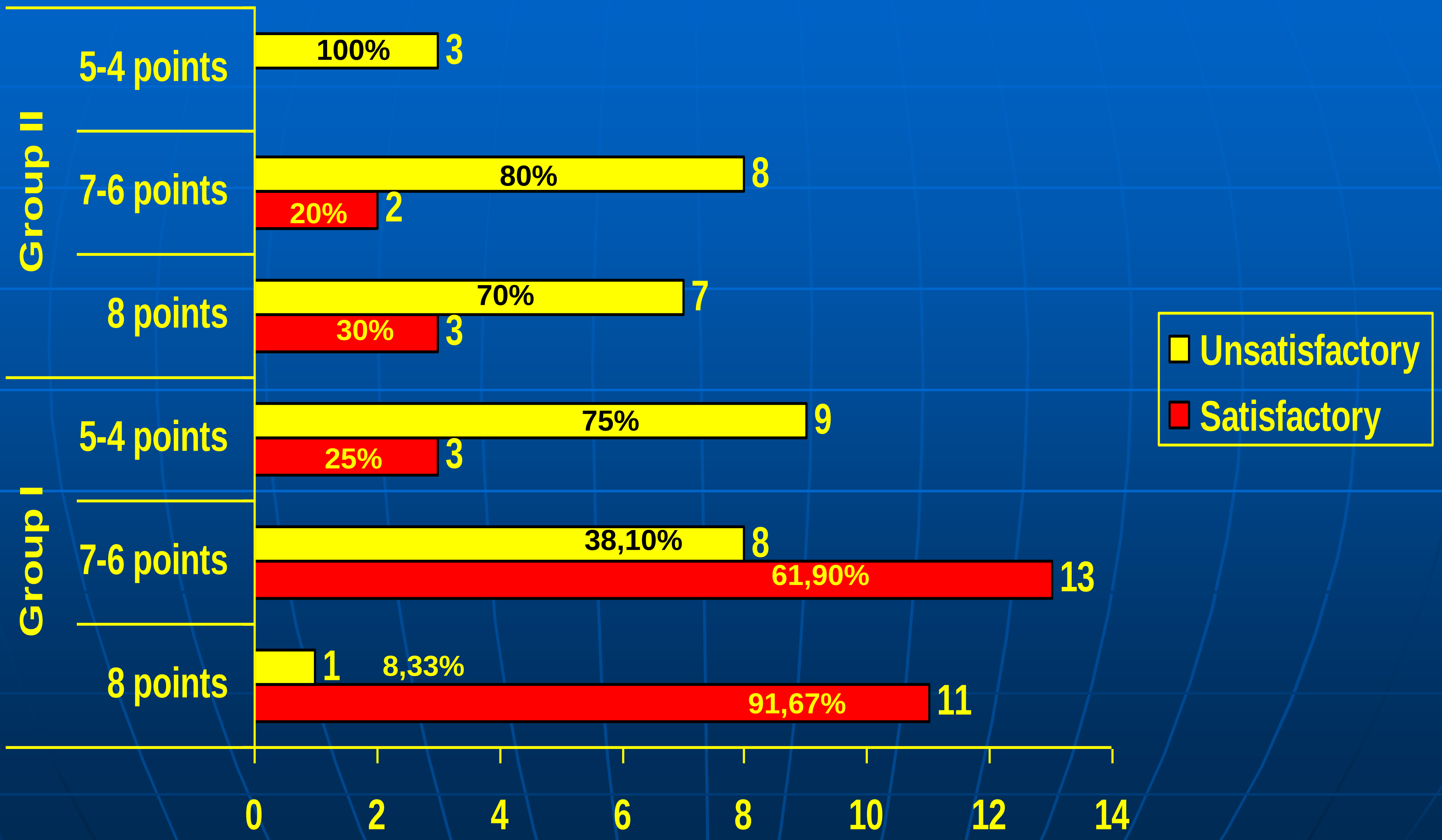
Mean time of patients arrival to Emergency Room after head trauma



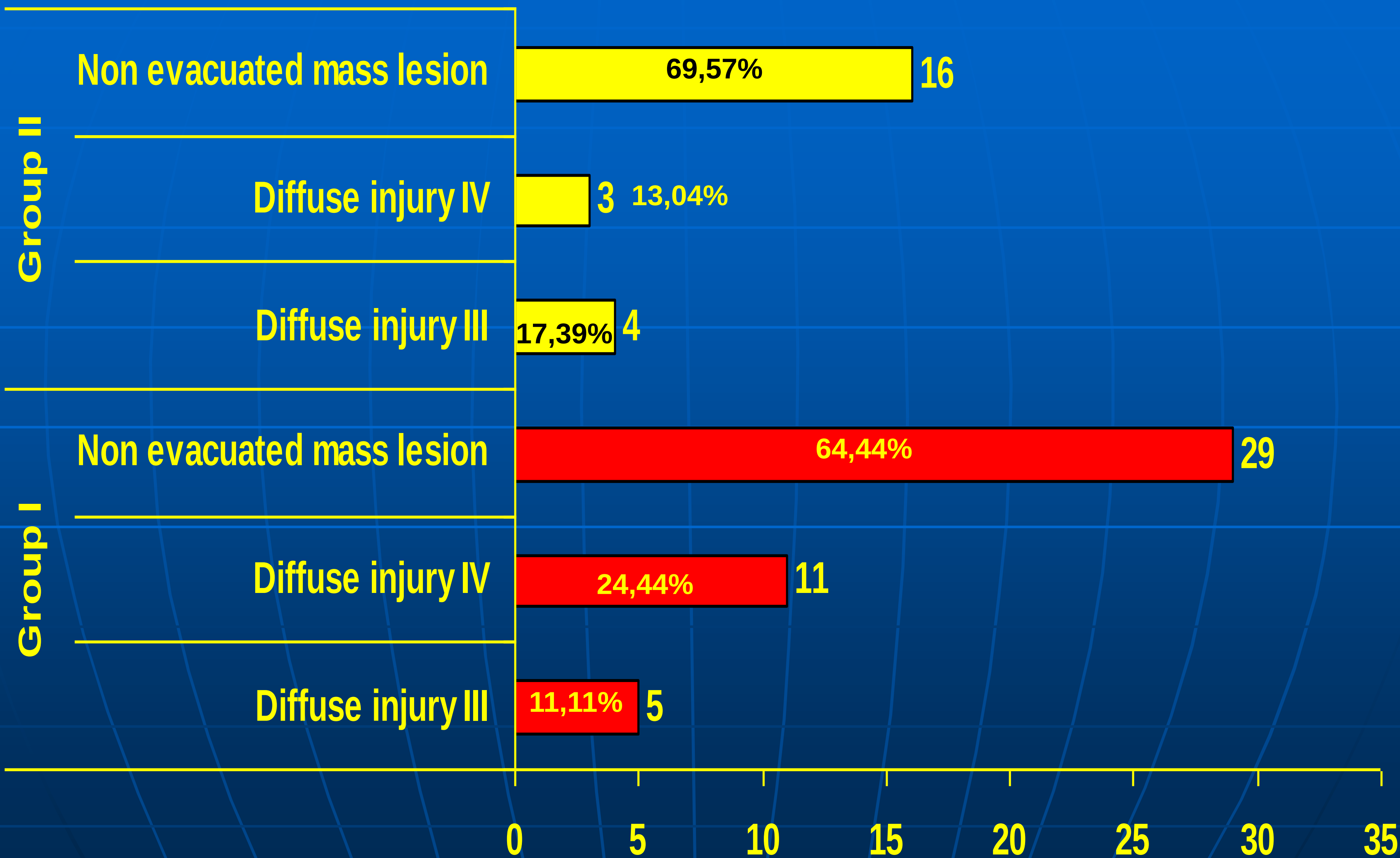
Initial Glasgow Coma Scale.



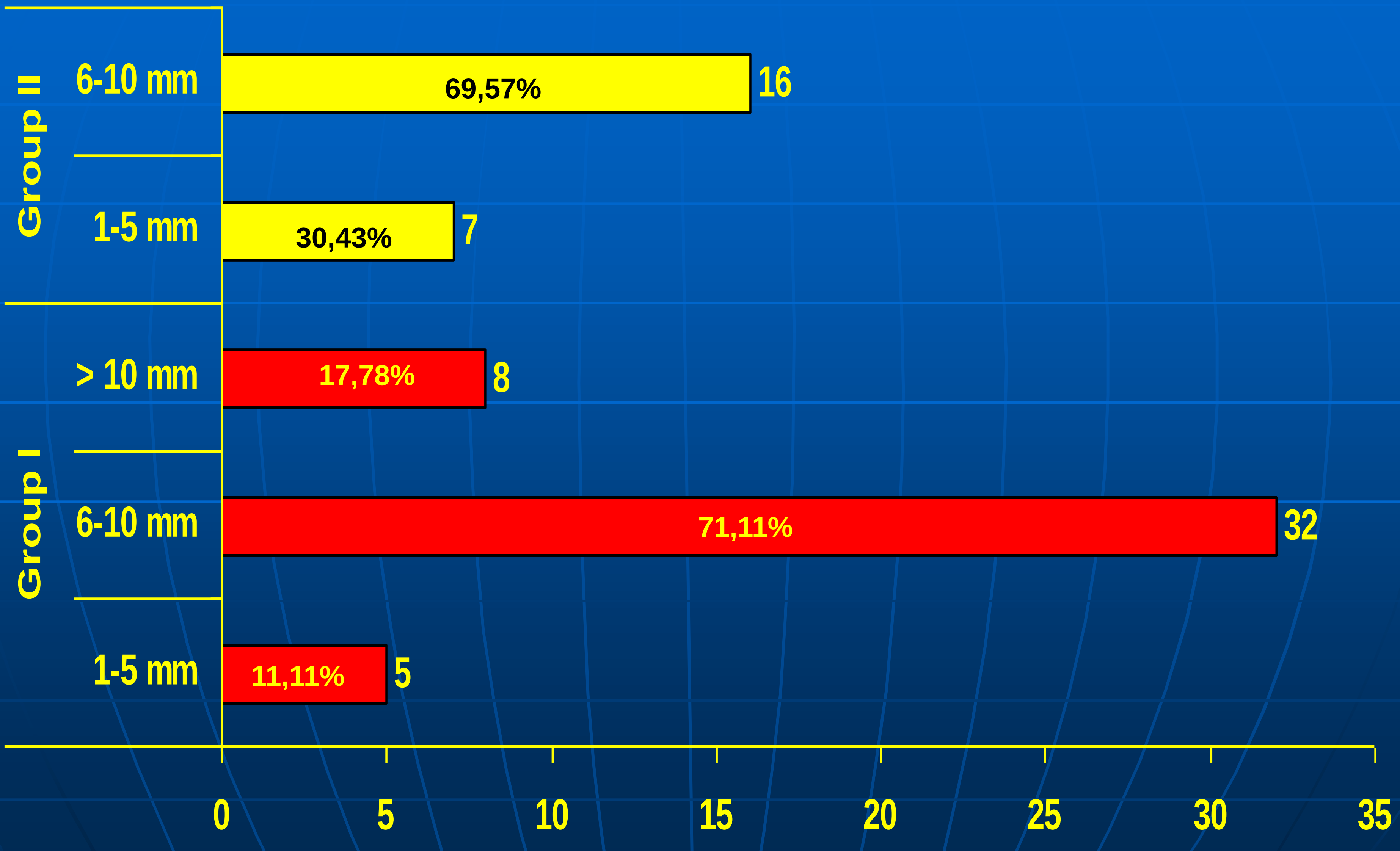
Relation between initial GCS and Outcome.



