NEUROPTICS

Critical Care, Emergency Medicine and the Pupil

1. Kuo JR, Lo CJ, Lu CL, Chio CC, Wang CC, Lin KC., Prognostic predictors of outcome in an operative series in traumatic brain injury patients. J Formos Med Assoc. 2011 Apr;110(4):258-64.

Abstract BACKGROUND: Although several prognostic factors for traumatic brain injury (TBI) have been evaluated, a useful predictive scoring model for outcome has yet to be developed for TBI patients. The aim of this study was to determine independent predictors and develop a multivariate logistic regression equation to determine prognosis in TBI patients. METHODS: A total of 13 different variables were evaluated. All 84 patients in this study were retrospectively evaluated between October 2003 and January 2008 and all underwent craniectomy or craniotomy for hematoma removal and were fitted with intracranial pressure (ICP) microsensor monitors. By using univari-ate, multiple logistic regression and prognostic regression scoring equations it was possible to draw Receiver-Operating Characteristic curves (ROC) to predict Glasgow Outcome Scale (GOS) 6 months after TBI. RESULTS: We found that patients over 40 years of age ($p < 0.001$), unresponsive pre-op pupil reaction ($p = 0.001$), pre-op midline shift ($p = 0.008$), higher injury severity score (ISS; $p=0.007$), and craniectomy ($p < 0.05$) were associated with poor outcome in patients with TBI. Using ROC curve to predict the probability of unfavorable outcome, the sensitivity was 97.5% and the specificity was 90.7%. CONCLUSION: In our preliminary findings, five variables to predict poor outcomes 6 months after TBI were useful. These sensitive variables can be used as a referential guideline in our daily practice to decide whether or not to perform advanced management or avoid decompressive craniectomy.

2. Abend NS, Topjian AA, Kessler S, Gutierrez-Colina AM, Berg R, Nadkarni V, Dlugos DJ, Clancy RR, Ichord RN., Outcome prediction by motor and pupillary responses in children treated with therapeutic hypothermia after cardiac arrest. Pediatr Crit Care Med. 2011 Apr 14. [Epub ahead of print]

Abstract OBJECTIVE: Clinical neurologic signs considered predictive of adverse outcome after pediatric cardiac arrest may have a different prognostic value in the setting of therapeutic hypothermia. We aimed to determine the prognostic value of motor and pupillary responses in children treated with therapeutic hypothermia after cardiac arrest. DESIGN: Prospective cohort study. SETTING: Pediatric intensive care unit in tertiary care hospital. PATIENTS: Children treated with therapeutic hypothermia after cardiac arrest. MEASUREMENTS AND MAIN RESULTS: Thirty-five children treated with therapeutic hypothermia after cardiac arrest were prospectively enrolled. Examinations were performed by emergency medicine physicians and intensive care unit bedside nurses. Examinations were performed after resuscitation, 1 hr after achievement of hypothermia, during the last hour of hypothermia, 1 hr after achievement of normothermia, after 24 hrs of normothermia, and after 72 hrs of normothermia. The primary outcome was unfavorable outcome at intensive care unit discharge, defined as a pediatric cerebral performance category score of 4-6 at hospital discharge. The secondary outcome was death (pediatric cerebral performance category = 6). The associations between exam responses and unfavorable outcomes (as both pediatric cerebral performance category 4, 5, 6 and pediatric cerebral performance category 6) are presented as positive predictive values, for both all subjects and subjects not receiving paralytics. Statistical significance for these comparisons was determined using Fisher's exact test. At all examination times and examination categories, positive predictive values were higher for the unfavorable outcome pediatric cerebral performance category 4, 5, 6 than the pediatric cerebral performance category 6. By normothermia hour 24, absent motor and pupil responses were highly predictive of unfavorable outcome (pediatric cerebral performance category 4, 5, 6) (positive predictive value 100% and $p < .03$ for all categories), while at earlier times the predictive value was lower. CONCLUSIONS: Absent motor and pupil responses are more predictive of unfavorable outcome when defined more broadly than when defined as only death. Absent motor and pupil responses during hypothermia and soon after return of spontaneous circulation were not predictive of unfavorable outcome while absent motor and pupil responses once normothermic were predictive of unfavorable short-term outcome. Further study is needed using more robust short-term and long-term outcome measures.

3. Kim YJ., A systematic review of factors contributing to outcomes in patients with traumatic brain injury. J Clin Nurs. 2011 Mar 31. doi: 10.1111/j.1365-2702.2010.03618.x. [Epub ahead of print]

Abstract Aim and objective. To review, systematically, factors contributing to outcomes in patients with traumatic brain injury. Background. Traumatic brain injury is a leading cause of death and disability. Several studies have determined the significant predictors of outcomes after traumatic brain injury. The comprehensive identification of these reliable factors for traumatic brain injury is critical to both clinical practice and research. Design. Systematic literature review. Methods. Eligible studies that combined at least two variables to predict outcomes in patient with traumatic brain injury were identified via electronic database searches, footnote chasing and contact with clinical experts. Quality of selected studies was assessed in terms of internal and external validity using 15 questions. Two reviewers independently examined titles, abstracts and whether each met the predefined inclusion criteria. Results. A total of 46 studies which met review criteria were finally selected. Most studies satisfied internal validity in terms of validity of research variables and multivariate analysis, but few were validated externally. The following factors were significantly associated with unfavourable outcomes: sociodemographic factors such as older age, male gender, lower level of education; clinical factors such as lower Glasgow Coma Scale score, injury caused by motor vehicle crash, hypotension, hypoxia, increased intracranial pressure, no pupil reaction, hypo- or hyperglycaemia, anaemia, coagulopathy, hypo- or hyperthermia, abnormal level of electrolytes, duration of coma; higher level of computed tomography classification by Marshall category; type of intracerebral lesions. Conclusion. Further studies on integrating the

sociodemographic factors, the course of the clinical condition and a unified CT scoring system, are recommended for the evaluation and improvement of the prognosis of traumatic brain injury. Relevance to clinical practice. A systematic review of factors contributing to outcome for patients with traumatic brain injury will be invaluable in triage criteria, injury prognostication, care and discharge planning, resource use and patient and family counselling.

4. Martínez-Ricarte F, Castro A, Poca MA, Sahuquillo J, Expósito L, Arribas M, Aparicio J., [Infrared pupillometry. Basic principles and their application in the non-invasive monitoring of neurocritical patients.] Neurologia. 2010 Nov 11. [Epub ahead of print]

Abstract

INTRODUCTION: Pupil assessment is a fundamental part of the neurological examination. Size and reactivity to light of each pupil should be recorded periodically since changes in these parameters may represent the only detectable sign of neurological deterioration in some patients. However, there is great intraobserver and interobserver variability in pupil examination due to the influence of many factors, such as the difference in ambient lighting, the visual acuity and experience of the examiner, the intensity of the luminous stimulus and the method used to direct this stimulus. In recent years, digital cameras have incorporated infrared devices allowing the development of user-friendly portable devices that permit repeated, non-invasive examination of the pupil size and its reactivity to light with an objective, accessible and inexpensive method.
DEVELOPMENT: The purpose of this review is to describe the fundamentals of infrared pupillometry and discuss potential applications in the monitoring of neurocritical patients. We also present some recommendations in the routine assessment of pupils in neurocritical patients.
CONCLUSIONS: The possibility of evaluating the changes in pupil reactivity in an early, objective and almost continuous way provides a new non-invasive monitoring method. This method could improve the predictive factor of neurological deterioration and the bedside monitoring of the neurological state of the patient, avoiding unnecessary examinations and enabling early therapeutic intervention.

5. Rittenberger JC, Sangl J, Wheeler M, Guyette FX, Callaway CW, Association between clinical examination and outcome after cardiac arrest., Resuscitation. 2010 Sep;81(9):1128-32. Epub 2010 Jun 17.

BACKGROUND: Neurologic prognostication after cardiac arrest relies on clinical examination findings derived before the advent of therapeutic hypothermia (TH). We measured the association between clinical examination findings at hospital arrival, 24, and 72 h after cardiac arrest in a modern intensive care unit setting.
METHODS: Between 1/1/2005 and 3/31/2009, hospital charts were reviewed in 272 subjects for neurologic examination findings (Glasgow Coma Score--motor examination, pupil response, corneal response) at hospital arrival, 24, and 72 h following cardiac arrest. Primary outcome was survival to hospital discharge. Secondary outcome was "good outcome," defined as discharge to home or acute rehabilitation facility.
RESULTS: Mean age was 61 years; 155 (57%) were male. Most were treated with TH (N=161; 59%) and 100 subjects (37%) were in ventricular fibrillation/ventricular tachycardia. Out-of-hospital cardiac arrest was common (N=169; 62%). Ninety-one (33%) survived, with 54 (20%) experiencing a good outcome. In subjects with a GCS Motor score < or = 3 at 24 and 72 h survival was 17% (13/76; 95% CI 7.9-26.2%) and 20% (6/27; 95% CI 6.3-33.6%), respectively. Subjects with a GCS Motor score < or = 2 at 24 and 72 h survived in 14% (9/66; 95% CI 4.6-22.6%) and 18% (6/33; 95% CI 3.5-32.8%), respectively. Absent pupil reactivity on arrival did not exclude survival (7/65; 11%; 95% CI 2.4-19%). A lack of pupil reactivity or corneal response at 72 h was associated with death (pupil: 0/17; 95% CI 0, 2.9%; corneal: 0/21; 95% CI 0, 2.4%).
CONCLUSIONS: GCS Motor score < or = 3 or < or = 2 at 24 or 72 h following cardiac arrest does not exclude survival or good outcome. However, absent pupil or corneal response at 72 h appears to exclude survival and good outcome.

6. Karasu A, Civelek E, Aras Y, Sabanci PA, Cansever T, Yanar H, Sağlam G, Imer M, Hepgül KT, Taviloğlu K, Canbolat A, Analyses of clinical prognostic factors in operated traumatic acute subdural hematomas., Ulus Travma Acil Cerrahi Derg. 2010 May;16(3):233-6.

BACKGROUND: Traumatic acute subdural hematoma is the most lethal of all head injuries. METHODS: In this study, 113 patients with the diagnosis of posttraumatic acute subdural hematoma, who were operated between 1998 and 2006, were reviewed retrospectively. Statistical analysis was performed to detect any effects of the variables of age, Glasgow Coma Scale (GCS) score on admission, time interval between the trauma and operation, and abnormality in the pupil reaction on the disease mortality and morbidity. RESULTS: Results obtained in the study are discussed and compared with the related current literature. The overall mortality in 113 patients was 56.6%. CONCLUSION: According to the results, the most important determinants of the prognosis are GCS score of the patient on admission, abnormality in pupil reaction, timing of the operation, and the patient's age.

7. Cipizzani AR, Drongowski R, Ehrlich PF, Assessment of termination of trauma resuscitation guidelines: are children small adults?, J Pediatr Surg. 2010 May;45(5):903-7.

BACKGROUND: Guidelines for termination of resuscitation in prehospital traumatic cardiopulmonary arrest (TCPA) have recently been published for

adults. Clinical criteria for termination of care include absent pulse, unorganized electrocardiogram (ECG), fixed pupils (all at the scene), and cardiopulmonary resuscitation (CPR) greater than 15 minutes. The goal of this study was to evaluate these guidelines in a pediatric trauma population. METHODS: Pediatric trauma patients with documented arrest were included in the study.

8. Chieregato A, Martino C, Pransani V, Nori G, Russo E, Noto A, Simini B, Classification of a traumatic brain injury: the Glasgow Coma scale is not enough., Acta Anaesthesiol Scand. 2010 Apr 15.

Background: Classifying the severity of a traumatic brain injury (TBI) solely by means of the Glasgow Coma scale (GCS) is under scrutiny, because it overlooks other important clinical signs. Clinicians treating patients with acute TBI are well placed to suggest which variables, in addition to the GCS, should concur in a new classification of TBI. Methods: In Italy, acute TBI patients are treated by anaesthetists, and so we asked them, in a questionnaire survey, to rate the weight they give to the GCS and to other clinical variables in their approach to TBI. Because sedation may underestimate GCS scores, we also inquired whether anaesthetists select sedatives that allow drug-free GCS scores. The questionnaire was distributed to 1334 anaesthetists attending courses on neurotrauma; the response rate was 63%. Results: Two thirds of the respondents believe that the definition of severe TBI should include, in addition to GCS scores, pupil reactivity to light and computer tomogram (CT) findings, the variables that guide Italian anaesthetists in TBI management. Most respondents (68.2%) administer sedation which allows prompt neurological evaluation and reliable GCS scoring. A minority of respondents (9.3%) withhold or antagonize sedation, delay tracheal intubation or allow patient-ventilator asynchrony. Conclusions: Italian anaesthetists would welcome a definition of TBI severity that includes CT findings and pupil reactivity in addition to the GCS.

9. Petridis AK, Doukas A, Barth H, Mehdorn M, Outcome of Craniocerebral Gunshot Injuries in the Civilian Population. Prognostic Factors and Treatment Options., Cen Eur Neurosurg. 2010 Mar 22.

AIM: Gunshot wounds to the head are rare in Europe. They may be inflicted by low-velocity handguns, captive bolt guns and tear gas cartridges and mostly result from suicide attempts. The experience of neurosurgeons with this kind of traumatic injury is decreasing; the aim of this study was therefore to analyse prognostic factors which help to decide whether or not to operate and to discuss treatment options. METHODS: Thirty patients with gunshot head injuries treated in our hospital from 1993 to 2008 were retrospectively evaluated. Glasgow Coma Scale (GCS) score, pupil reactivity, lesion localisation, number of bone fragments, intracranial pressure (ICP), midline shift, hypotension, and dural penetration were analysed for their prognostic value. Surgically and non-surgically treated patients were evaluated separately. Complications were registered. RESULTS: A low GCS of 3-8, fixed pupils, >2 bone fragments, bilobar or posterior fossa/brainstem lesions and ICP >45 mmHg were indicators of a poor prognosis. CONCLUSION: Patients with a GCS of 3-8 and two non-reactive pupils should not be operated. If one or both of the pupils are reactive, surgery should be performed irrespective of the GCS score, except in patients with translobar/transventricular wounds. Even if there are no clear contraindications to surgery, the outcome is expected to be poor in patients with a low GCS score, midline shift >10 mm, >2 bone fragments in the brain, and a bilobar, posterior fossa/brainstem or ventricular lesion and ICP >45 mmHg. When surgery is performed the wound and the missile or bone track should be debrided meticulously, the wound and dura should be closed in a watertight fashion and antibiotic prophylaxis as well as tetanus serum should be given.

10. Hofbauer M, Kdolsky R, Figl M, Grünauer J, Aldrian S, Ostermann RC, Vècsei V, Predictive Factors Influencing the Outcome After Gunshot Injuries to the Head-A Retrospective Cohort Study., J Trauma. 2010 Feb 18.

BACKGROUND:: Civilian gunshot injuries to the head are relatively rare in the irenical European Union, and studies of treatment and outcomes are seldom for this region in the current literature. METHODS:: A cohort of 85 patients with civilian head gunshot injuries, who were admitted to our University hospital over a period of 16 years, was reviewed retrospectively. Clinical manifestation, computed tomography scan findings, and surgical treatment were described, with special regard to prognostic factors and outcome. RESULTS:: The mean age was 48 years (range, 17.8-98.4 years), and 87% were men. Sixty patients sustained penetrating craniocerebral injuries (P-group) and 25, nonpenetrating gunshot wounds (NP-group). The overall mortality was 87% in the P-group and 4% in the NP-group. The Glasgow Coma Scale (GCS) score at admission was recorded to be 3 to 5 in 58 patients (96%) and 7 patients (28%) in the P-group and NP-group, respectively. Only 8 patients (13%) survived in the P-group compared with 24 patients (96%) in the NP-group. Excluding wound debridement, there were 16 surgical procedures in the P-group and 8 in the NP-group, with a mortality rate of 63% and 13%, respectively. CONCLUSIONS:: Glasgow Coma Score at admission and the status of pupils and hemodynamic situation seem to be the most significant predictors of outcome in penetrating craniocerebral gunshot wounds. Computed tomography scans, bi- or multilobar injury, and intraventricular hemorrhage were correlated with poor outcome. Patients with a GCS score >8, normal pupil reaction, and single lobe of brain injury may benefit from early aggressive management.

11. Nijboer JM, van der Naalt J, ten Duis HJ, Patients beyond salvation? Various categories of trauma patients with a minimal Glasgow Coma Score., Injury. 2010 Jan;41(1):52-7.

INTRODUCTION: Trauma patients in an unresponsive state upon presentation to the Emergency Department have a poor prognosis. Rapid

assessment of injuries combined with life-preserving therapy is required but defining the optimal strategy can be complicated when multiple organ systems are involved. This study analysed various categories of trauma patients with a Glasgow Coma Scale (GCS) of 3 on admission and evaluated the relation between injuries, clinical condition, treatment and outcome. PATIENTS AND METHODS: A retrospective cohort-study, performed at a level 1 Trauma Center from 2002 to 2005. Trauma patients of all ages with GCS of 3 (without sedation) and Injury Severity Score (ISS) > or = 16 were included. The collected patient data comprised data on demographics, mechanism of injury, physiological condition on admission, diagnosis, ISS, treatment, admission to Intensive Care Unit, complications and outcome. RESULTS: Ninety-seven patients were included and divided into three groups based on the pathology that caused the GCS of 3: traumatic brain injury N=48 (49%), anoxic brain injury N=27 (28%) and haemorrhagic shock N=22 (23%). The overall mortality was 81%; 91% of the haemorrhagic shock patients, 81% of the ABI patients and 77% of the TBI patients died. Eighteen patients survived of whom five patients (5%) made a good recovery. The pupillary light response and pH on admission were related to mortality. No relation with ISS, age or hypothermia was found. DISCUSSION: Distinguishing salvageable patients from those beyond salvation remains problematic. This study illustrated the diversity of patients, their injuries and their condition upon presentation to the hospital as well as the limitations of therapy. CONCLUSION: Trauma patients with a GCS of 3 have a poor outcome. Despite aggressive treatment only 5% of the patients made a good recovery. Pupil reactivity and the pH on admission were found to be related to mortality.

12. Théaudin M, Crassard I, Bresson D, Saliou G, Favrole P, Vahedi K, Denier C, Bousser MG., Should Decompressive Surgery Be Performed in Malignant Cerebral Venous Thrombosis? A Series of 12 Patients. Stroke. 2010 Feb 25. [Epub ahead of print]

BACKGROUND AND PURPOSE: In malignant cerebral venous thrombosis (CVT) patients, emergency decompressive surgery has been suggested as a life-saving procedure. We report 12 patients with malignant CVT, among whom 8 underwent operation. METHODS: Retrospective study of 12 patients from 3 stroke units who had a malignant CVT as defined: (1) supratentorial cortical lesions attributable to superficial venous system thrombosis with or without sinus involvement; (2) with clinical (decreased consciousness and dilated pupils) or radiological signs of transtentorial herniation; (3) either at onset or after worsening despite heparin therapy. Surgery or abstention was decided individually by neurosurgeons on call. RESULTS: There were 9 women and 3 men with a mean age of 45+/-15 years. The delay between heparin therapy and signs of malignancy ranged from 2 to 30 hours. At malignant worsening all but 1 patient had hemorrhagic lesions; the median deviation of septum pellucidum was 12 mm (interquartile range, 6.7-13); 5 patients (including 3 who underwent operation) had a unilateral dilated pupil; and 4 (2 who underwent operation) had bilateral dilated pupils. Eight patients underwent surgical decompression, external decompression in 4, both external and internal decompression in 3, and internal decompression in 1. The 4 patients who did not undergo operation died within 1 to 5 days after diagnosis. One patient who underwent operation died of a pulmonary embolism. The 7 others survived, with, at last follow-up (median, 23.1 months; interquartile range, 19.7-45.6), an excellent recovery of mRS 0 or 1 in 6 and mRS 3 in 1. CONCLUSIONS: Decompressive surgery may save lives and may even allow a good functional outcome in malignant CVT, even in patients with bilateral dilated pupils.

13. Hofbauer M, Kdolsky R, Figl M, Grünauer J, Aldrian S, Ostermann RC, Vècsei V., Predictive Factors Influencing the Outcome After Gunshot Injuries to the Head-A Retrospective Cohort Study. J Trauma. 2010 Feb 18. [Epub ahead of print]

BACKGROUND:: Civilian gunshot injuries to the head are relatively rare in the irenical European Union, and studies of treatment and outcomes are seldom for this region in the current literature. METHODS:: A cohort of 85 patients with civilian head gunshot injuries, who were admitted to our University hospital over a period of 16 years, was reviewed retrospectively. Clinical manifestation, computed tomography scan findings, and surgical treatment were described, with special regard to prognostic factors and outcome. RESULTS:: The mean age was 48 years (range, 17.8-98.4 years), and 87% were men. Sixty patients sustained penetrating craniocerebral injuries (P-group) and 25, nonpenetrating gunshot wounds (NP-group). The overall mortality was 87% in the P-group and 4% in the NP-group. The Glasgow Coma Scale (GCS) score at admission was recorded to be 3 to 5 in 58 patients (96%) and 7 patients (28%) in the P-group and NP-group, respectively. Only 8 patients (13%) survived in the P-group compared with 24 patients (96%) in the NP-group. Excluding wound debridement, there were 16 surgical procedures in the P-group and 8 in the NP-group, with a mortality rate of 63% and 13%, respectively. CONCLUSIONS:: Glasgow Coma Score at admission and the status of pupils and hemodynamic situation seem to be the most significant predictors of outcome in penetrating craniocerebral gunshot wounds. Computed tomography scans, bi- or multilobar injury, and intraventricular hemorrhage were correlated with poor outcome. Patients with a GCS score >8, normal pupil reaction, and single lobe of brain injury may benefit from early aggressive management.

14. Yatsushige H, Takasato Y, Masaoka H, Hayakawa T, Otani N, Yoshino Y, Sumiyoshi K, Sugawara T, Miyawaki H, Aoyagi C, Takeuchi S, Suzuki G., Prognosis for severe traumatic brain injury patients treated with bilateral decompressive craniectomy. Acta Neurochir Suppl. 2010;106:265-70.

PURPOSE: Decompressive craniectomy for traumatic brain injury patients has been shown to reduce intracranial hypertension, while it often results in increased brain edema and/or contralateral space-occupied hematoma. The purpose of this study was to determine the prognosis of bilateral decompressive craniectomy in severe head injury patients with the development of either bilateral or contralateral lesions after ipsilateral decompressive craniectomy. METHODS: Twelve patients underwent bilateral decompressive craniectomy among 217 individuals who had been

treated with decompressive craniectomy with dural expansion from September 1995 to August 2006. The following patient data were retrospectively collected: age, neurological status at admission, time between injury and surgical decompression, time between first and second decompression, laboratory and physiological data collected in the intensive care unit, and outcome according to the Glasgow Outcome Scale. RESULTS: Patient outcomes fell into the following categories: good recovery (three patients); mild disability (one patient); severe disability (two patients); persistent vegetative state (one patient); and death (five patients). Patients with good outcomes were younger and had better pupil reactions and neurological statuses on admission. Other factors existing prior to the operation did not directly correlate with outcome. At 24 h post-surgery, the average intercranial pressure (ICP), cerebral perfusion pressure (CPP), glucose level, and lactate level in patients with poor outcomes differed significantly from those of patients with a good prognosis. CONCLUSION: Head injury patients with either bilateral or contralateral lesions have poor prognosis. However, bilateral decompressive craniectomy may be a favorable treatment in certain younger patients with reactive pupils, whose ICP and CPP values are stabilized 24 h post-surgery.

15. Wong GK, Hung YW, Chong C, Yeung J, Chi-Ping Ng S, Rainer T, Poon WS., Assessing the neurological outcome of traumatic acute subdural hematoma patients with and without primary decompressive craniectomies., Acta Neurochir Suppl. 2010;106:235-7.

BACKGROUND: We have investigated the impact of primary decompressive craniectomies on neurological outcomes after adjusting for other predictive variables. METHOD: We have collected data from trauma patients with acute subdural hematomas in a regional trauma center in Hong Kong over a 4-year period. Patient risk factors were investigated using logistic regression. RESULTS: Out of 464 patients with significant head injuries, 100 patients had acute subdural hematomas and were recruited for analysis. Forty-four percent of the patients achieved favorable neurological outcomes after 6 months. Favorable neurological outcomes at 1 year were related to age, pupil dilatation, and motor GCS scores at the time of admission. In the 34 patients who underwent evacuation of acute subdural hematomas, primary decompressive craniectomy was not associated with favorable neurological outcomes. CONCLUSION: Primary decompressive craniectomy failed to show benefit in terms of neurological outcomes and should be reserved for cases with uncontrolled intra-operative brain swelling.

16. Nijboer JM, van der Naalt J, ten Duis HJ., Patients beyond salvation? Various categories of trauma patients with a minimal Glasgow Coma Score., Injury. 2010 Jan;41(1):52-7.

INTRODUCTION: Trauma patients in an unresponsive state upon presentation to the Emergency Department have a poor prognosis. Rapid assessment of injuries combined with life-preserving therapy is required but defining the optimal strategy can be complicated when multiple organ systems are involved. This study analysed various categories of trauma patients with a Glasgow Coma Scale (GCS) of 3 on admission and evaluated the relation between injuries, clinical condition, treatment and outcome. PATIENTS AND METHODS: A retrospective cohort-study, performed at a level 1 Trauma Center from 2002 to 2005. Trauma patients of all ages with GCS of 3 (without sedation) and Injury Severity Score (ISS) > or = 16 were included. The collected patient data comprised data on demographics, mechanism of injury, physiological condition on admission, diagnosis, ISS, treatment, admission to Intensive Care Unit, complications and outcome. RESULTS: Ninety-seven patients were included and divided into three groups based on the pathology that caused the GCS of 3: traumatic brain injury N=48 (49%), anoxic brain injury N=27 (28%) and haemorrhagic shock N=22 (23%). The overall mortality was 81%; 91% of the haemorrhagic shock patients, 81% of the ABI patients and 77% of the TBI patients died. Eighteen patients survived of whom five patients (5%) made a good recovery. The pupillary light response and pH on admission were related to mortality. No relation with ISS, age or hypothermia was found. DISCUSSION: Distinguishing salvageable patients from those beyond salvation remains problematic. This study illustrated the diversity of patients, their injuries and their condition upon presentation to the hospital as well as the limitations of therapy. CONCLUSION: Trauma patients with a GCS of 3 have a poor outcome. Despite aggressive treatment only 5% of the patients made a good recovery. Pupil reactivity and the pH on admission were found to be related to mortality.

17. Mauritz W, Leitgeb J, Wilbacher I, Majdan M, Janciak I, Brazinova A, Rusnak M., Outcome of brain trauma patients who have a Glasgow Coma Scale score of 3 and bilateral fixed and dilated pupils in the field. Eur J Emerg Med. 2009 Jun;16(3):153-8.