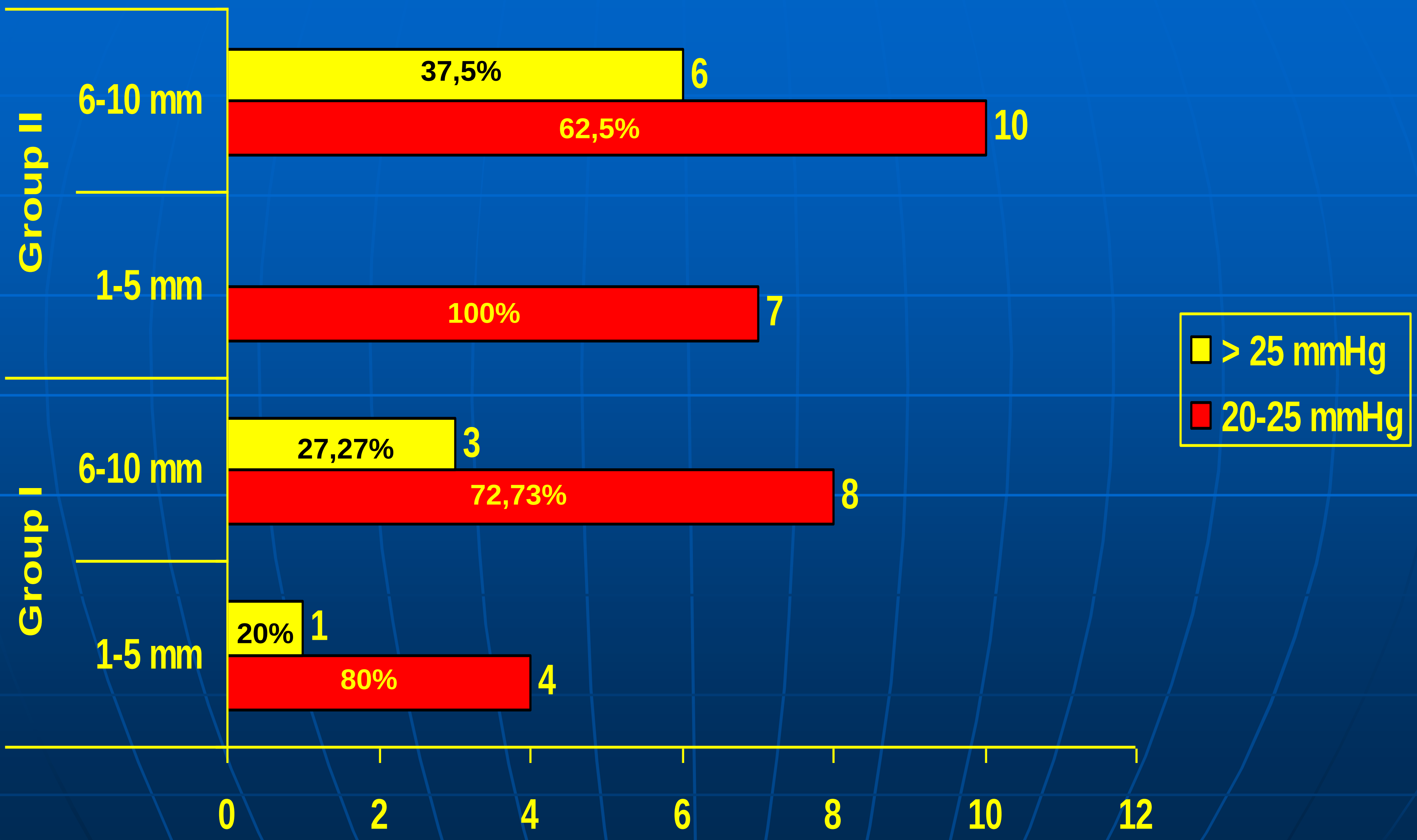
Initial CT classification of severe head injury.



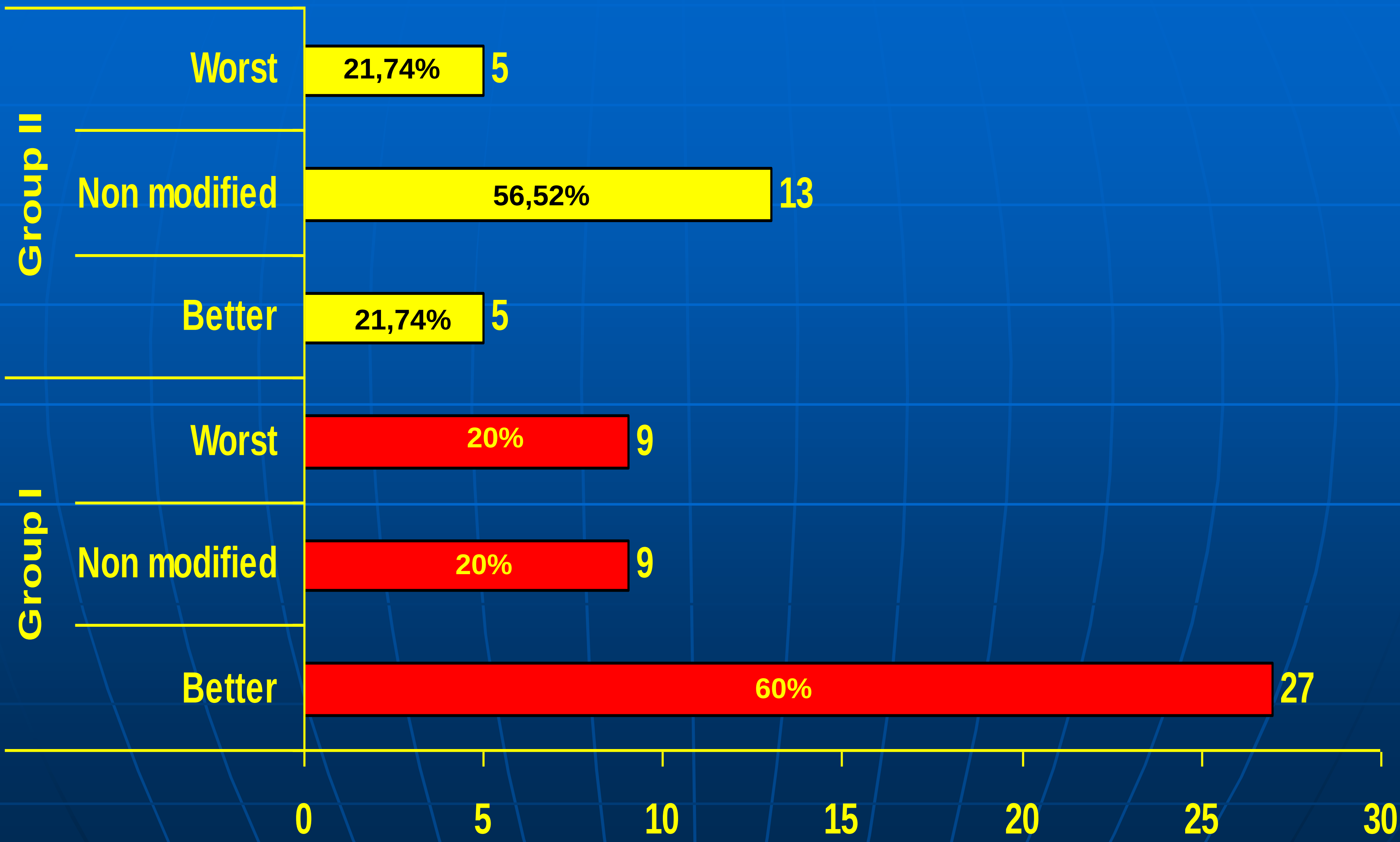
Presence of midline shift deviation on initial CT scan.



Relation between midline shift deviation and ICP (in patients monitoring before operation).