OBJECTIVE: To investigate the outcome of brain trauma patients who had a Glasgow Coma Scale score (GCS) of 3 and bilateral fixed and dilated pupils (BFDP) in the field. METHODS: Between January 2001 and December 2005, 13 European centres enrolled patients with severe brain trauma. Data sets of all patients who had a GCS of 3 as well as BFDP were analysed. Patients were classified according to the Glasgow Outcome Scale, 12 months after trauma as 'good' (Glasgow Outcome Scale of 5 or 4) or 'poor' functional recovery; relevant data for these two groups were compared. Variables that showed differences in univariate analyses (chi and Wilcoxon-Mann-Whitney tests) were then used as covariates in logistic regression models. A P value of less than 0.05 was considered significant. RESULTS: Ninety-two (7.8%) of 1172 patients had a GCS of 3 and BFDP; eight had 'good', 84 had 'poor' recovery. We found no significant differences in sex (79% male), age (median 32 years), and trauma mechanisms. Trauma was significantly less severe, probability of survival significantly higher (0.48 vs. 0.23) in the 'good' group. Only one of 39 patients who had closed basal cisterns on the first computed tomography scan, and none of the patients with midline shift greater than 15 mm had good outcomes. Logistic regression revealed that age, trauma severity, and status of basal cisterns on the first computed tomography scan were the factors determining outcomes. CONCLUSION: Patients with a GCS of 3 and BFDP in the field should be resuscitated aggressively, especially if the trauma seems to be

not too severe

18. Petridis AK, Dörner L, Doukas A, Eifrig S, Barth H, Mehdorn M., Acute subdural hematoma in the elderly; clinical and CT factors influencing the surgical treatment decision. Cen Eur Neurosurg. 2009 May;70(2):73-8. Epub 2009 May 25.

OBJECTIVE: Acute subdural hematomas (aSDH) are severe traumatic brain injuries. Older patients have a higher mortality rate. In the present study the computed tomography (CT) and neurological deficits caused by aSDH were used as prognostic factors to define the outcome and surgical treatment indication in older patients. METHODS: The affect of the Glasgow Coma Scale (GCS) score on initial presentation, pupil abnormalities, parenchymal lesions, SDH-thickness, midline shift and intracranial pressure (ICP) in the outcome of older patients (>or=65 years old) admitted to our hospital between 1993 and 2006 with aSDH was evaluated. The outcome was assessed with the Glasgow Outcome Scale (GOS). The data were collected retrospectively. Statistical analysis was performed with Chi-square test and ANOVA. RESULTS: Older patients have a high mortality after aSDH. A low GCS score (3-8), pupil abnormalities, the presence of contusions and subarachnoid bleeding, midline shift>aSDH thickness as well as a highly elevated ICP>40 mmHg are unfavorable factors in the prognosis of aSDH. CONCLUSION: Patients with a GCS of 13-15 can be observed clinically (the expected outcome is very good). Comatose patients (GCS 3-8) with bilateral dilatation of the pupils should not be operated (very high mortality rate). If the GCS score is <13 and both pupils or only one are reactive to light and the midline shift<10 mm, surgery is indicated. If the midline shift is >10 mm and aSDH thickness>midline shift, surgery is also indicated. If in the same patient group midline shift>SDH thickness and ICP>40 mmHg, surgery is not indicated. (c) Georg Thieme Verlag KG Stuttgart, New York.

19. Yatsushige H, Takasato Y, Masaoka H, Hayakawa T, Otani N, Yoshino Y, Sumiyoshi K, Sugawara T, Miyawaki H, Aoyagi C, Takeuchi S, Suzuki G., Prognosis for severe traumatic brain injury patients treated with bilateral decompressive craniectomy. Acta Neurochir Suppl. 2010;106:265-70.

PURPOSE: Decompressive craniectomy for traumatic brain injury patients has been shown to reduce intracranial hypertension, while it often results in increased brain edema and/or contralateral space-occupied hematoma. The purpose of this study was to determine the prognosis of bilateral decompressive craniectomy in severe head injury patients with the development of either bilateral or contralateral lesions after ipsilateral decompressive craniectomy. METHODS: Twelve patients underwent bilateral decompressive craniectomy among 217 individuals who had been treated with decompressive craniectomy with dural expansion from September 1995 to August 2006. The following patient data were retrospectively collected: age, neurological status at admission, time between injury and surgical decompression, time between first and second decompression, laboratory and physiological data collected in the intensive care unit, and outcome according to the Glasgow Outcome Scale. RESULTS: Patient outcomes fell into the following categories: good recovery (three patients); mild disability (one patient); severe disability (two patients); persistent vegetative state (one patient); and death (five patients). Patients with good outcomes were younger and had better pupil reactions and neurological statuses on admission. Other factors existing prior to the operation did not directly correlate with outcome. At 24 h post-surgery, the average intercranial pressure (ICP), cerebral perfusion pressure (CPP), glucose level, and lactate level in patients with poor outcomes differed significantly from those of patients with a good prognosis. CONCLUSION: Head injury patients with either bilateral or contralateral lesions have poor prognosis. However, bilateral decompressive craniectomy may be a favorable treatment in certain younger patients with reactive pupils, whose ICP and CPP values are stabilized 24 h post-surgery.

20. Otani N, Takasato Y, Masaoka H, Hayakawa T, Yoshino Y, Yatsushige H, Miyawaki H, Sumiyoshi K, Sugawara T, Chikashi A, Takeuchi S, Suzuki G., Surgical outcome following a decompressive craniectomy for acute epidural hematoma patients presenting with associated massive brain swelling. Acta Neurochir Suppl. 2010;106:261-4.

Acute epidural hematomas (AEDH) are generally managed with rapid surgical hematoma evacuation and bleeding control. However, the surgical outcome of patients with serious brain edema is poor. This study reviewed the clinical outcome for AEDH patients and evaluated the efficacy of the DC, especially in patients with associated massive brain swelling. Eighty consecutive patients surgically treated with AEDH were retrospectively assessed. The patients were divided into two groups: (a) hematoma evacuation (HE: 46 cases) and (b) HE+ an external decompression (ED: 34 cases). The medical charts, operative findings, radiological findings, and operative notes were reviewed. In the poor outcome group, there were 18 patients (72%), with a GCS score of less than 8 (severe injury), and 22 patients (88%) who showed pupil abnormalities. Many more patients showed a midline shift, basal cistern effacement, and brain contusion in comparison to the favorable outcome group. In the favorable outcome group, almost all of the patients (98%) showed less than 12 mm of a midline shift. The influential factors may be age, GCS, pupil abnormalities, size, midline shift, basal cistern effacement, coincidence of contusion and swelling. We conclude that an A DC may be effective to manage the AEDH patients with cerebral contusion or massive brain swelling.

21. Wong GK, Hung YW, Chong C, Yeung J, Chi-Ping Ng S, Rainer T, Poon WS., Assessing the neurological outcome of traumatic acute subdural hematoma patients with and without primary decompressive craniectomies. Acta Neurochir Suppl. 2010;106:235-7.

BACKGROUND: We have investigated the impact of primary decompressive craniectomies on neurological outcomes after adjusting for other predictive variables. METHOD: We have collected data from trauma patients with acute subdural hematomas in a regional trauma center in Hong Kong over a 4-year period. Patient risk factors were investigated using logistic regression. RESULTS: Out of 464 patients with significant head injuries, 100 patients had acute subdural hematomas and were recruited for analysis. Forty-four percent of the patients achieved favorable neurological outcomes after 6 months. Favorable neurological outcomes at 1 year were related to age, pupil dilatation, and motor GCS scores at the time of admission. In the 34 patients who underwent evacuation of acute subdural hematomas, primary decompressive craniectomy was not associated with favorable neurological outcomes. CONCLUSION: Primary decompressive craniectomy failed to show benefit in terms of neurological outcomes and should be reserved for cases with uncontrolled intra-operative brain swelling.

22. Chamoun RB, Robertson CS, Gopinath SP., Outcome in patients with blunt head trauma and a Glasgow Coma Scale score of 3 at presentation, J Neurosurg. 2009 Mar 27.

Object A Glasgow Coma Scale (GCS) score of 3 on presentation in patients with severe traumatic brain injury due to blunt trauma has been recognized as a bad prognostic factor. The reported mortality rate in these patients is very high, even approaching 100% in the presence of fixed and dilated pupils in some series. Consequently, there is often a tendency to treat these patients less aggressively because of the low expectations for a good recovery. In this paper, the authors' purpose is to report their experience in the management of this patient population, analyzing the mortality rate, prognostic factors, and functional outcome of survivors. Methods The authors performed a retrospective review of patients who presented between 1997 and 2007 with blunt head trauma and a GCS score of 3. Demographics, mechanism of injury, examination, blood alcohol level, associated injury, intracranial pressure (ICP), surgical procedures, and outcome were all recorded. Results A total of 189 patients met the inclusion criteria and were included in this study. The overall mortality rate was 49.2%. At the 6-month follow-up, 13.2% of the entire series achieved a good functional outcome (Glasgow Outcome Scale [GOS] score of 1 or 2). The patient population was then divided into 2 groups: Group 1 (patients who survived [96]) and Group 2 (patients who died [93]). Patients in Group 1 were younger (mean 33.3 +/- 12.8 vs 40.3 +/- 16.97 years; p = 0.002) and had lower ICP on admission (mean 16.3 +/- 11.1 vs 25.7 +/- 12.7 mm Hg; p < 0.001) than those in Group 2. The difference between the 2 groups regarding sex, mechanism of injury, hypotension on admission, alcohol, surgery, and associated injuries was not statistically significant. The presence of bilateral fixed, dilated pupils was found to be associated with the highest mortality rate (79.7%). Although not statistically significant because of the sample size, pupil status was also a good predictor of the functional outcome at the 6-month follow-up; a good functional outcome (GOS Score 1 or 2) was achieved in 25.5% of patients presenting with bilateral reactive pupils, and 27.6% of patients presenting with a unilateral fixed, dilated pupil, compared with 7.5% for those presenting with bilateral fixed, nondilated pupils, and 1.4% for patients with bilateral fixed, dilated pupils. Conclusions Overall, 50.8% of patients survived their injury and 13.2% achieved a good functional outcome afterat 6 months of follow-up (GOS Score 1 or 2). Age, ICP on admission, and pupil status were found to be significant predictive factors of outcome. In particular, pupil size and reactivity appeared to be the most important prognostic factor since the mortality rate was 23.5% in the presence of bilateral reactive pupils and 79.7% in the case of bilateral fixed, dilated pupils. The authors believe that patients having suffered traumatic brain injury and present with a GCS score of 3 should still be treated aggressively initially since a good functional outcome can be obtained in some cases.

23. Minardi J, Crocco TJ, Management of traumatic brain injury: first link in chain of survival., Mt Sinai J Med. 2009 Apr;76(2):138-44.

Traumatic brain injury is a significant cause of morbidity and mortality. The prehospital care of the patient with a traumatic brain injury is critical to maximizing the chances for a good outcome. Prehospital management of the traumatic brain injury patient is directed toward preventing and limiting secondary brain injury while facilitating rapid transport to an appropriate facility capable of providing definitive neurocritical care. Key points in management include the assessment of oxygenation, blood pressure, and mental status (as measured with the Glasgow Coma Scale) and the pupillary examination. Treatment strategies are directed toward maintaining adequate oxygenation and perfusion and treating herniation. Judicious use of temporary hyperventilation and hypertonic saline are considerations. This review provides the most recent evidence regarding the treatment of traumatic brain injury in the prehospital setting and introduces areas in need of future research.

24. Park JE, Kim SH, Yoon SH, Cho KG, Kim SH., Risk Factors Predicting Unfavorable Neurological Outcome during the Early Period after Traumatic Brain Injury., J Korean Neurosurg Soc. 2009 Feb;45(2):90-5. Epub 2009 Feb 27.

OBJECTIVE: We aimed to identify clinico-radiological risk factors that may predict unfavorable neurological outcomes in traumatic brain injury (TBI), and to establish a guideline for patient selection in clinical trials that would improve neurological outcome during the early post TBI period. METHODS: Initial clinico-radiological data of 115 TBI patients were collected prospectively. Regular neurological assessment after standard treatment divided the above patients into 2 groups after 6 months : the Favorable neurological outcome group (GOS : good & moderate disability, DRS : 0-6, LCFS : 8-10) and the Unfavorable group (GOS : severe disability-death, DRS : 7-29 and death, LCFS : 1-7 and death). RESULTS: There was a higher incidence of age >/=35 years, low initial GCS score, at least unilateral pupil dilatation, and neurological deficit in the Unfavorable group. The presence of bilateral parenchymal lesions or lesions involving the midline structures in the initial brain CT was observed to be a radiological risk factor for unfavorable outcome. Multivariate analysis demonstrated that age and initial GCS score were independent risk factors. The majority of the Favorable group patients with at least one or more risk factors showed improvement of GCS scores within 2 months after TBI. CONCLUSION: Patients with the above mentioned clinico-radiological risk factors who received standard treatment, but did not demonstrate neurological

improvement within 2 months after TBI were deemed at risk for unfavorable outcome. These patients may be eligible candidates for clinical trials that would improve functional outcome after TBI.

25. Chaudhuri K, Malham GM, Rosenfeld JV., Survival of trauma patients with coma and bilateral fixed dilated pupils. Injury. 2009 Jan;40(1):28-32. Epub 2008 Dec 13.

BACKGROUND: Survival of patients with severe trauma presenting with Glasgow Coma Score (GCS) 3 and bilateral fixed dilated pupils is uncertain. Pre-hospital management of these patients affects the true measurement of the GCS and other factors may affect pupillary status. PATIENTS AND METHODS: A retrospective review was undertaken of all patients who were classified GCS 3 and had bilateral fixed dilated pupils on admission to a Level 1 Adult Trauma Centre between July 2001 and March 2005. Pre-hospital assessment, hospital interventions and outcomes were determined. RESULTS: Ninety-three patients fulfilled the criteria for inclusion into the study. There were 6 survivors who were all less than 28 years of age, had at least one GCS score above 3 in the pre-hospital phase and were more likely to have had an evacuable mass lesion on CT brain scan and undergo craniotomy. Of the 6 surviving patients, none had significant thoracoabdominal injuries. Four of the survivors had Glasgow Outcome Score (GOS) of 4 or 5. Time to hospital, mechanism of injury and pre-hospital haemodynamic parameters had no significant effect on survival. Of the 57 patients who were GCS 3 at the scene of the accident, post-basic resuscitation and on admission, none survived. CONCLUSION: Pre-hospital GCS scores, prior to the effects of intubation, sedation and paralysis should be given more attention when assessing prognosis in patients who are GCS 3 on admission. Trauma patients with GCS 3 persisting from the scene with bilaterally fixed dilated pupils have no appreciable chance of survival. Further interventions such as ICU admission and surgery may not be warranted. Physicians may need to consider stopping treatment and discussing organ donation.

26. Ss Hon KL, Ho JK, Hung EC, Cheung KL, Ng PC, Poisoning necessitating pediatric ICU admissions: size of pupils does matter., J Natl Med Assoc. 2008 Aug;100(8):952-6.

INTRODUCTION: Childhood poisonings are common, but usually trivial, and infrequently necessitate intensive care unit (ICU) admissions. METHODS: A retrospective record review was conducted to analyze the pattern of severe poisoning-associated ICU admissions at a teaching hospital between May 2002 and December 2007. RESULTS: Six cases (4 boys and 2 girls, aged 2 months to 11 years) of drug poisoning-associated ICU admissions were identified. Methadone was the culprit in 3 boys and 1 girl, resulting in respiratory failure, depressed conscious state and pinpoint pupils. As relevant exposure history was not immediately apparent, diagnosis at the emergency department was only made correctly in 2 patients. Phenobarbitone overdose occurred in 1 girl with past history of phenobarbitone overdose as a clue. She was also considered to have pinpoint pupils that were unresponsive to naloxone. Features consistent with cholinergic toxidrome, including small pupils, and increased secretion occurred in an infant fed with milk prepared with an herbal broth suspected to have been adulterated with a pesticide. Atropine as an antidote was used when the child was in the pediatric ICU. All children made an uneventful recovery following their short ICU stay. CONCLUSIONS: Life-threatening poisonings requiring ICU support can pose diagnostic difficulties and challenges to frontline medical officers at the emergency department. Children from all age groups can be affected. Prompt diagnosis is based on relevant history, careful clinical examination and a high index of suspicion in patients known to be at risk. The pupillary size and its reaction following treatment serves as an important diagnostic clue.

27. Taussky P, Widmer HR, Takala J, Fandino J., Outcome after acute traumatic subdural and epidural haematoma in Switzerland: a single-centre experience., Swiss Med Wkly. 2008 May 3;138(19-20):281-5.

BACKGROUND: Acute epidural and subdural haematomas remain among the most common causes of mortality and disability resulting from traumatic brain injury. In the last three decades improvements in rescue, neuromonitoring and intensive care have led to better outcomes. The purpose of this study was to evaluate the impact of these strategies on outcome in patients treated in a single institution in Switzerland. METHODS: A total of 76 consecutive patients who underwent emergency craniotomy for acute traumatic epidural and subdural haematoma at University Hospital Bern between January 2000 and December 2003 were included in this study. RESULTS: Thirty-seven patients presented with an epidural haematoma and 46 with a subdural haematoma. In seven patients both haematomas could be documented. The median age was 54 years (IQR 28). The median initial GCS score was 7 (IQR 6). The median time from primary injury to surgery was 3 hours (IQR 2.5 hours). The median stay in the ICU was 3 days (IQR: 3 days). The outcome was favourable (GOS 4 and 5) in 43 patients (57%). Thirteen patients (17%) remained severely or moderately disabled (GOS 3). Finally, a total of 21 patients (28%) died or remained in a persistent vegetative state (GOS 1 and 2). Mortality was 41% for acute subdural haematoma (19/46) and 3% (1/37) for patients with epidural haematoma. Only age, GCS at admission and pupil abnormalities seemed to be associated with outcome. Time to surgery was not. CONCLUSION: In patients admitted with acute traumatic epidural and subdural haematomas that are treated within a median of 3 hours after primary injury, factors such as age, initial GCS and pupil abnormalities still appear to be the most important factors correlating with outcome.

28. Martins ET, Linhares MN, Sousa DS, Schroeder HK, Meinerz J, Rigo LA, Bertotti MM, Gullo J, Hohl A, Dal-Pizzol F, Walz R., Mortality in severe traumatic brain injury: a multivariated analysis of 748 Brazilian patients from Florianópolis City., J Trauma. 2009 Jul;67(1):85-90.

BACKGROUND: Traumatic brain injury (TBI) is a major cause of incapacity and mortality worldwide, with most of the burden occurring in low-income and middle-income countries. A number of clinical, demographic, and neurosurgical variables of patients with TBI were associated with their outcome. METHODS: We investigated the mortality of Brazilian patients with severe TBI at the time of discharge, using a multiple logistic regression analysis. Clinical, demographic, radiologic, and neurosurgical variables, and mortality at time of discharge of all consecutive patients (n = 748) with severe TBI (admission Glasgow scale < or = 8) treated in our intensive care unit were analyzed. The variables were collected in a prospective manner between January 1994 and December 2003. RESULTS: Eighty-four percent (n = 631) of the patients were men. The mean age was 34.8 (+/-16.3) years and the mortality was 33.3%. After the multiple logistic regression, the adjusted odds ratio (OR) for death was higher in older (> 60 years) than younger (up to 30 years) patients (OR = 2.51, 95% confidence interval [CI] 1.31-4.79, p = 0.006). The mortality was also associated with sub-arachnoid hemorrhage (OR = 1.86, 95% CI = 1.23-2.81, p = 0.003) on computed tomography (CT) scan; admission Glasgow Scale of 3 or 4 in comparison to 7 or 8 (OR = 3.97, 95% CI = 2.49- 6.31, p < 0.001); bilateral midryasis (OR = 11.52, 95% CI = 5.56-23.87, p < 0.0001), or anisocoria (OR = 2.65, 95% CI = 1.69-4.17, p < 0.0001) in comparison to isocoric pupils. There was a trend for higher mortality in patients with type III injury on the Marshall classification of CT (OR = 3.63, 95% CI = 0.84-15.76, p = 0.08) than in patients with normal CT. Patients without thoracic trauma disclose higher mortality than patients with associated thoracic trauma do (OR = 2.02, 95% CI = 1.19-3.41, p = 0.009). The final model presented disclosed 76.9% of overall correct prediction with the survival and death predicted at 87.6% and 55.6%, respectively. CONCLUSION: Age, CT findings, Glasgow coma scale, pupil examination, and the presence of thoracic trauma at admission were independently associated with mortality at the time of discharge in Brazilian patients with severe TBI.

29. Nijboer JM, van der Naalt J, Ten Duis HJ., Patients beyond salvation? Various categories of trauma patients with a minimal Glasgow Coma Score., Injury. 2009 Jun 29.

INTRODUCTION: Trauma patients in an unresponsive state upon presentation to the Emergency Department have a poor prognosis. Rapid assessment of injuries combined with life-preserving therapy is required but defining the optimal strategy can be complicated when multiple organ systems are involved. This study analysed various categories of trauma patients with a Glasgow Coma Scale (GCS) of 3 on admission and evaluated the relation between injuries, clinical condition, treatment and outcome. PATIENTS AND METHODS: A retrospective cohort-study, performed at a level 1 Trauma Center from 2002 to 2005. Trauma patients of all ages with GCS of 3 (without sedation) and Injury Severity Score (ISS) >/=16 were included. The collected patient data comprised data on demographics, mechanism of injury, physiological condition on admission, diagnosis, ISS, treatment, admission to Intensive Care Unit, complications and outcome. RESULTS: Ninety-seven patients were included and divided into three groups based on the pathology that caused the GCS of 3: traumatic brain injury N=48 (49%), anoxic brain injury N=27 (28%) and haemorrhagic shock N=22 (23%). The overall mortality was 81%; 91% of the haemorrhagic shock patients, 81% of the ABI patients and 77% of the TBI patients died. Eighteen patients survived of whom five patients (5%) made a good recovery. The pupillary light response and pH on admission were related to mortality. No relation with ISS, age or hypothermia was found. DISCUSSION: Distinguishing salvageable patients from those beyond salvation remains problematic. This study illustrated the diversity of patients, their injuries and their condition upon presentation to the hospital as well as the limitations of therapy. CONCLUSION: Trauma patients with a GCS of 3 have a poor outcome. Despite aggressive treatment only 5% of the patients made a good recovery. Pupil reactivity and the pH on admission were found to be related to mortality.

30. Fasano CJ, O'Malley GF, Lares C, Rowden AK., Pediatric ziprasidone overdose., Pediatr Emerg Care. 2009 Apr;25(4):258-9.

We describe the first ziprasidone overdose with quantitative serum levels of a pediatric patient in coma and with pinpoint pupils. This case is an important contribution to the pediatric ziprasidone literature because it illustrates that ingestion of just 1 pill may result to profound mental status and respiratory depression in a child. H.C., a 30-month-old girl, presented to the emergency department approximately 30 minutes after an accidental ingestion of an adult family member's medication. The child was found on the floor surrounded by numerous pills and was witnessed to have ingested at least 1 tablet by a caregiver. After finding the child with the pills, the family observed the child for a brief period but transported her to the hospital after she became lethargic and unresponsive. The child received 2 doses of 0.4 mg of intravenous naloxone without change in her neurologic status. The child then underwent a rapid sequence intubation for airway protection and subsequently received gastrointestinal decontamination with 15 g of activated charcoal via the orogastric tube. Ziprasidone is an atypical antipsychotic drug that was approved by the Food and Drug Administration in February 2001 for the general treatment of schizophrenia in adults. Previously reported pediatric ziprasidone overdoses describe a syndrome of sedation, tachycardia, hypotonia, and coma consistent with that of the patient described in this paper. In pediatric ziprasidone overdose, QTc prolongation and hypotension have also been illustrated, but seizures have not been reported. An interesting aspect of this case is the development of pinpoint pupils unresponsive to naloxone. This phenomenon has been reported before with overdose of olanzapine, a similar atypical antipsychotic. The mechanism of miosis associated with overdose of atypical antipsychotics is unclear but is likely related to interference with central innervation of the pupil. Pupil size is maintained by a balance between sympathetic and parasympathetic neurohumeral tones. We propose that an overdose of an alpha-1 receptor blocking agent, such as ziprasidone, results in unopposed parasympathetic stimulation resulting in miosis.

31. De Castro P., [Patients with alteration of consciousness in the emergency department], An Sist Sanit Navar. 2008;31 Suppl 1:87-97.

A subject is conscious when he is awake and with an adequate awareness of him and the environment. The term alteration of consciousness requires specification as to whether it defines alteration of arousal--when the patient might be confused, in a stupor or in some degree of coma (light, deep)--or alteration of awareness--that is, confused (spatio-temporally disoriented, with difficulty in maintaining his attention), with or without delirious ideation. The coma, in the strict sense, originates from structural (neurological) or functional (metabolic) dysfunction of the ascending reticular activator system, but it is accepted that it can derive also from diffuse bi-hemispheric cortical-subcortical damage. In the emergency department the starting point is the triad of situations that requires immediate treatment applying the normal protocol (ABC); next, pathologies involving risk to life, which might cause cerebral hypoxia, are ruled out: diminished cardiac output, shock and respiratory failure. Subsequently, a neurological evaluation is made, bearing in mind two situations of potential gravity: endocranial hypertension and diseases that might cause respiratory failure due to muscular fatigue. Neurological exploration will specify the respiratory, pupil and ocular patterns and motor responses. The depth of the coma is established through scales; a simplification of Jouvet's scale is proposed. The etiological diagnosis will on occasion require image tests and lumbar puncture.

32. Adoni A, McNett, M, The pupillary response in traumatic brain injury: a guide for trauma nurses., J Trauma Nurs. 2007 Oct-Dec;14(4):191-6; quiz 197-8.

Traumatic brain injuries (TBIs) affect more than 1.4 million Americans annually. Trauma nurses caring for these patients routinely perform serial neurologic assessments, including pupillary examinations. While trauma nurses are likely familiar with basic components of the pupillary examination, some confusion about more specific aspects of the examination and the physiologic basis of the pupillary response may still remain, particularly as it pertains to patients with TBI. Therefore, the purpose of this article is to identify the key components of a pupillary examination and its associated physiologic response. A case study is provided to illustrate the application of this information among patients with TBI.

33. Carter BG, Butt W, Taylor A, Bilaterally absent pupillary responses: not always a bad sign, Anaesth Intensive Care. 2007 Dec;35(6):984-7.

Pupillary responses are a simple test commonly used as a predictor of outcome after severe brain injury. It is also common for clinicians to associate bilaterally absent pupillary responses with very poor prognosis. We report a series of cases of severely brain injured children with bilaterally absent pupillary responses who had favourable outcomes. From a group of 89 patients with brain injury, 32 had bilaterally absent pupillary responses and six (four with traumatic brain injury and two with infective brain injury) subsequently had favourable outcomes. This represents 18.8% of patients and should be a reminder to clinicians that the clinical sign of bilaterally absent pupillary responses is not always associated with a hopeless outcome.