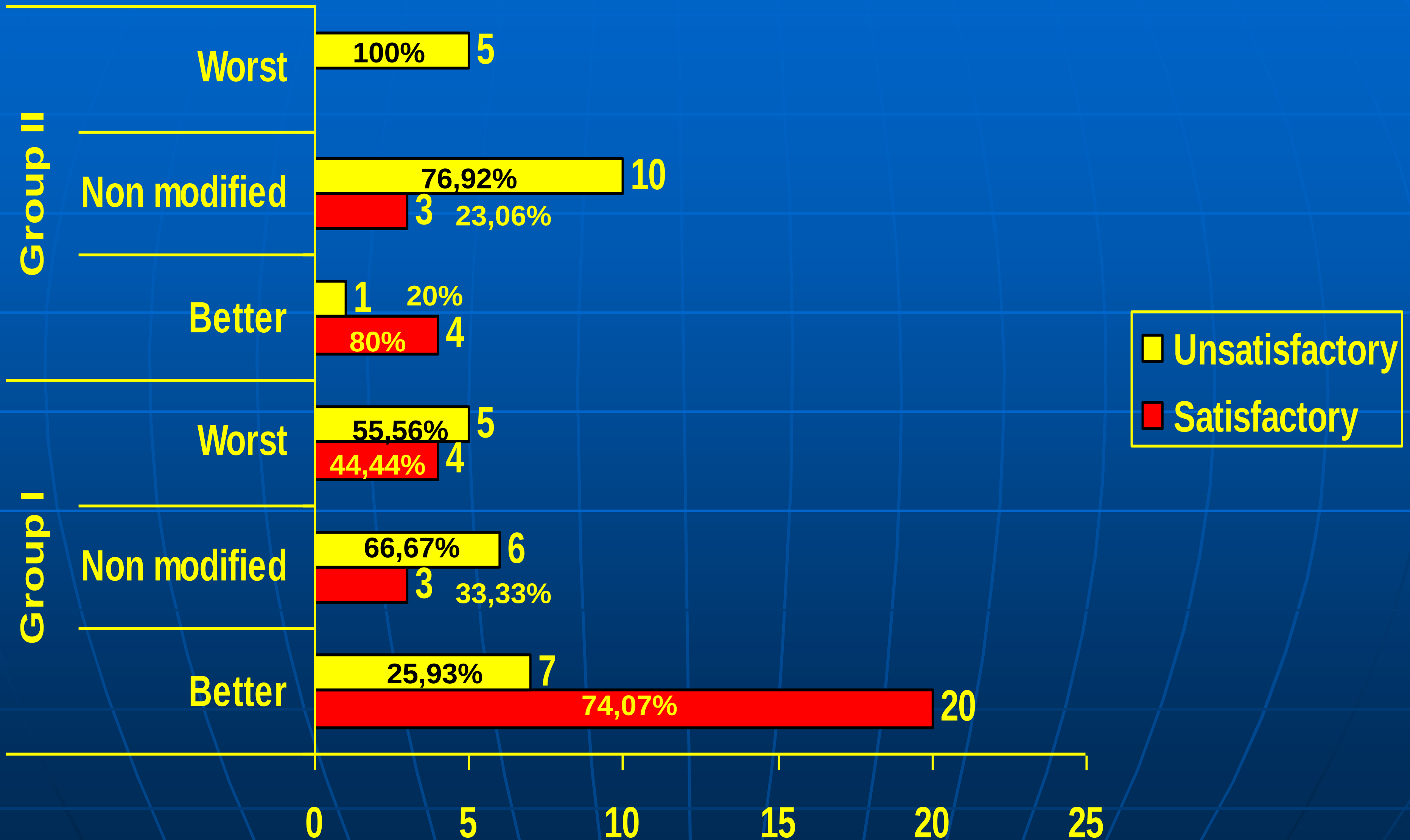
Sequential CT scan.



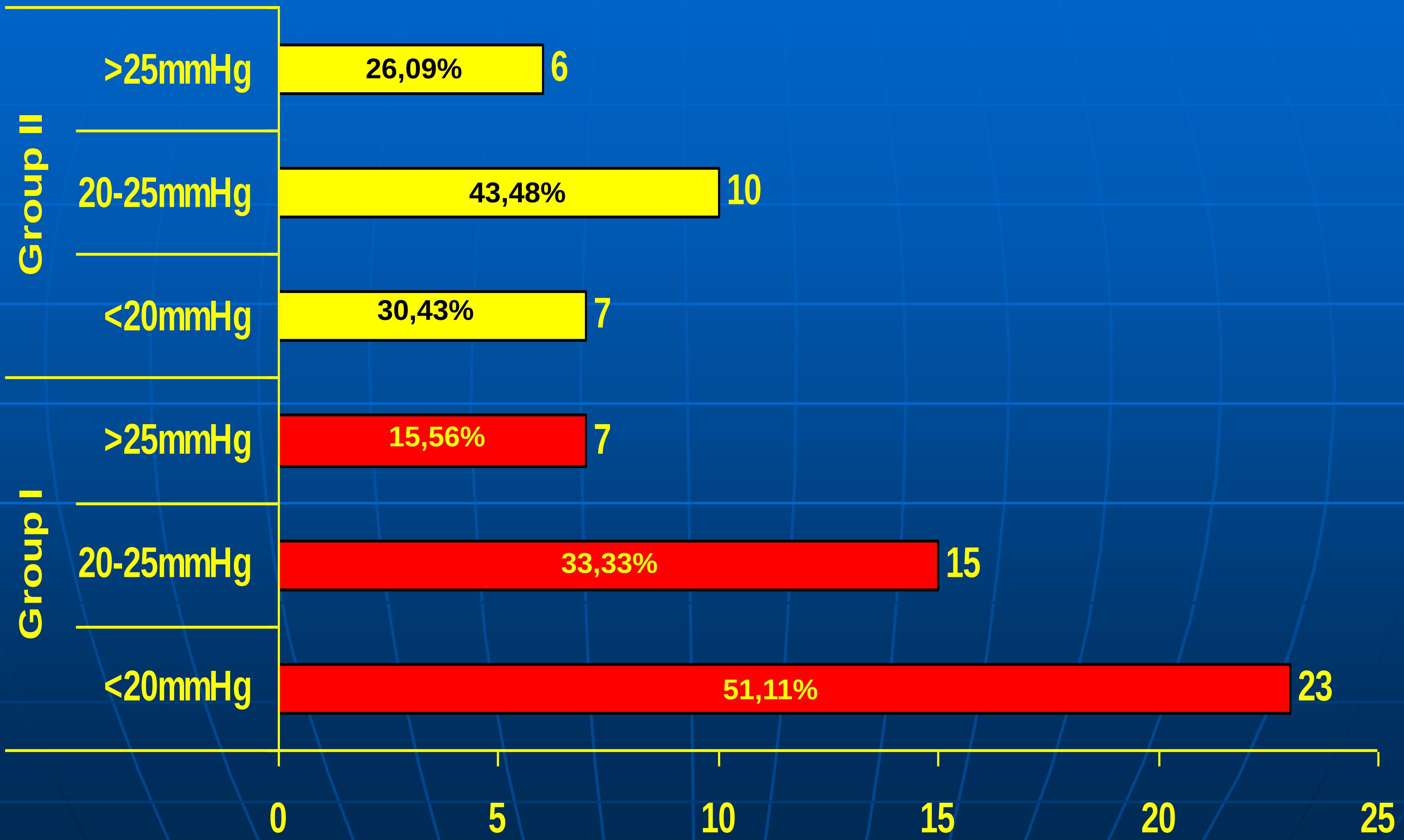
Relation between initial CT scan and sequential CT scan.

Initial CT scan	Sequential CT scan					
	Group I			Group II		
	Better	Non modified	Worst	Better	Non modified	Worst
Diffuse injury III	4 (8,89%)	1 (2,22%)	-	1 (4,35%)	3 (13,04%)	-
Diffuse iinjury IV	9 * (20%)	1 (2,22%)	1 (2,22%)	1 (4,35%)	2 (8,70%)	-
Non evacuated mass lession	14 (31,11%)	7 (15,56%)	8 (17,78%)	3 (13,04%)	8 (34,78%)	5 (21,74%)
Total	27 * (60%)	9 (20%)	9 (20%)	5 (21,74%)	13 (56,52%)	5 (21,74%)

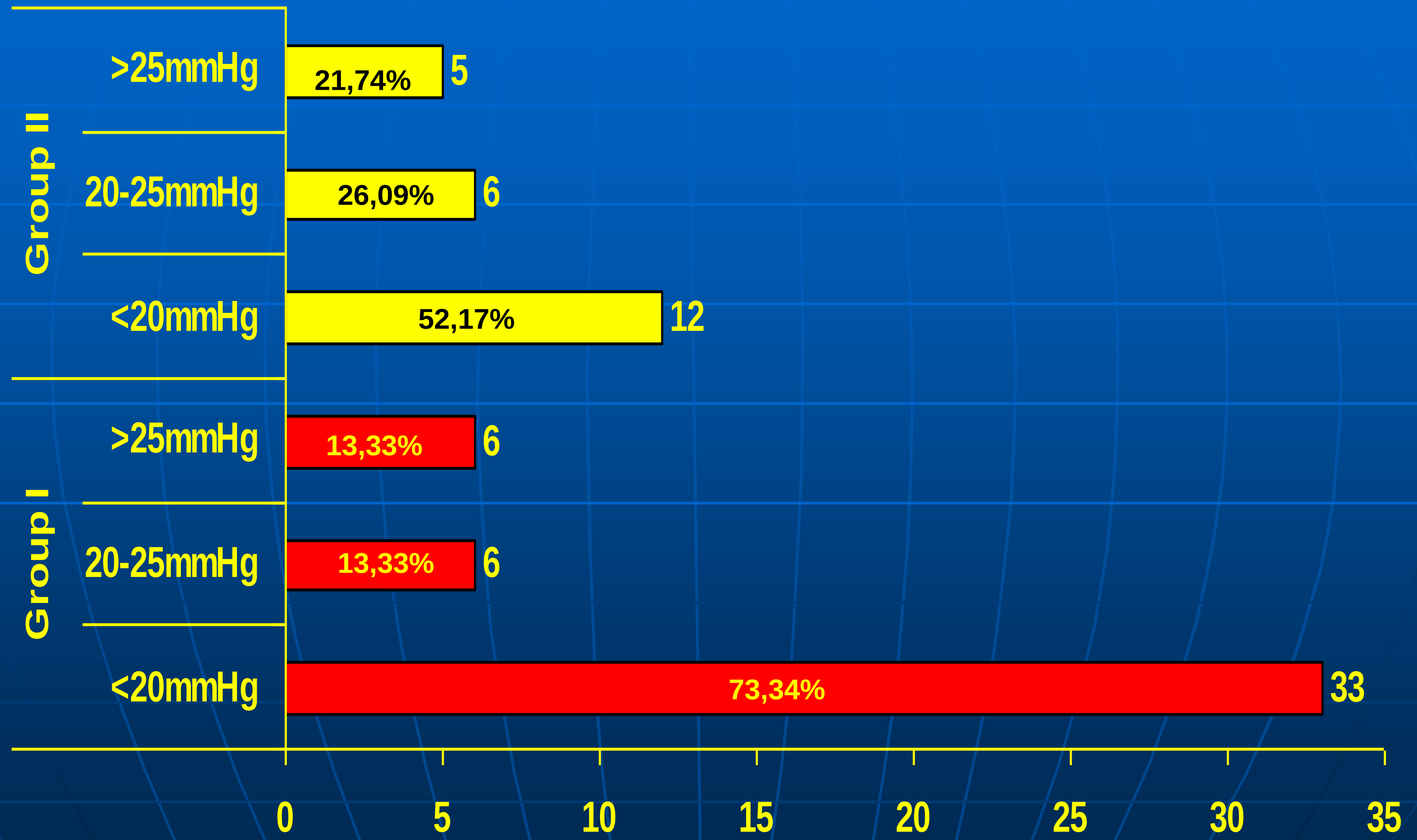
Relation between sequential CT scan and Outcome.



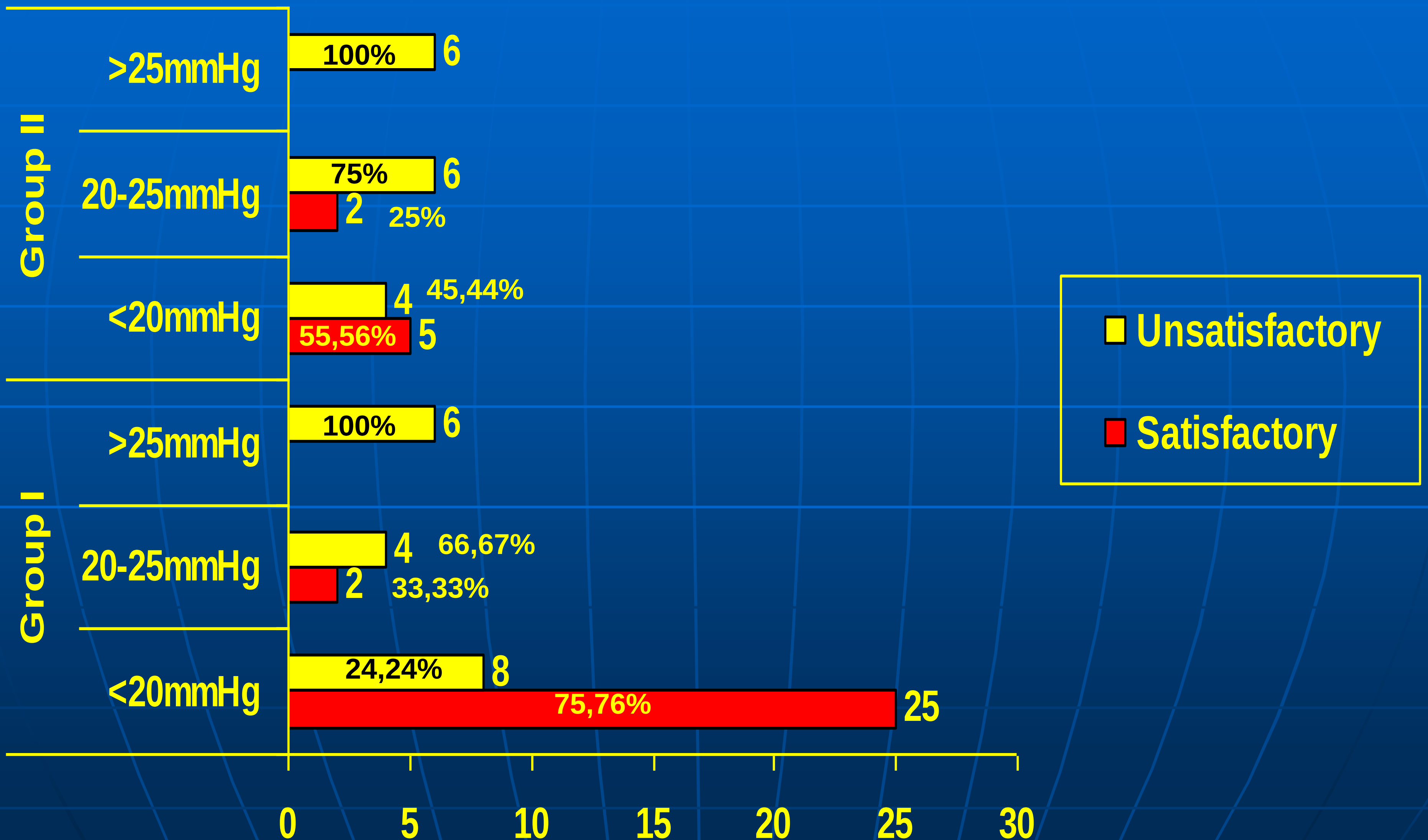
ICP at first 24 hours of treatment.



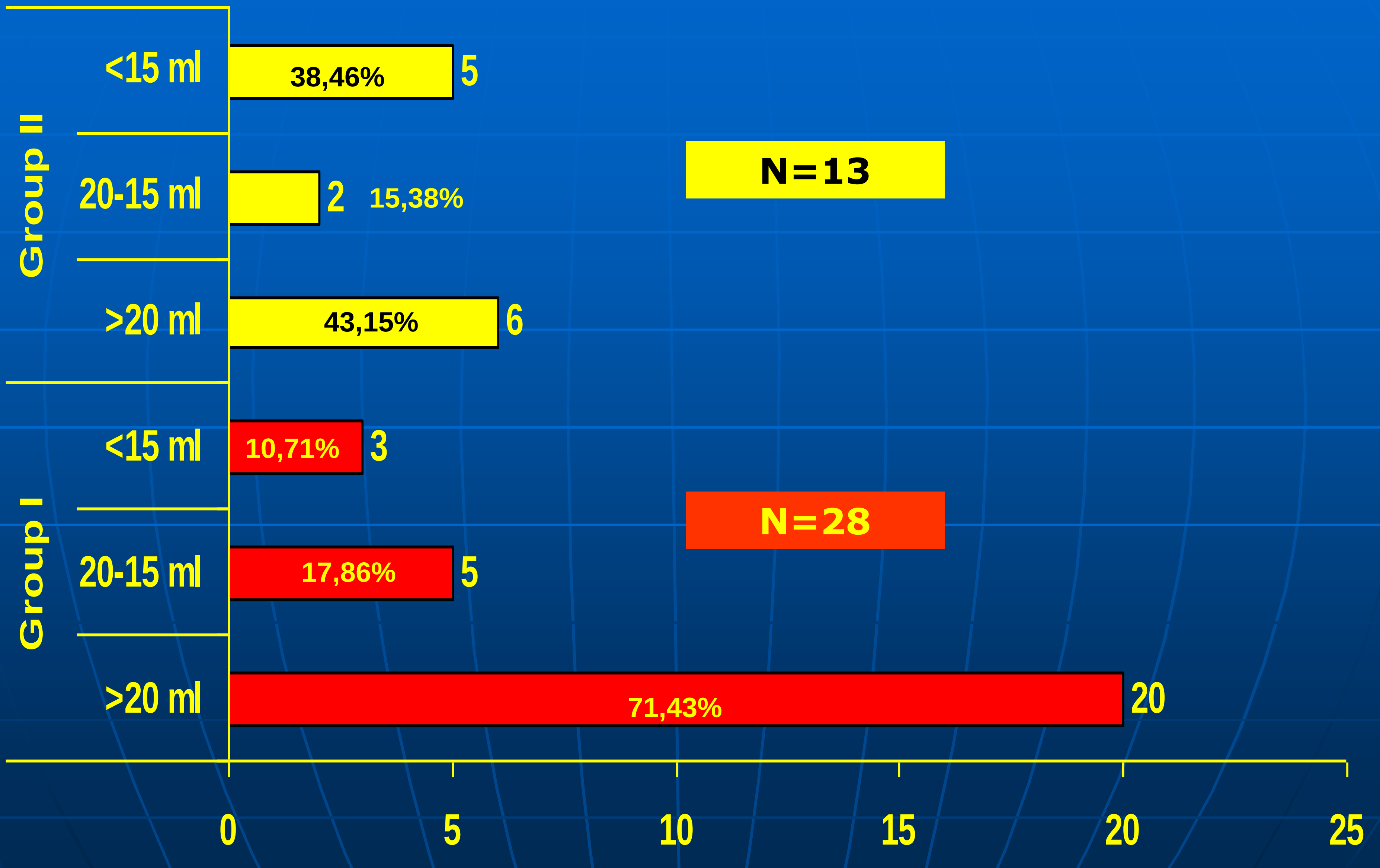
ICP between 2nd-5th days of treatment.