34. MRC CRASH Trial Collaborators, Perel P, Arango M, Clayton T, Edwards P, Komolafe E, Poccock S, Roberts I, Shakur H, Steverberg E, Yutthakesemsunt S, Predicting outcome after traumatic brain injury: practical prognostic models based on large cohort of international patients, BMJ. 2008 Feb 23;336(7641):425-9. Epub 2008 Feb 12.

OBJECTIVE: To develop and validate practical prognostic models for death at 14 days and for death or severe disability six months after traumatic brain injury. DESIGN: Multivariable logistic regression to select variables that were independently associated with two patient outcomes. Two models designed: "basic" model (demographic and clinical variables only) and "CT" model (basic model plus results of computed tomography). The models were subsequently developed for high and low-middle income countries separately. SETTING: Medical Research Council (MRC) CRASH Trial. SUBJECTS: 10,008 patients with traumatic brain injury. Models externally validated in a cohort of 8509. RESULTS: The basic model included four predictors: age, Glasgow coma scale, pupil reactivity, and the presence of major extracranial injury. The CT model also included the presence of petechial haemorrhages, obliteration of the third ventricle or basal cisterns, subarachnoid bleeding, midline shift, and non-evacuated haematoma. In the derivation sample the models showed excellent discrimination (C statistic above 0.80). The models showed good calibration graphically. The Hosmer-Lemeshow test also indicated good calibration, except for the CT model in low-middle income countries. External validation for unfavourable outcome at six months in high income countries showed that basic and CT models had good discrimination (C statistic 0.77 for both models) but poorer calibration. CONCLUSION: Simple prognostic models can be used to obtain valid predictions of relevant outcomes in patients with traumatic brain injury.

35. Marmarou A, Lu J, Butcher I, McHugh GS, Murray GD, Steyerberg EW, Mushkudiani NA, Choi S, Maas AI, Prognostic value of the Glasgow Coma Scale and pupil reactivity in traumatic brain injury assessed pre-hospital and on enrollment: an IMPACT analysis., J Neurotrauma. 2007 Feb;24(2):270-80.

We studied the prognostic strength of the individual components of the Glasgow Coma Scale (GCS) and pupil reactivity to Glasgow Outcome Score (GOS) at 6 months post-injury. A total of 8721 moderate or severe traumatic brain injury (TBI) patient data from the IMPACT database on traumatic brain injury comprised the study cohort. The associations between motor score and pupil reactivity and 6-month GOS were analyzed by binary logistic regression and proportional odds methodology. The strength of prognostic effects were expressed as the unadjusted odds ratios presented for all individual studies as well as in meta-analysis. We found a consistent strong association between motor score and 6-month GOS across all studies (OR 1.74-7.48). The Eye and Verbal components were also strongly associated with GOS. In the pooled population, one or both un-reactive

pupils and lower motor scores were significantly associated with unfavorable outcome (range 2.71-7.31). We also found a significant change in motor score from pre-hospital direct to study hospital enrollment ($p < 0.0001$) and from the first in-hospital to study enrollment scores ($p < 0.0001$). Pupil reactivity was more robust between these time points. It is recommended that the study hospital enrollment GCS and pupil reactivity be used for prognostic analysis.

36. Murray GD, Butcher I, McHugh GS, Lu J, Mushkudiani NA, Maas AI, Marmarou A, Steyerberg EW, Multivariable prognostic analysis in traumatic brain injury: results from the IMPACT study., J Neurotrauma. 2007 Feb;24(2):329-37.

We studied the prognostic value of a wide range of conventional and novel prognostic factors on admission after traumatic brain injury (TBI) using both univariate and multivariable analysis. The outcome measure was Glasgow Outcome Scale at 6 months after injury. Individual patient data were available on a cohort of 8686 patients drawn from eight randomized controlled trials and three observational studies. The most powerful independent prognostic variables were age, Glasgow Coma Scale (GCS) motor score, pupil response, and computerized tomography (CT) characteristics, including the Marshall CT classification and traumatic subarachnoid hemorrhage. Prothrombin time was also identified as a powerful independent prognostic factor, but it was only available for a limited number of patients coming from three of the relevant studies. Other important prognostic factors included hypotension, hypoxia, the eye and verbal components of the GCS, glucose, platelets, and hemoglobin. These results on prognostic factors will underpin future work on the IMPACT project, which is focused on the development of novel approaches to the design and analysis of clinical trials in TBI. In addition, the results provide pointers to future research, including further analysis of the prognostic value of prothrombin time, and the evaluation of the clinical impact of intervening aggressively to correct abnormalities in hemoglobin, glucose, and coagulation.

37. Fountas KN, Kapsalaki EZ, Machinis TG, Boev AN, Robinson JS, Troup EC, Clinical implications of quantitative infrared pupillometry in neurosurgical patients., Neurocrit Care. 2006;5(1):55-60.

Pupillometry has been widely employed in the evaluation of a large number of pathological conditions, including intracranial pathology. The recent introduction of a portable, user-friendly, infrared pupillometer (ForSite, NeurOptics Inc., Irvine, CA) has enabled the accurate and reproducible measurement of several pupillary parameters, such as maximum and minimum apertures, constriction and dilation velocities, and latency period. It should be noted that various clinical conditions, especially neurological and ocular diseases, as well as numerous medications, may interfere with the measurements. Furthermore, a number of physiological parameters, such as the intensity of retinal illumination, the level of patient's alertness, the intensity of ambient light, as well as the time of day that the examination is performed may alter the obtained values. The potential implications of pupillometry in the clinical assessment of neurosurgical patients, including its complex relationship to intracranial pressure changes, mandate the undertaking of prospective clinical studies validating the clinical significance of this noninvasive, diagnostic modality.

38. Bader MK, Gizmos and gadgets for the neuroscience intensive care unit., J Neurosci Nurs. 2006 Aug;38(4):248-60.

Managing the critical neuroscience patient population challenges practitioners because of both the devastating injury involved and the complexity of care required. Emerging technology provides the neuroscience intensive care unit team with better information on the intricate physiology and dynamics inside the cranium. In particular, the team is better able to detect changes in pressure, oxygen, and blood flow. With improved data in hand, the team can intervene to optimize intracranial dynamics, possibly reducing disability and death among such patients.

39. Oh HS, Seo WS, Lee S, Song H, Comparisons of the prognostic predictors of traumatic brain injury according to admission Glasgow Coma Scale scores-based on 1- and 6-month assessments., Taehan Kanho Hakhoe Chi. 2006 Jun;36(4):621-9.

PURPOSE: The purpose of this study was to identify the clinical variables that predict functional and cognitive recovery at 1- and 6-month in both severe and moderate/mild traumatic brain injury patients. METHODS: The subjects of this study were 82 traumatically brain-injured patients who were admitted to a Neurological Intensive Care Unit at a university hospital. Potential prognostic factors included were age, motor and pupillary response, systolic blood pressure, heart rate, and the presence of intracranial hematoma at admission. RESULTS: The significant predictors of functional disability in severe traumatic brain injury subjects were, age, systolic blood pressure, the presence of intracranial hematoma, motor response, and heart rate at admission. In moderate/mild traumatic brain injury patients, motor response, abnormal pupil reflex, and heart rate at admission were identified as significant predictors of functional disability. On the other hand, the significant predictors of cognitive ability for severe traumatic brain injury patients were motor response and the presence of intracranial hematoma at admission, whereas those for moderate/mild patients were motor response, pupil reflex, systolic blood pressure at admission, and age. CONCLUSIONS: The results of the present study indicate that the significant predictors of TBI differ according to TBI severity on admission, outcome type, and outcome measurement time. This can be meaningful to critical care nurses for a better understanding on the prediction of brain injury patients. On the other hand, the model used in the present study appeared to produce relatively low explicabilities for functional and cognitive recovery although a direct comparison of our results with those of others is difficult due to differences in outcome definition and validation Methods. This implies that other clinical variables should be added to the model used in the present study to increase its predicting power for determining functional and cognitive outcomes.

40. Tien HC, Cunha JR, Wu SN, Chughtai T, Tremblay LN, Brenneman FD, Rizoli SB., Do trauma patients with a Glasgow Coma Scale score

of 3 and bilateral fixed and dilated pupils have any chance of survival?, J Trauma. 2006 Feb;60(2):274-8.

BACKGROUND: Low Glasgow Coma Scale score (GCS) and pupillary status predict poor outcomes in head injury (HI) patients. We compared the mortality of GCS 3 patients having bilateral fixed and dilated pupils (BFDP) with GCS 3 patients having reactive pupils (RP). We then determined if trauma system or patient factors were responsible for the difference in mortality. METHODS: We reviewed all adult, blunt HI patients with GCS=3, admitted to our institution from January 1, 2001 to December 31, 2003. Demographics, injury data, prehospital times, procedures, and outcomes were recorded. RESULTS: During this period, 245 patients were admitted with GCS of 3, and met inclusion criteria. In all, 173 patients were analyzed, after excluding 23 patients who were dead-on-arrival, and 45 others, who were intoxicated with alcohol, or received paralytic agents in the trauma room. All BFDP patients died, whereas 42.0% of reactive pupil (RP) patients died ($p < 0.0001$). With regards to patient factors, BFDP patients were more likely to be unstable, have extra-axial bleeding, and evidence of midline shift and/or herniation. Trauma system factors, however, may also have had an impact on outcome. Despite having more extra-axial bleeding, BFDP patients were less likely to have a neurosurgical operation than RP patients. CONCLUSION: Patients with GCS of 3 and BFDP have a dismal prognosis. These patients have suffered devastating brain injuries and tend to be hemodynamically unstable. Clinicians, however, are less likely to aggressively treat BFDP patients than RP patients. Further prospective studies are required to determine which patients with GCS of 3 and BFDP are likely to benefit from aggressive treatment.

41. Clark A, Clarke TN, Gregson B, Hooker PN, Chambers IR., Variability in pupil size estimation., Emerg Med J. 2006 Jun;23(6):440-1.

BACKGROUND: The clinical estimation of pupil size and reactivity is central to the neurological assessment of patients, particularly those with or at risk of neurological damage. Health care professionals who examine pupils have differing levels of skill and training, yet their recordings are passed along the patient care pathway and can influence care decisions. The aim of this study was to determine if any statistical differences existed in the estimation of pupil size by different groups of health care professionals. METHODS: A total of 102 health care professionals working in the critical care environment were asked to estimate and record the pupil size of a series of 12 artificial eyes with varying pupil diameter and iris colour. All estimations were performed indoors under ambient lighting conditions. RESULTS: Our results established a statistically significant difference between staff groups in the estimation of pupil size. CONCLUSION: The demonstrated variability in pupil size estimation may not be clinically significant. However, it remains desirable to have consistency of measurement throughout the patient care pathway.

42. UK Paediatric Brain Injury Study Group and the Paediatric Intensive Care Society Study Group; Tasker RC, Morris KP, Forsyth RJ, Hawley CA, Parslow RC., Severe head injury in children: emergency access to neurosurgery in the United Kingdom., Emerg Med J. 2006 Jul;23(7):519-22.

OBJECTIVE: To determine the scale of acute neurosurgery for severe traumatic brain injury (TBI) in childhood, and whether surgical evacuation for haematoma is achieved within four hours of presentation to an emergency department. METHODS: A 12 month audit of emergency access to all specialist neurosurgical and intensive care services in the UK. Severe TBI in a child was defined as that necessitating admission to intensive care. RESULTS: Of 448 children with severe head injuries, 91 (20.3%) underwent emergency neurosurgery, and 37% of these surgical patients had at least one non-reactive and dilated pupil. An acute subdural or epidural haematoma was present in 143/448 (31.9%) children, of whom 66 (46.2%) underwent surgery. Children needing surgical evacuation of haematoma were at a median distance of 29 km (interquartile range (IQR) 11.8-45.7) from their neurosurgical centre. One in four children took longer than one hour to reach hospital after injury. Once in an accident and emergency department, 41% took longer than fours hours to arrive at the regional centre. The median interval between time of accident and arrival at the surgical centre was 4.5 hours (IQR 2.23-7.73), and 79% of inter-hospital transfers were undertaken by the referring hospital rather than the regional centre. In cases where the regional centre undertook the transfer, none were completed within four hours of presentation-the median interval was 6.3 hours (IQR 5.1-8.12). CONCLUSIONS: The system of care for severely head injured children in the UK does not achieve surgical evacuation of a significant haematoma within four hours. The recommendation to use specialist regional paediatric transfer teams delays rather than expedites the emergency service.

43. Oh HS, Seo WS, Lee S, Song H., Comparisons of the Prognostic Predictors of Traumatic Brain Injury According to Admission Glasgow Coma Scale Scores-Based on 1- and 6-month Assessments., Taehan Kanho Hakhoe Chi. 2006 Jun;36(4):621-9.

PURPOSE: The purpose of this study was to identify the clinical variables that predict functional and cognitive recovery at 1- and 6-month in both severe and moderate/mild traumatic brain injury patients. METHODS: The subjects of this study were 82 traumatically brain-injured patients who were admitted to a Neurological Intensive Care Unit at a university hospital. Potential prognostic factors included were age, motor and pupillary response, systolic blood pressure, heart rate, and the presence of intracranial hematoma at admission. RESULTS: The significant predictors of functional disability in severe traumatic brain injury subjects were, age, systolic blood pressure, the presence of intracranial hematoma, motor response, and heart rate at admission. In moderate/mild traumatic brain injury patients, motor response, abnormal pupil reflex, and heart rate at admission were identified as significant predictors of functional disability. On the other hand, the significant predictors of cognitive ability for severe traumatic brain injury patients were motor response and the presence of intracranial hematoma at admission, whereas those for moderate/mild patients were motor response, pupil reflex, systolic blood pressure at admission, and age. CONCLUSIONS: The results of the present study indicate that the significant predictors of TBI differ according to TBI severity on admission, outcome type, and outcome measurement time. This can be meaningful to critical care nurses for a better understanding on the prediction of brain injury patients. On the other hand, the model used in the present study appeared to produce relatively low explicabilities for functional and cognitive recovery although a direct comparison of our results with

those of others is difficult due to differences in outcome definition and validation Methods. This implies that other clinical variables should be added to the model used in the present study to increase its predicting power for determining functional and cognitive outcomes.