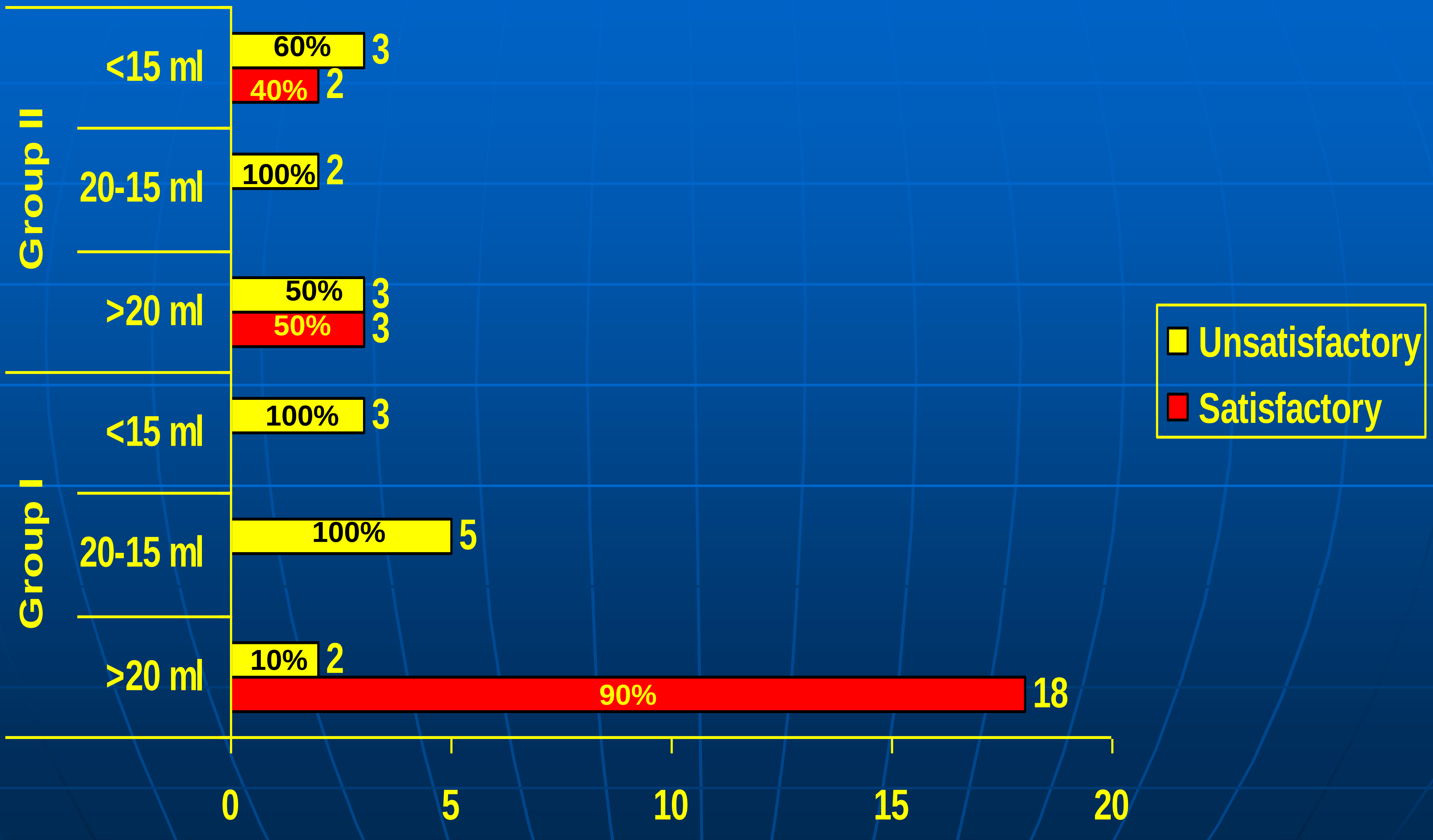
Relation between mean ICP and Outcome.



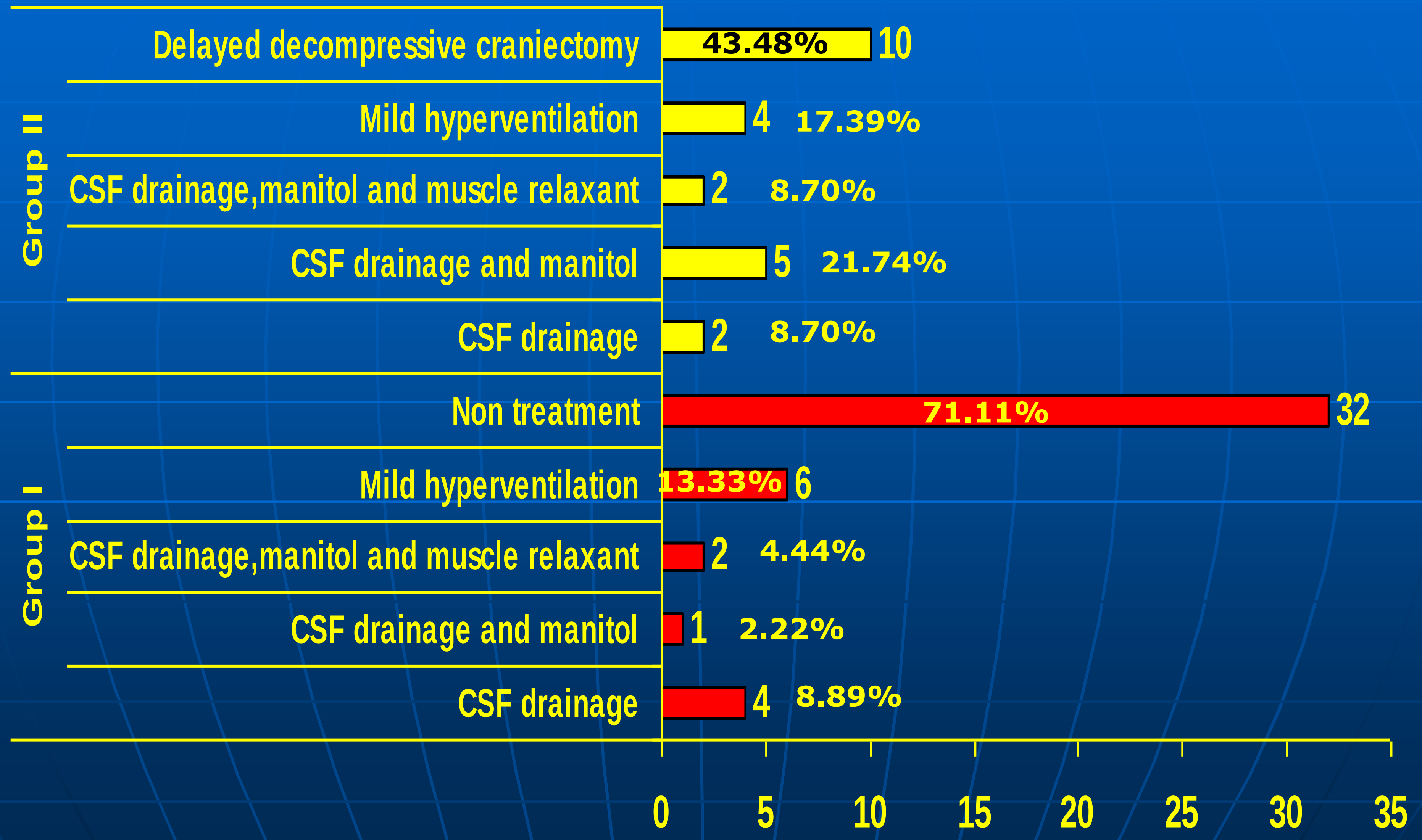
Compliance behavior.



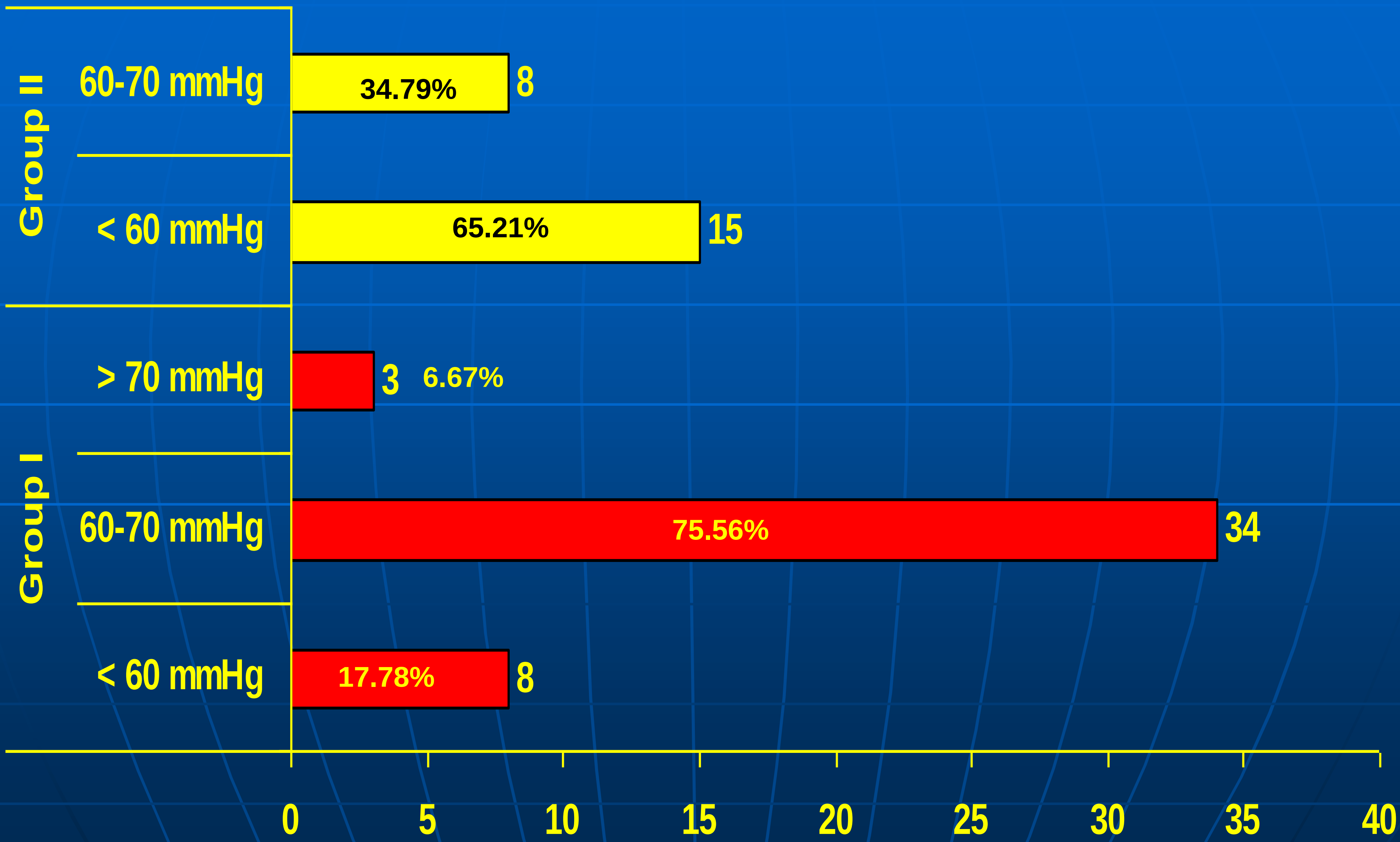
Relation between compliance behavior and outcome.



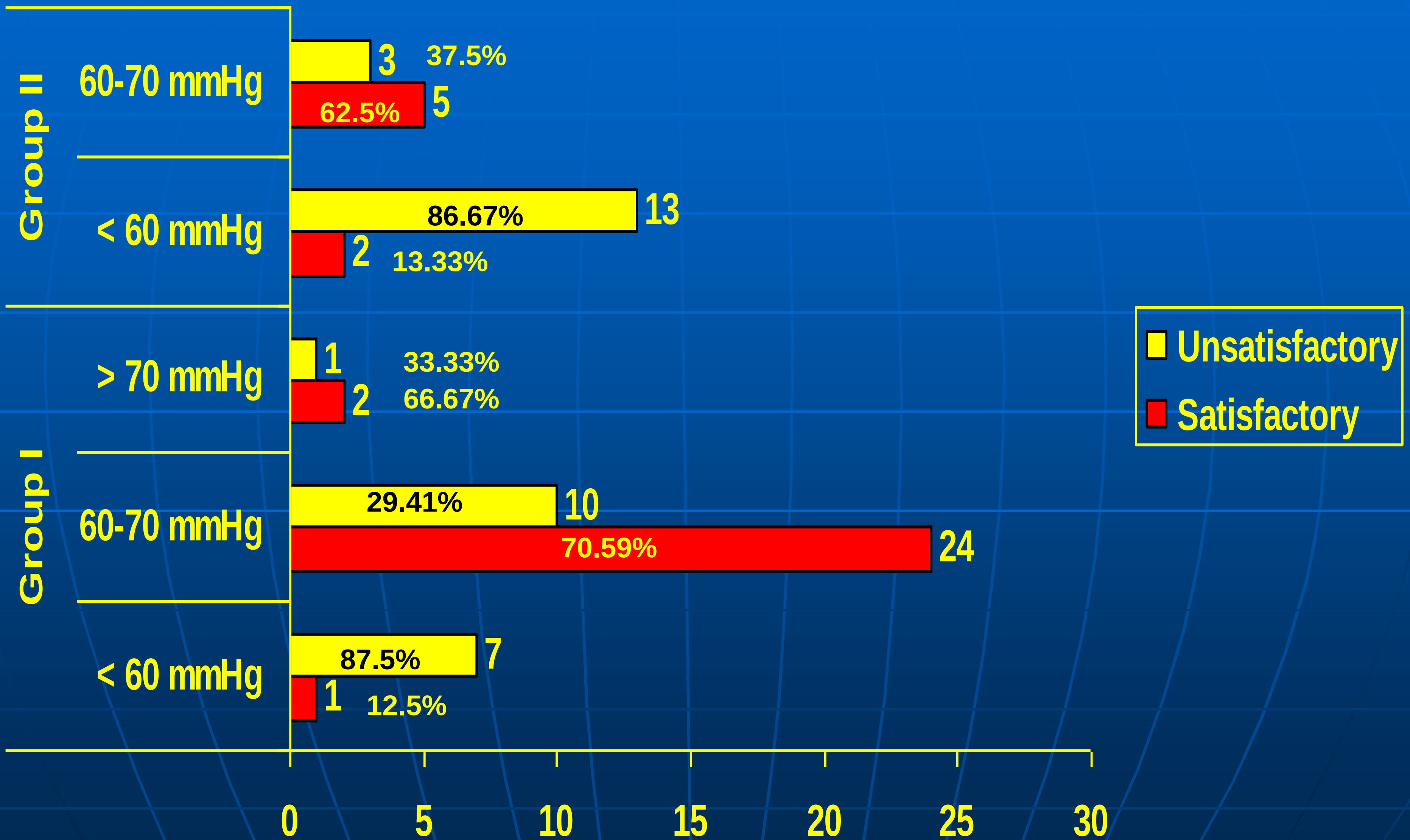
Treatment for intracranial hypertension.



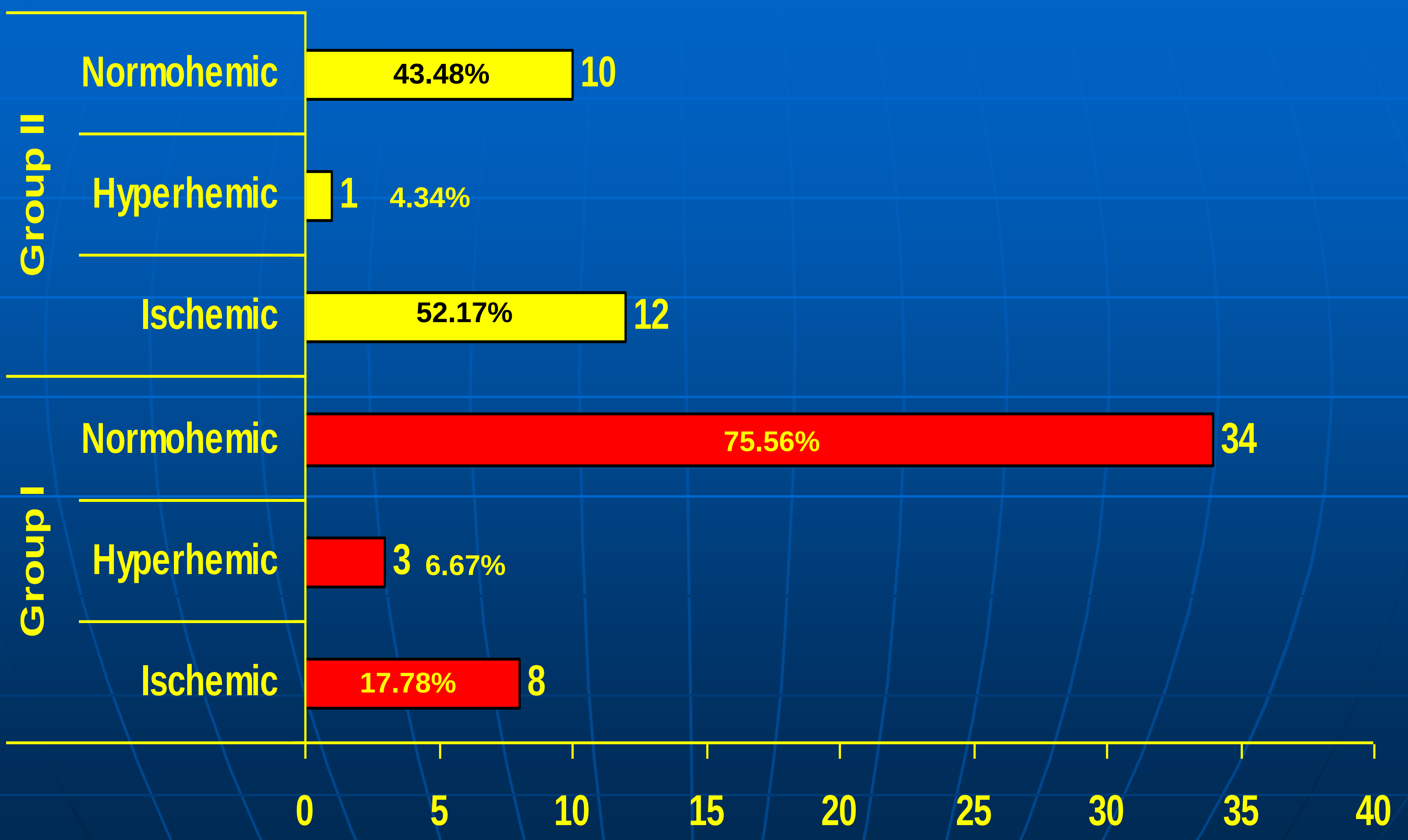
Cerebral Perfusion Pressure (CPP).



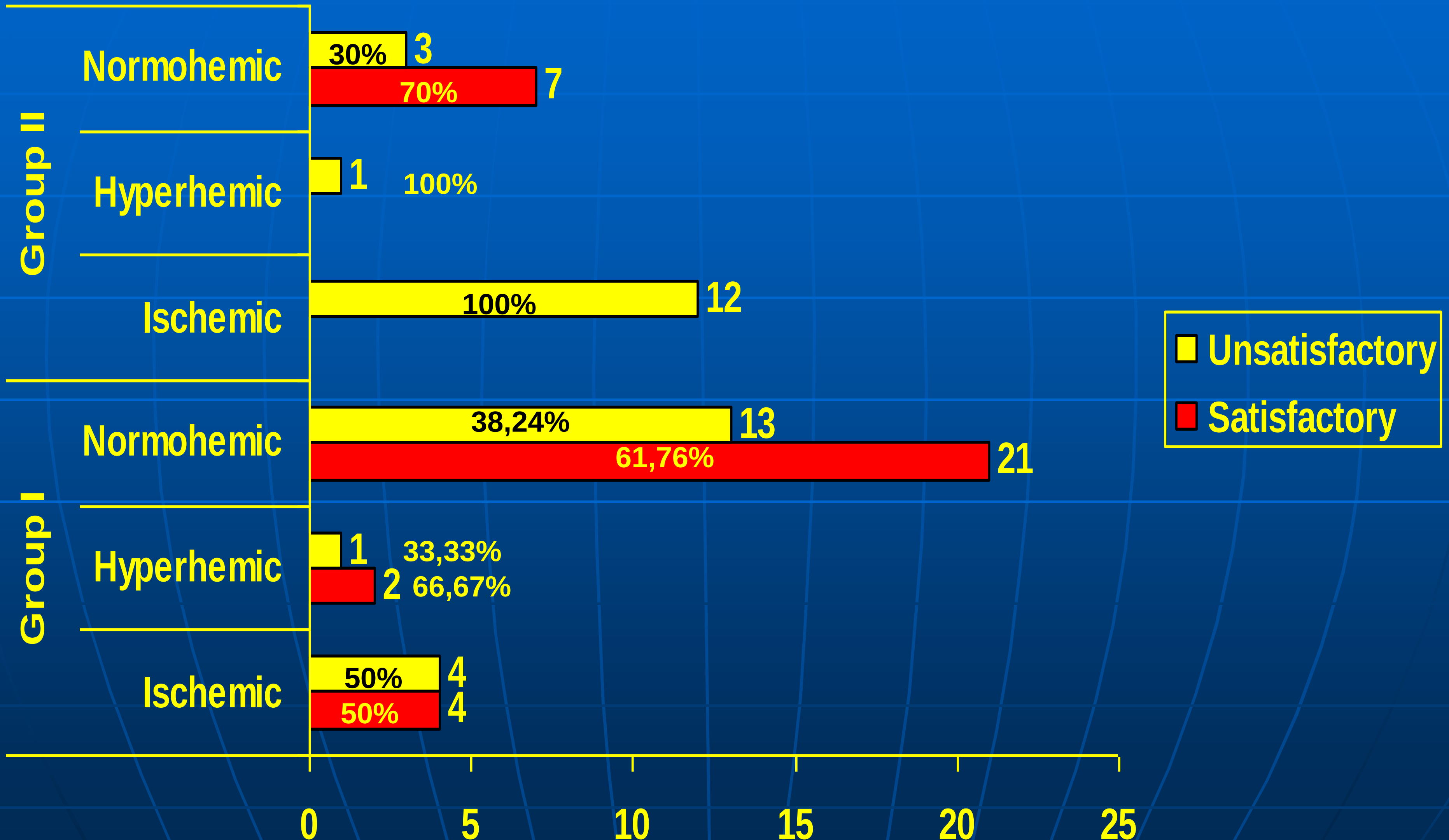
Relation between CPP and Outcome.