44. Turan Suslu H, Celikoglu E, Cecen A, Bozbuga M., A statistical analysis for the identification of factors effecting prognosis of civilian patients with cranial gunshot wounds., Ulus Travma Derg. 2005 Jul;11(3):206-211.

BACKGROUND: Patients with civil cranial gunshot injuries who were treated in our hospital were statistically analized for the factors acting on 7 days survival and prognosis without regarding treatment modalities. MATERIAL AND METHOD: Patients were divided into two groups according to the mortality rates in 7 days following the trauma without regarding treatment modalities. Initial GCS score, pupillary response to light, coagulopathy, ventricular penetration and number of hemispheres affected are 5 differentials evaluated separately and in combination for their effects on mortality rates within 7 days posttraumatically and their statistical significance. RESULTS: Thirty six male (75%) and 12 female (25%) patients included in the study. Total and 7 day- survival rates were 27% (13/48), and 31% (15/48) respectively. Among GCS scores, pupillary defects, coagulopathy, intraventricular penetration, the number of hemispheres affected, the most important prognostic factors of the patients living less than 7 days were found to be primarily coagulopathy and then pupillary defects. The other variables were not significantly effective and the results were in accordance with the literature. CONCLUSION: In civilian patients with cranial gunshot injuries pupillary defect and coagulopathy were statistically significant prognostic factors. We think that agressive medical and surgical treatment will be beneficial even if the patients' neurological status is deteriorating.

45. Du R, Meeker M, Bacchetti P, Larson MD, Holland MC, Manley GT., Evaluation of the portable infrared pupillometer., Neurosurgery. 2005 Jul;57(1):198-203; discussion 198-203.

There are two different components to the inaccuracies in manual pupillary measurements. One is the interexaminer consistency, and the other is the precision of measurement. The interexaminer inconsistency makes it difficult to detect early or small changes. The pupillometer serves as a quantitative standard that solves both problems. Because it is a mechanical measurement, there is minimal interexaminer variability and higher sensitivity in detecting pupillary reaction. Thus, the pupillometer may be a useful tool in future studies that use the pupillary examination to predict clinical outcomes or radiological findings.

The NeurOptics ForSite quantitative dynamic pupillometer is manufactured by NeurOptics, Inc. (Irvine, CA), www.NeurOptics.com.

46. Chiao L, Sharipov S, Sargsyan AE, Melton S, Hamilton DR, McFarlin K, Dulchavsky SA., Ocular Examination For Trauma; Clinical Ultrasound Aboard The International Space Station., J Trauma. 2005 May;58(5):885-889.

BACKGROUND: Ultrasound imaging is a successful modality in a broad variety of diagnostic applications including trauma. Ultrasound has been shown to be accurate when performed by non-radiologist physicians; recent reports have suggested that non-physicians can perform limited ultrasound examinations. A multipurpose ultrasound system is installed on the International Space Station (ISS) as a component of the Human Research Facility (HRF). This report documents the first ocular ultrasound examination conducted in space, which demonstrated the capability to assess physiologic alterations or pathology including trauma during long-duration space flight. METHODS:: An ISS crewmember with minimal sonography training was remotely guided by an imaging expert from Mission Control Center (MCC) through a comprehensive ultrasound examination of the eye. A multipurpose ultrasound imager was used in conjunction with a space-to-ground video downlink and two-way audio. Reference cards with topological reference points, hardware controls, and target images were used to facilitate the examination. Multiple views of the eye structures were obtained through a closed eyelid. Pupillary response to light was demonstrated by modifying the light exposure of the contralateral eye. RESULTS:: A crewmember on the ISS was able to complete a comprehensive ocular examination using B- and M-mode ultrasonography with remote guidance from an expert in the MCC. Multiple anteroposterior, oblique, and coronal views of the eye clearly demonstrated the anatomic structures of both segments of the globe. The iris and pupil were readily visualized with probe manipulation. Pupillary diameter was assessed in real time in B- and M-mode displays. The anatomic detail and fidelity of ultrasound video were excellent and could be used to answer a variety of clinical and space physiologic questions. CONCLUSIONS:: A comprehensive, high-quality ultrasound examination of the eye was performed with a multipurpose imager aboard the ISS by a non-expert operator using remote guidance. Ocular ultrasound images were of diagnostic quality despite the 2-second communication latency and the unconventional setting of a weightless spacecraft environment. The remote guidance techniques developed to facilitate this successful NASA research experiment will support wider applications of ultrasound for remote medicine on Earth including the assessment of pupillary reactions in patients with severe craniofacial trauma and swelling.

47. Hukkelhoven CW, Steyerberg EW, Habbema JD, Maas AI., Admission of patients with severe and moderate traumatic brain injury to specialized ICU facilities: a search for triage criteria., Intensive Care Med. 2005 Apr 16.

OBJECTIVE: To investigate whether triage for direct admission of patients with traumatic brain injury to a trauma center is facilitated by predicting the risk of potentially removable lesions or raised intracranial pressure (ICP).DESIGN AND SETTING: Cohort study in a level I university trauma center.PATIENTS AND PARTICIPANTS: A prospective cohort of primarily (n=200) and secondarily (n=75) referred patients with moderate or severe traumatic brain injury.MEASUREMENTS AND RESULTS: Predictive characteristics for the risk of surgically removable lesions and the risk of raised ICP (repeatedly >/= 20 mmHg) were identified and included in prognostic models. These models were validated internally with bootstrapping techniques and externally on a historic sample (n=205) regarding discriminative ability (AUC). Among the cohort patients, 67% had raised ICP and

54% had surgically removable lesions. Both outcomes occurred more frequently in patients secondarily referred, but the incidence in patients primarily referred was also high (62% and 33% respectively). No strong predictors of raised ICP were identified. Age and pupillary reactivity were significant predictors of surgically removable lesions. The models discriminated reasonably for surgically removable lesions (AUC=0.78 at development and AUC=0.67 at external validation) but not for raised ICP (AUC=0.59 at development and AUC=0.50 at external validation).CONCLUSIONS: It is difficult accurately to identify patients in need of specialized intensive care using baseline characteristics. The high incidence of both outcomes in patients primarily referred support direct admission of more and particularly older patients with severe or moderate brain trauma to level I trauma centers.

48. Meeker M, Du R, Bacchetti P, Privitera CM, Larson MD, Holland MC, Manley G., Pupil examination: validity and clinical utility of an automated pupillometer., J Neurosci Nurs. 2005 Feb;37(1):34-40.

Pupillary size and reactivity have long been a critical component of the clinical assessment of patients with neurological disorders. The pupillary examination may provide critical information related to new or worsening intracranial pathology and facilitate prompt intervention to minimize further neuronal damage. With this in mind, intensive care nurses caring for neurologically impaired patients frequently must perform pupillary examinations in concert with assigning a Glasgow Coma Scale score. The purpose of this study was to test the accuracy and reliability of an automated pupillometer compared with the standard manual examination as a preliminary step in assessing the usefulness of automated pupillometry in the critical care setting. Twenty patients in the intensive care units of a teaching hospital were examined by two groups of three examiners using both the manual examination with a penlight or similar light source and a portable automated pupillometer capable of measuring pupil size and reaction. Measurements by a static pupillometer before and after each pupillary examination were used to determine the mean "true" size of the pupil. This study found that the automated pupillometer is more accurate and reliable than the manual examination in measuring pupil size and reactivity. For these reasons, such a device may be a beneficial addition in the clinical assessment of neurologically impaired patients.

49. Raman SV, Jacob J., Mydriasis due to Datura inoxia., Emerg Med J. 2005 Apr;22(4):310-1.

Unilateral, dilated unresponsive pupil may be secondary to a wide range of ocular and neurological disorders. "Gardener's pupil" is a pharmacological mydriasis caused by exposure to plants containing alkaloids. We report a case of mydriasis related to Datura inoxia, and detail a number of plants that have toxic effects. This report emphasises the importance of accurate history taking when evaluating fixed dilated pupil. We recommend that labelling of such poisonous plants should detail the local and systemic effects of accidental exposure, rather than merely the fact that they are poisonous.

50. Witting MD., Validity of simple measurement to diagnose pupillary dilation., Am J Emerg Med. 2005 Mar;23(2):155-8.

Abstract Study Objective The aim of the study was to compare the validity of 3 methods of detecting pupillary dilation: bright-light measurement, room-light measurement, and gestalt judgment. Methods In reach volunteer, by random assignment, placebo was instilled in one eye and dilute phenylephrine in the other. Emergency care providers judged whether each pupil was dilated and measured it in bright light (>54 000 lux) and in room light (2700-5400 lux) while the other eye was covered. Test characteristics for measurement were determined according to published cut-points, and measurement methods were compared using receiver operating curve analysis. Results There were 136 pupillary assessments-68 in placebo and 68 in phenylephrine eyes. Compared with gestalt judgment, bright-light measurement had higher specificity (0.94 vs 0.68) but lower sensitivity (0.43 vs 0.79). Bright-light measurement was more discriminating than room-light measurement. Conclusion Bright-light measurement has higher specificity, but lower sensitivity, than gestalt judgement, and is superior to room-light measurement.

51. Holstege C, Baer A, Brady WJ., The electrocardiographic toxidrome: The ECG presentation of hydrofluoric acid ingestion., Am J Emerg Med. 2005 Mar;23(2):171-6.

Abstract The clinician can approach the poisoned patient using the toxidrome system of toxin identification; this approach makes use of findings noted on the physical examination, highlighting the importance of abnormalities in blood pressure, heart rate, respiratory effort, body temperature, mental status, pupillary size, skin color, diaphoresis, and gastrointestinal sounds. Such a method provides structure and guidance to the clinical evaluation, providing the clinician with rapid diagnostic information and suggesting urgent management issues. A case of hydrofluoric acid poisoning is used as an example of this diagnostic approach. The patient demonstrated systemic toxicity accompanied by oral irritation and electrocardiographic abnormality (QRS complex widening and QT interval prolongation). The constellation of these findings suggested the possibility of a caustic agent (history and examination) with potential effect on potassium and calcium metabolism (electrocardiographic abnormalities). Such a constellation strongly suggested hydrofluoric acid as the culprit toxin.

52. Lu J, Marmarou A, Choi S, Maas A, Murray G, Steyerberg EW, Impact and Abic Study Group, Mortality from traumatic brain injury., Acta Neurochir Suppl. 2005;95:281-5.

It is the general sense that mortality has been decreasing in recent years compared to earlier studies described by the NIH traumatic coma data bank. We studied mortality during the period of 1984 to 1996 to determine if indeed mortality from severe traumatic brain injury was decreasing and to identify factors which might account for the reduction. The study population (N = 1839) consisted of severely head injured patients extracted

retrospectively from the TCDB (635), MCV (382), and 822 patients from clinical trial databases conducted in the United States. Mortality was obtained from each of the databases for the age range form 16 to 65. Penetrating injury and treatment groups in the clinical trial databases were excluded. Mortality in the year 1984 equaled 39% and gradually decreased to a level of 27% in 1996. When adjusting for age, motor score and pupil reaction, the mortality of the period from 1984 to 1987 was significantly higher ($p < 0.05$) than that of the period 1988 to 1996. During the period 1984 through 1996, mortality from severe brain injury steadily declined. Factors other than age, motor score and pupil reactivity over time are responsible for this reduction. This reduction over time is an important factor for prognostic modeling of TBI.

53. Boev AN, Fountas KN, Karampelas I, Boev C, Machinis TG, Feltes C, Okosun I, Domopoulos V, Troup C, Quantitative pupillometry: normative data in healthy pediatric volunteers., J Neurosurg. 2005 Dec;103(6 Suppl):496-500.

OBJECT: The authors describe the prospective use of a new hand-held point-and-shoot pupillometer (NeurOptics) to assess pupil function quantitatively. METHODS: Repetitive measurements were made in 90 pediatric participants ranging in age from 1 to 18 years, providing a total of 100 measurements under ambient light conditions. The participants consisted of 45 patients without known intracranial or ophthalmological pathological conditions as well as 45 volunteers in the outpatient setting. Quantitative pupil measurements were reliably replicated in the study participants. The mean resting pupil aperture was 4.11 mm and the minimal diameter after stimulation was 2.65 mm, resulting in a 36% change in pupil size. The mean constriction velocity was 2.34 mm/second, with a mean dilation velocity of 2.2 mm/second. CONCLUSION: Pupil symmetry was impressive in the entire cohort.

54. Brown CV, Weng J, Oh D, Salim A, Kasotakis G, Demetriades D, Velmahos GC, Rhee P., Does routine serial computed tomography of the head influence management of traumatic brain injury? A prospective evaluation., J Trauma. 2004 Nov;57(5):939-43.