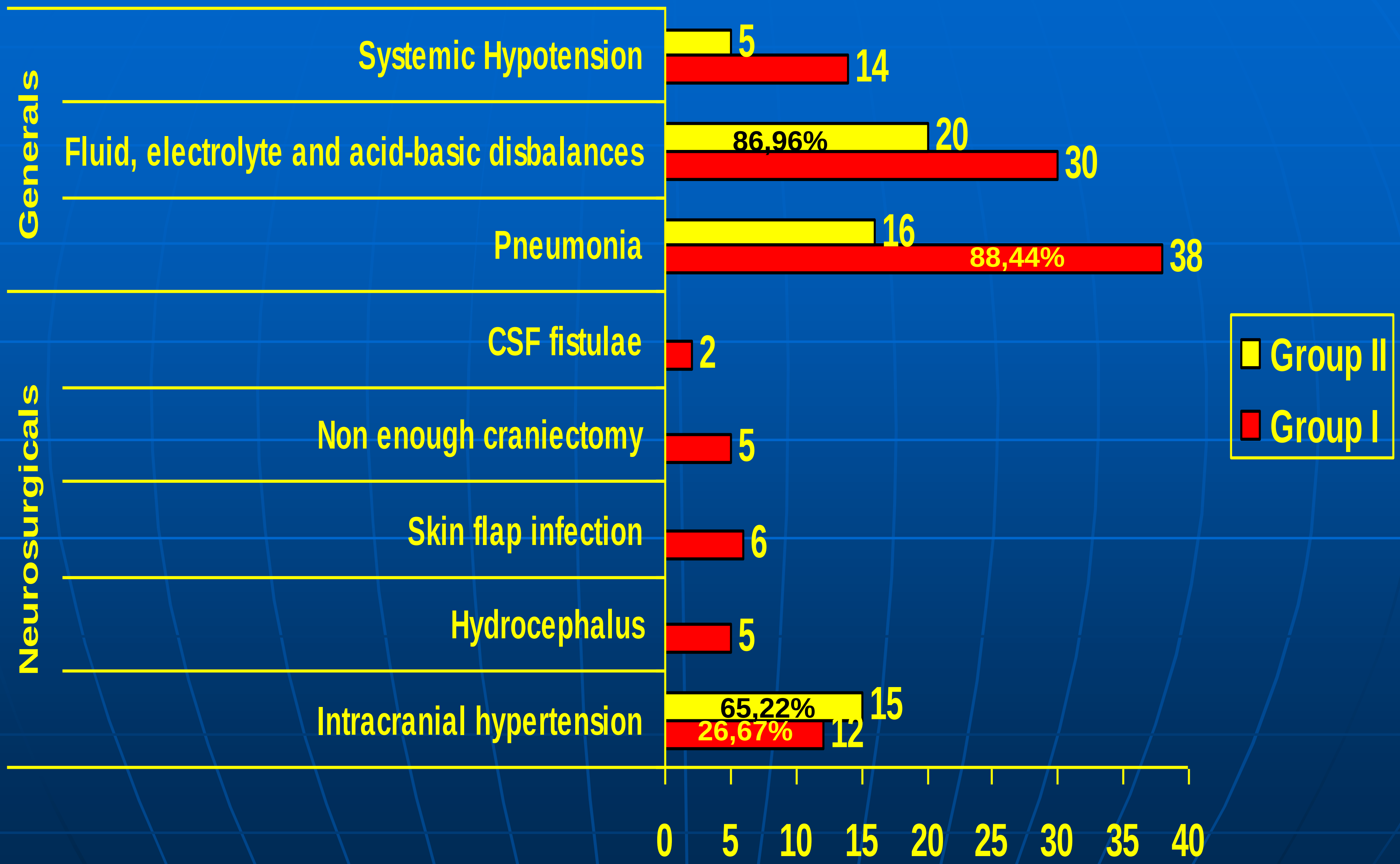
Cerebral Hemodynamic.



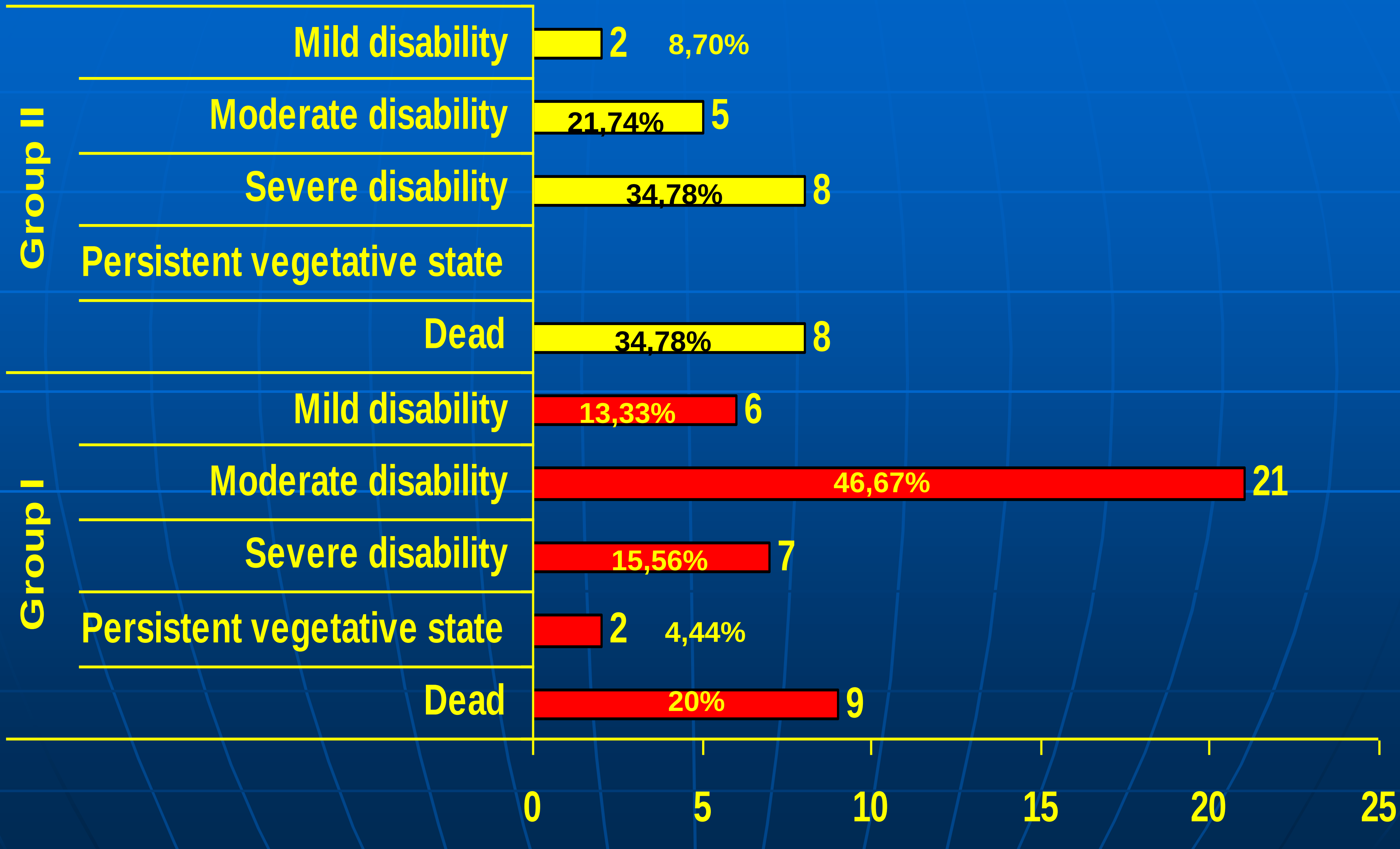
Relation between Cerebral Hemodynamic and Outcome.