BACKGROUND: Computed tomography (CT) of the head is the current standard for diagnosing intracranial pathology following blunt head trauma. It is common practice to repeat the head CT to evaluate any progression of injury. Recent retrospective reviews have challenged the need for serial head CT after traumatic brain injury (TBI). This study intends to prospectively examine the value of routine serial head CT after TBI. METHODS: Consecutive adult blunt trauma patients with an abnormal head CT admitted to an urban, Level I trauma center from January 2003 to September 2003 were prospectively studied. Variables collected included: initial head CT results, indication for repeat head CT (routine versus neurologic change), number and results of repeat head CT scans, and clinical interventions following repeat head CT. RESULTS: Over the 9-month period, there were 128 patients admitted with an abnormal head CT after sustaining blunt trauma. The 16 patients who died within 24 hours and the 12 patients who went directly to craniotomy were excluded. The remaining 100 patients make up the study population. Abnormal head CT findings were subarachnoid hemorrhage (47%), intraparenchymal hemorrhage (37%), subdural hematoma (28%), contusion (14%), epidural hematoma (11%), intraventricular hemorrhage (3%), and diffuse axonal injury (2%). Overall, 32 patients (32%) had only the admission head CT, while 68 patients (68%) underwent 90 repeat CT scans. Of the repeat head CT scans, 81 (90%) were performed on a routine basis without neurologic change. The remaining 9 (10%) were performed for a change in Glasgow Coma Scale ($n = 5$), change in intracranial pressure ($n = 1$), change in Glasgow Coma Scale and intracranial pressure ($n = 1$), change in pupil size ($n = 1$), or sudden appearance of a headache ($n = 1$). Three patients had their care altered after repeat head CT: two underwent craniotomy and one was started on barbiturate therapy. All three patients had their repeat head CT after neurologic change (decrease in Glasgow Coma Scale in 2 and increase in intracranial pressure in 1). CONCLUSIONS: Serial head CT is common after TBI. Most repeat head CT scans are performed on a routine basis without neurologic change. Few patients with TBI have their management altered after repeat head CT, and these patients have neurologic deterioration before the repeat head CT. The use of routine serial head CT in patients without neurologic deterioration is not supported by the findings of this study.

55. Cruz J, Minoja G, Okuchi K, Facco E., Successful use of the new high-dose mannitol treatment in patients with Glasgow Coma Scale scores of 3 and bilateral abnormal pupillary widening: a randomized trial., J Neurosurg. 2004 Mar;100(3):376-83.

OBJECT: The authors evaluated long-term clinical outcomes in selected acutely comatose patients with severe diffuse brain swelling and recent clinical signs of impending brain death who received a novel high-dose mannitol treatment compared with those who received conventional-dose mannitol in the emergency room. METHODS: Forty-four adult patients with traumatic, nonmissile-inflicted, acute, severe diffuse brain swelling were prospectively and randomly evaluated. All patients were selected based on the presence of recent clinical signs of impending brain death on the first emergency room evaluation. These signs included bilateral abnormal pupillary widening and lack of motor responses to painful stimulation (Glasgow Coma Scale score of 3). The study group (23 patients) received ultra-early and fast intravenous high-dose mannitol treatment (approximately 1.4 g/kg), whereas the control group (21 patients) received half that dose (approximately 0.7 g/kg). Ultra-early improvement of bilateral abnormal pupillary widening was significantly more frequent in the high-dose mannitol group than in the conventional-dose group ($p < 0.02$). High-dose mannitol treatment in the emergency room was also associated with significantly better 6-month clinical outcomes ($p < 0.02$); the best rate of favorable outcomes was 43.5%, compared with only 9.5% in the conventional-dose mannitol group. The two groups of patients were well matched with respect to all emergency room and head computerized tomography findings, as well as the timing of initial mannitol treatment (approximately 80-90 minutes after the first evaluation at the scene of the injury). Comparative evaluation of bilateral pupillary widening between the scene of the injury and the emergency room showed no significant differences between groups, whereas mannitol dose dependence was statistically significant ($p < 0.05$), insofar as early pupillary improvement in the emergency room was concerned. CONCLUSIONS: Ultra-early high-dose mannitol administration in the emergency room is the first known treatment strategy significantly to reverse recent clinical signs of impending brain death, and also to contribute directly to improved long-term clinical outcomes for these patients who have previously been considered unsalvageable.

56. Alexander JL, Burton JH, Bradshaw JR, Colin F., Suspected opioid-related emergency medical services encounters in a rural state, 1997-2002., Prehosp Emerg Care. 2004 Oct-Dec;8(4):427-30.

INTRODUCTION: News organizations and governmental agencies have reported substantial increases in the number of opioid-related overdose cases in recent years. OBJECTIVE: To describe the utilization of emergency medical services (EMS) for suspected opioid-related overdose cases in a rural state during the period 1997 through 2002. METHODS: Statewide EMS records were reviewed for 1997 through 2002. Data reviewed included prehospital diagnosis and medications given to all patients by prehospital providers. For cases with a prehospital diagnosis of poisoning or overdose, data reviewed included medications given to patients by prehospital providers, pupil size, and respiratory rate. All records were reviewed in a defined sequence. RESULTS: The study period encompassed 1,175,781 patient encounters. Poisoning or overdose patients accounted for 19,808 (1.7%) encounters. Naloxone was administered by the EMS provider to 2,668 (0.2%) patients. For all poisoning or overdose patients, 1,308 (6.6%) had miotic pupils, 450 (2.2%) had a respiratory rate of <12 breaths/min, and 1,569 (7.9%) received naloxone. During the investigation period, total EMS patient encounters increased 25%, while patients with a complaint of poisoning or overdose increased 47%. The incidences of EMS overdose patients with miotic pupils, respiratory rate <10 breaths/min, and naloxone administration increased 167%, 295%, and 154%, respectively. CONCLUSION: In this rural state, prehospital patients with findings suspicious for opioid overdose disproportionately outpaced the growth of all EMS encounters as well as general overdose encounters during the defined investigation period.

57. Gattey D., The pupil examination in the trauma patient., J Emerg Nurs. 2004 Oct;30(5):512-3.

No abstract available.

58. Lieberman JD, Pasquale MD, Garcia R, Cipolle MD, Mark Li P, Wasser TE., Use of admission Glasgow Coma Score, pupil size, and pupil reactivity to determine outcome for trauma patients., J Trauma. 2003 Sep;55(3):437-42; discussion 442-3.

BACKGROUND: Determination of nonsurvival in trauma patients is difficult because valid prognostic indicators are lacking. It was hypothesized that patients presenting with a Glasgow Coma Score (GCS) of 3 as well as fixed and dilated (FD) pupils do not have a reasonable chance of survival. METHODS: From 1999 through 2001, adult trauma patients (age, >14 years) admitted with a GCS of 3 were reviewed. Patients receiving paralytic agents before initial assessment were excluded from analysis. Fixed and dilated pupils were defined as being 4 mm or more in diameter bilaterally and nonreactive to light. In this study, the FD patients were evaluated for survival, resuscitative measures, surgical procedures, length of hospital stay, and organ donation. The non-FD patients were evaluated for survival and length of hospital stay. RESULTS: Of the 137 patients evaluated with a GCS of 3, 104 had FD pupils and 33 did not. In the FD group, there were no survivors. On arrival, 28 (37.3%) of the patients were declared dead, and no further interventions were undertaken. Of the 76 patients (62.7%) who underwent further resuscitation, which included 53 surgical procedures, 30 died in the resuscitation bay, 39 within 24 hours, 4 within 48 hours, 2 within 72 hours, and 1 on day 6. There were 18 (23.7%) organ donors. Of the 33 patients without FD pupils, 11 (33%) survived to discharge (mean hospital stay, 21.4 days). Of the 22 nonsurvivors (67%), 10 died in the resuscitation bay, 8 within 24 hours, 1 within 48 hours, 1 on day 4, and 2 on day 6. CONCLUSIONS: Patients presenting with a GCS of 3 and FD pupils have no reasonable chance for survival. A significant percentage of these patients can be salvaged for organ donation. This information should be used in deciding to pursue aggressive resuscitation efforts and in discussing prognosis with family. Patients with a GCS of 3 who are not FD should be aggressively resuscitated because many of these patients survive to discharge.

59. Temkin NR., Risk factors for posttraumatic seizures in adults., Epilepsia. 2003;44 Suppl 10:18-20.

PURPOSE: Traumatic brain injury has long been known to be a cause of epilepsy. Most information on risk factors for developing posttraumatic seizures is from before computed tomography (CT) scanning became universal. This article looks at factors about the injury or individual that put people at especially high risk of developing posttraumatic seizures. METHODS: We considered 783 cases at high risk of developing seizures, followed up for 2 years as part of seizure prophylaxis studies. Cumulative incidence of seizures in subgroups and standardized incidence ratios were used to identify factors related to unprovoked seizure risk. RESULTS: Subgroups with significantly elevated risk include those with evacuation of a subdural hematoma; surgery for an intracerebral hematoma; Glasgow Coma Scale in the severe range of 3 to 8; early seizures, especially delayed early seizures; time to following commands of a week or more; depressed skull fracture that was not surgically elevated; dural penetration by injury; at least one nonreactive pupil; and parietal lesions on CT scan. CONCLUSIONS: Both the risk factors and the time course of the risk are important for designing seizure-prophylaxis studies and, if an effective prophylactic regimen is identified, for deciding on appropriate candidates for prophylaxis.

60. Martins RS, Siqueira MG, Santos MT, Zanon-Collange N, Moraes OJ., Prognostic factors and treatment of penetrating gunshot wounds to the head., Surg Neurol. 2003 Aug;60(2):98-104; discussion 104.

BACKGROUND: In an attempt to evaluate the predictive factors of morbidity and mortality in patients who suffered from civilian gunshot wounds to the head, we reviewed a series of 319 patients admitted to the Hospital Santa Marcelina, Sao Paulo, Brazil, between 1994 and 2000. METHODS: Clinical and cranial computed tomography (CT) results are described. The initial Glasgow Coma Scale (GCS), the presence of an unilateral dilated pupil or medium fixed pupils, and five different findings in the CT scan were considered as variables. The Qui-Square Fisher test was utilized to

verify the correlation between the presence of the variables and the occurrence of an increased mortality rate and of an unfavorable outcome (Glasgow Outcome Scale = 2 and 3). RESULTS: In 265 cases the missile penetrated the dura (83%). In our study there was a significant correlation between the low GCS scores on admission and a higher mortality ($p < 0.001$). This kind of correlation was also noted with patients admitted with unilateral dilated pupil and medium fixed pupil. There were 187 patients (70.5%) evaluated by CT scan. There was a significant correlation between the presence of transventricular or bihemispheric central type trajectory and high mortality. The patients admitted with unilobar supratentorial wounds resulted in better outcome when compared to those with bilobar or multilobar wounds ($p < 0.001$). A group of 156 patients was submitted to an aggressive surgical protocol. The best results were seen in patients admitted with initial GCS score higher than 8. CONCLUSIONS: We conclude that low GCS scores at admission, unilateral dilated pupil or medium fixed pupil, transventricular or bihemispheric central type trajectory, and bilobar or multilobar wounds noted through CT scan are predictive factors of high morbidity and mortality in patients with gunshot wounds to the head, in our clinical experience. We also conclude that surgical treatment is not recommended for patients with penetrating wounds and GCS score of 3 to 5 in the absence of hematoma causing a mass effect.

61. Hayes MM, Berg RA, Otto CW., Monitoring during cardiac arrest: are we there yet?, Curr Opin Crit Care. 2003 Jun;9(3):211-7.

Advancements in electronic data acquisition have translated into improved monitoring of victims of cardiac arrest, but initial techniques remain direct observation of pulses and respirations. The most essential monitor continues to be the electrocardiogram. However, monitoring diastolic blood pressure, myocardial perfusion pressure, and end-tidal carbon dioxide are extremely useful. Most of the current research on monitoring during cardiopulmonary resuscitation focuses on methods for analyzing ventricular fibrillation waveforms. By analyzing the waveform, defibrillation shocks may be delivered at the time when the chance of success is optimal. Low-amplitude and low-frequency fibrillation waveforms are associated with increased rates of asystole and pulseless electrical activity after defibrillation. Methods of analyzing the ventricular fibrillation waveform include measuring the amplitude and frequency and combining the contributions of amplitude and frequency by various methods to improve discrimination. Other types of monitoring being studied for their usefulness during cardiac arrests include sonography, Bispectral Index monitoring, tissue carbon dioxide monitors, and pupil observation. The test of these monitoring techniques is ultimately their ability to improve patient survival to hospital discharge, which is a major challenge for resuscitation researchers.

62. Cera SM, Mostafa G, Sing RF, Sarafin JL, Matthews BD, Heniford BT., Physiologic predictors of survival in post-traumatic arrest., Am Surg. 2003 Feb;69(2):140-4.

Traumatic cardiac or pulmonary arrest is often associated with a dismal outcome and is considered by many to be an example of medical futility and inappropriate use of resources. This study aimed to identify the predictors of survival in patients experiencing traumatic cardiac arrest. We retrospectively reviewed all trauma patients undergoing cardiopulmonary resuscitation on arrival to the Emergency Department (ED) at an American College of Surgeons-designated Level I trauma center over 4 years. ED survival, hospital survival, and neurologic outcomes on discharge were the primary outcomes. Survival rates were examined in relation to demographics, mechanism of injury, airway management, cardiac electrical rhythm, and pupil size and reactivity. Statistical analyses used chi-square and t tests, $P < 0.05$ was considered significant. A total of 195 patients arrived in the ED with traumatic cardiac arrest; 34 were pronounced dead on arrival (no signs of life), and no resuscitation efforts were initiated. Of the remaining 161 patients 53 (33%) survived to leave the ED, and only 15 (9%) left the hospital alive. Demographic features were similar in survivors and nonsurvivors. The setting of intubation (prehospital vs ED) did not influence survival ($P = 0.36$). Penetrating trauma adversely affected survival in the ED ($P = 0.01$); however, this only approached significance in the final outcome of hospital survival ($P = 0.06$). The presence of sinus rhythm and nondilated reactive pupils was highly significant in predicting ED and hospital survival ($P = 0.001$). No patient with agonal rhythm or ventricular fibrillation/tachycardia survived, and 14 of the 15 hospital survivors had reactive pupils on arrival to the ED. We conclude that sinus rhythm and pupil size and reactivity are important physiologic variables that predict potential survival and may be used to guide continuation of resuscitative efforts in patients with traumatic cardiac arrest.