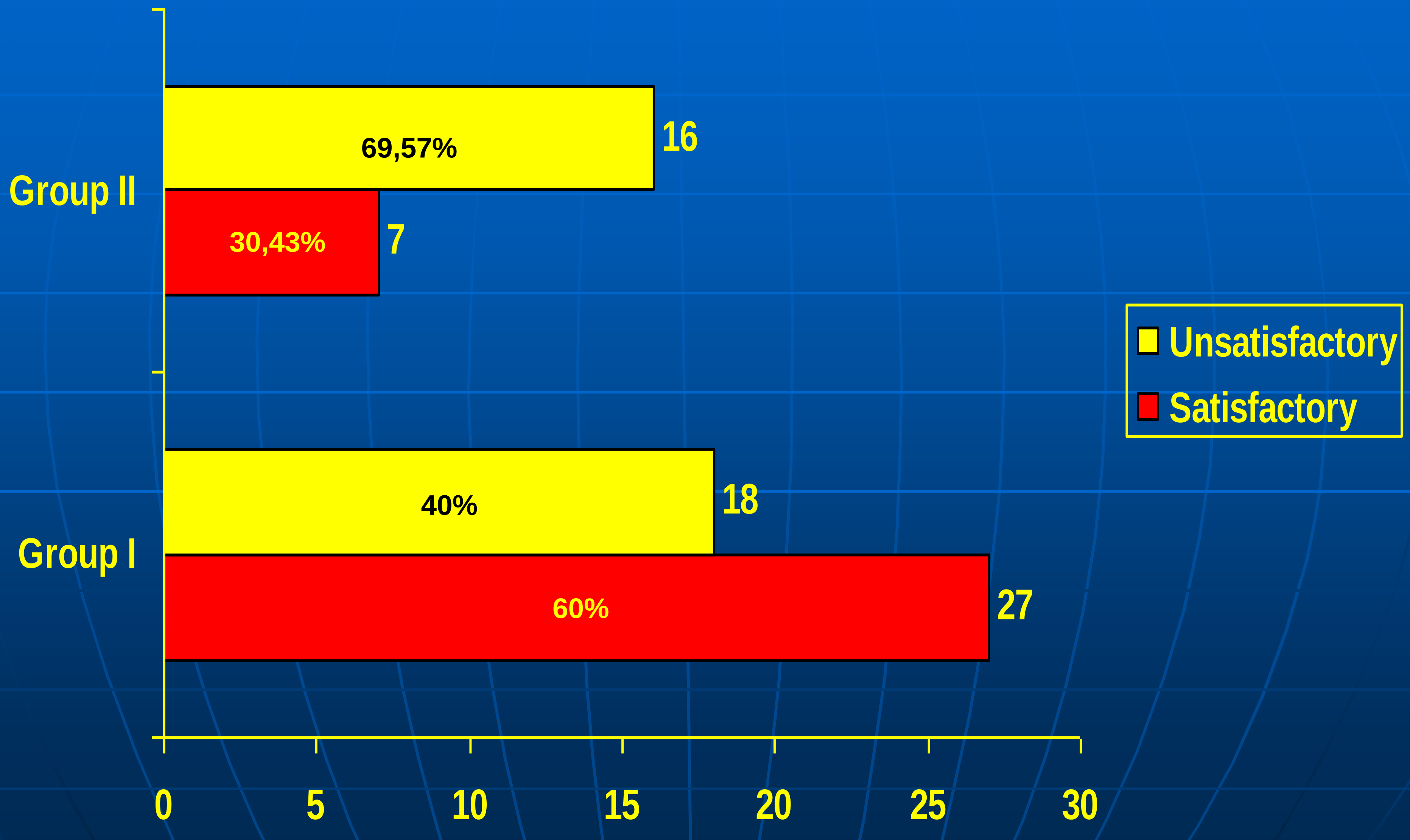
Complications.



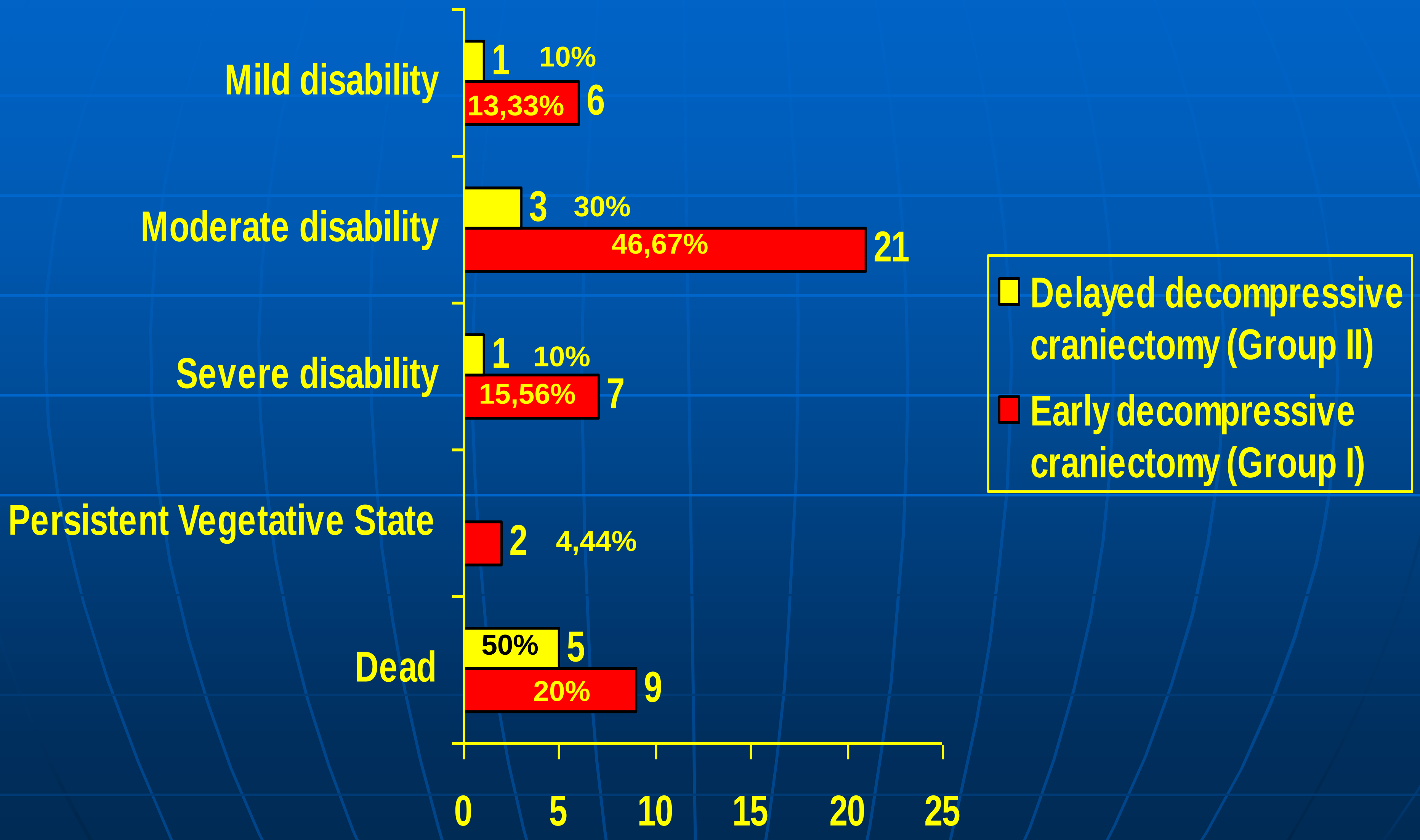
Glasgow Outcome Scale.



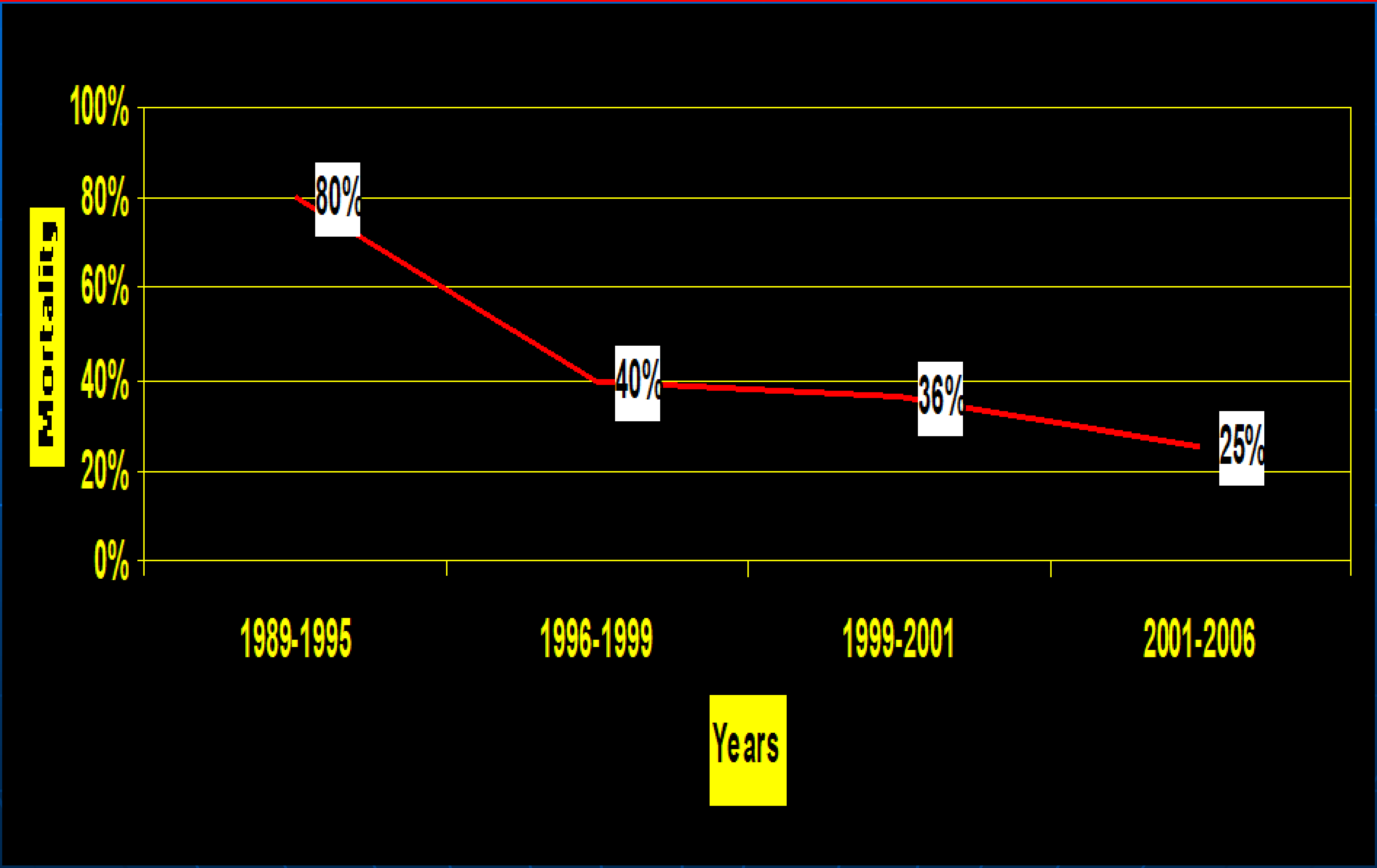
General Outcome.



Comparison between early and delayed decompressive craniectomy.



Severe head injury mortality in Moron General Hospital.



Conclusion:

1. Our results seem to support that decompressive craniectomy may be an effective way to reduce intractable raised intracranial pressure, and probably to improve patients outcome.
2. A linear relationship exists between characteristics of initial CT scan and ICP level monitoring in the first 24 hours.
3. There was correlation between CPP values over 60 mmHg and good results.
4. A high number of patients with early DC (Group I) didn´t need other medical therapy to control intracranial pressure.

5. The majority of survivors after decompressive craniectomy have a good functional outcome.
6. Complications related to surgical decompression not affect the benefits of decompressive craniec tomy.

THANK YOU VERY MUCH