63. Taylor WR, Chen JW, Meltzer H, Gennarelli TA, Kelbch C, Knowlton S, Richardson J, Lutch MJ, Farin A, Hults KN, Marshall LF., Quantitative pupillometry, a new technology: normative data and preliminary observations in patients with acute head injury. Technical note., J Neurosurg. 2003 Jan;98(1):205-13.

The authors prospectively used a new hand-held point-and-shoot pupillometer to assess pupillary function quantitatively. Repetitive measurements were initially made in more than 300 healthy volunteers ranging in age from 1 to 87 years, providing a total of 2,432 paired (alternative right eye, left eye) measurements under varying light conditions. The authors studied 17 patients undergoing a variety of nonintracranial, nonophthalmological, endoscopic, or surgical procedures and 20 seniors in a cardiology clinic to learn more about the effects of a variety of drugs. Additionally, the authors carried out detailed studies in 26 adults with acute severe head injury in whom intracranial pressure (ICP) was continuously monitored. Finally, five patients suffering from subarachnoid hemorrhage were also studied. Quantitative pupillary measurements could be reliably replicated in the study participants. In healthy volunteers the resting pupillary aperture averaged 4.1 mm and the minimal aperture after stimulation was 2.7 mm, resulting in a 34% change in pupil size. Constriction velocity averaged 1.48 +/- 0.33 mm/second. Pupillary symmetry was striking in both healthy volunteers and patients without intracranial or uncorrected visual acuity disorders. In the 2,432 paired measurements in healthy volunteers, constriction velocity was noted to fall below 0.85 mm/second on only 33 occasions and below 0.6 mm/second on eight occasions (< one in 310 observations). In outpatients, the reduction in constriction velocity was observed when either oral or intravenous narcotic agents and diazepam analogs were administered. These effects were transient and always symmetrical. Among the 26 patients with head injuries, eight were found to have elevations of ICP above 20 mm

Hg and pupillary dynamics in each of these patients remained normal. In 13 patients with a midline shift greater than 3 mm, elevations of ICP above 20 mm Hg, when present for 15 minutes, were frequently associated with a reduction in constriction velocity on the side of the mass effect to below 0.6 mm/second (51% of 156 paired observations). In five patients with diffuse brain swelling but no midline shift, a reduction in constriction velocities did not generally occur until the ICP exceeded 30 mm Hg. Changes in the percentage of reduction from the resting state following stimulation were always greater than 10%, even in patients receiving large doses of morphine and propofol in whom the ICP was lower than 20 mm Hg. Asymmetry of pupillary size greater than 0.5 mm was observed infrequently (< 1%) in healthy volunteers and was rarely seen in head-injured patients unless the ICP exceeded 20 mm Hg. Pupillometry is a reliable technology capable of providing repetitive data on quantitative pupillary function in states of health and disease.

64. Witting MD, Goyal D., Interrater reliability in pupillary measurement., Ann Emerg Med. 2003 Jun;41(6):832-7.

STUDY OBJECTIVE: A previous report documented ranges of normal pupil size on the basis of measurements by the principal investigator. In this report, we examine interrater reliability of pupillary measurement. METHODS: According to a randomized double-blind assignment, healthy volunteers received phenylephrine in one eye and sterile water in the other. After a wait period, the principal investigator and then other observers, using a gauge with a modified Haab scale, took measurements of each pupil, both in fluorescent light (2,700 to 5,400 lux) and bright light (>54,000 lux), whereas the contralateral pupil was concealed. For the first pupil observed in each session, each observer also provided a gestalt judgment of whether the pupil was dilated. In the study's main comparison, paired differences between principal investigator and nonprincipal investigator measurements were summarized by using the median and interquartile range for measurements taken in both light intensities. Interrater agreement in diagnosing pupillary dilation was also calculated for gestalt judgment and for simple measurement. RESULTS: Among 149 principal investigator/nonprincipal investigator pairs taken from 102 participants, principal investigator room-light measurements were 0.2 mm (median 0.2 mm; interquartile range -0.4 to 0.7 mm) greater than those from other observers, but there was no difference in bright-light measurements (median 0 mm; interquartile range -0.5 to 0.4 mm). Nevertheless, principal investigator/nonprincipal investigator percentage agreement in judging dilation by means of measurement was high in both light intensities (85% to 86%). In pupils with gestalt judgment of the presence or absence of pupillary dilation, percentage agreement between nonprincipal investigator observers was higher for measurement (75% to 82%) than for gestalt judgment (61%). CONCLUSION: There was no systematic difference between principal investigator and nonprincipal investigator bright-light measurements, supporting the range of normal values published previously. Interrater agreement in diagnosing pupillary dilation by means of measurement was high.

65. Witting MD, Goyal D., Normal pupillary size in fluorescent and bright light., Ann Emerg Med. 2003 Feb;41(2):247-50.

STUDY OBJECTIVE: Despite its common clinical use, the range of normal pupillary size has been described only crudely. The objective of this report is to describe the distribution of normal pupillary sizes in 2 light conditions that are available in clinical settings. METHODS: Pupillary size measurements were taken from healthy patients by the principal investigator using a modified Haab scale. Measurements were obtained in areas with fluorescent lighting with an intensity of between 2,700 and 5,400 lux and by using bright handheld light sources producing a light intensity of greater than 54,000 lux. The effect of varying the type of handheld device (otoscope, ophthalmoscope, or penlight) on mean pupillary size was analyzed on the basis of intervals calculated from the t distribution. RESULTS: One hundred twenty-eight patients were enrolled, with a mean age of 35+/-9 years. The mean pupillary size in fluorescent light was 3.6+/-0.7 mm, and the mean size in bright light was 2.6+/-0.5 mm. Extreme values in fluorescent light were 2.6 mm (5th percentile) and 5.0 mm (96th percentile). Extreme values in bright light were 1.9 mm (3rd percentile) and 3.6 mm (96th percentile). The type of bright light source had no effect on pupillary size measurement. CONCLUSION: Pupillary sizes of greater than 5.0 mm or less than 2.6 mm are rare (<10%) in normal individuals in fluorescent lighting (2,700 to 5,400 lux), and sizes of greater than 3.6 mm or less than 1.9 mm are rare (<10%) in bright light.

66. Vigue B., Update on medical management of severe head trauma, Neurochirurgie. 2003 Dec;49(6):583-94.

Significant progress in prognosis after brain injury has been achieved over the last 20 years. Knowledge of post-traumatic brain hypersensitivity to ischemic events is critical for management. Therefore, all recommended emergency treatments (intubation, oxygenation, prevention of hypotension) focus on situations where oxygen delivery to the brain is compromised (peripheral hypoxia or hypotension but also compressible cerebral hematoma). Analysis of European prehospital medical care showed success in peripheral oxygenation but no real benefit regarding blood pressure. Guidelines for osmotherapy in patients with pupil abnormalities are not followed despite recent studies emphasizing better prognosis after acute perfusion of high-dose mannitol followed by rapid surgical treatment. It is well known that a short delay between trauma and surgery improves prognosis. After controlling peripheral hemodynamics and hemostasis, multimodal monitoring (intracranial pressure, transcranial Doppler, SvjO(2)) is necessary to achieve cerebral hemodynamic equilibrium. Management during the first hours after trauma is important for outcome in patients with traumatic brain injury. A well-organized medical referral system with close collaboration between specialists will be able to control this socially accepted silent epidemic.

67. Tokuda Y, Nakazato N, Stein GH., Pupillary evaluation for differential diagnosis of coma., Postgrad Med J. 2003 Jan;79(927):49-51.

OBJECTIVES: To determine the usefulness of bedside evaluation of pupils in determining the aetiology of coma by adopting a probabilistic approach. PATIENTS AND METHODS: One hundred and fifteen consecutive patients presenting with coma were enrolled in this prospective cohort

during the 12 month study period in the emergency room of a community teaching hospital. Patients underwent structured clinical examinations and laboratory and imaging tests. Assignment of aetiology of coma was based on strict adherence to predetermined criteria and achieved by consensus of the two physician investigators. One year follow up was obtained in all patients. RESULTS: Aetiology of coma was determined in 98% of the patients. It was metabolic in 69 patients (60%) and structural in 46 patients (40%). Metabolic causes included drug overdose, acute alcohol intoxication, hypoglycaemia, sepsis, and pneumonia. Structural causes included intracerebral haemorrhage, subarachnoid haemorrhage, cerebral infarction, subdural haematoma, and epidural haematoma. Multivariate logistic regression analysis showed light reflex loss (likelihood ratio for positive test result 3.59) and anisocoria (likelihood ratio for positive test result 9.0) as independent predictors of structural origin. CONCLUSIONS: In this prospective study of patients presenting to the emergency room of a community based teaching hospital with coma, in about 60% the coma is of metabolic origins and in about 40% of structural origins. Light reflex loss and anisocoria suggest a structural aetiology.

68. Fanshawe M, Venkatesh B, Boots RJ., Outcome of stroke patients admitted to intensive care: experience from an Australian teaching hospital. Anaesth Intensive Care. 2002 Oct;30(5):628-32.

The objective of this study was to determine the mortality rate and the functional outcomes of stroke patients admitted to the intensive care unit (ICU) and to identify predictors of poor outcome in this population. The records of all patients admitted to the ICU with the diagnosis of stroke between January 1994 and December 1999 were reviewed. Patients with subarachnoid haemorrhage were excluded. Data were collected on clinical and biological variables, risk factors for stroke and the presence of comorbidities. Mortality (ICU, in-hospital and three-month) and functional outcome were used as end-points. In the six-year-period, 61 patients were admitted to the ICU with either haemorrhagic or ischaemic stroke. Medical records were available for only 58 patients. There were 23 ischaemic and 35 haemorrhagic strokes. The ICU, in-hospital and three-month mortality rates were 36%, 47% and 52% respectively. There were no significant differences in the prevalence of premorbid risk factors between survivors and non-survivors. The mean Barthel score was significantly different between the independent and dependent survivors (94+/-6 vs 45+/-26, P<0.001). A substantial number of patients with good functional outcomes had lower Rankin scores (92% vs 11%, P<0.001). Only 46% of those who were alive at three months were functionally independent. Intensive care admission was associated with a high mortality rate and a high likelihood of dependent lifestyle after hospital discharge. Haemorrhagic stroke, fixed dilated pupil(s) and GCS <10 during assessment were associated with increased mortality and poor functional outcome.

69. Nozaki T, Sakai N, Oishi H, Nishizawa S, Namba H., Cholinergic dysfunction in cognitive impairments after aneurysmal subarachnoid hemorrhage., Neurosurgery. 2002 Oct;51(4):944-7; discussion 947-8.

OBJECTIVE: Although cognitive impairments have been observed after subarachnoid hemorrhage (SAH), little is known about their neurobiological bases. To examine cholinergic function in such patients, we used a known test for Alzheimer's disease based on an exaggerated pupil dilation response to a cholinergic antagonist, tropicamide (the tropicamide drop test). METHODS: Seventeen patients who were treated surgically after aneurysmal SAH were divided into two groups on the basis of their scores on the Mini-Mental State Examination (MMSE): Group A (MMSE > or =28) and Group B (MMSE < or =27). The mean interval of time between surgery and administration of the MMSE was 4.7 +/- 2.1 years for Group A and 4.2 +/- 1.3 years for Group B. The tropicamide drop test was performed within 1 month after the MMSE for each patient. After measurement of the baseline pupil diameter (R1, right pupil size: L1, left pupil size), one drop of 0.01% tropicamide was applied to the right eye and physiological saline to the left eye. Pupil diameter (R2, right pupil size; L2, left pupil size) was then remeasured. Data were represented as the dilation ratio of the right pupil (R2/R1) and as the relative dilation ratio of the right pupil to that of the left pupil (R2L1/R1L2). RESULTS: The mean dilation ratio of the right pupil (R2/R1) was higher in Group B (1.13 +/- 0.09) than in Group A (1.07 +/- 0.11), although the difference did not reach statistical significance (P = 0.18). The relative dilation ratio (R2L1/R1L2) was significantly higher in Group B (1.41 +/- 0.36) than in Group A (1.06 +/- 0.20) (P < 0.05). CONCLUSION: We determined cholinergic dysfunction in patients with cognitive impairment after SAH on the basis of the pupillary response to tropicamide. The results provide an insight into the pathophysiology of cognitive impairments after SAH, which might lead to future treatment strategies.

70. Cruz J, Minoja G, Okuchi K., Major clinical and physiological benefits of early high doses of mannitol for intraparenchymal temporal lobe hemorrhages with abnormal pupillary widening: a randomized trial., Neurosurgery. 2002 Sep;51(3):628-37; discussion 637-8.

OBJECTIVE: We evaluated long-term clinical outcomes and postoperative physiological findings in acutely comatose patients with nonmissile surgical intraparenchymal temporal lobe hemorrhages and abnormal pupillary widening who received early preoperative high-dose mannitol (HDM) versus conventional dose mannitol treatment in the emergency room. METHODS: One hundred forty-one adult patients with traumatic, nonmissile, acute, intraparenchymal temporal lobe hemorrhages associated with early abnormal pupillary widening were prospectively and randomly assigned to receive emergency preoperative intravenous HDM treatment (approximately 1.4 g/kg; 72 patients) and were compared with a control group that was treated with a lower preoperative mannitol dose (approximately 0.7 g/kg; 69 patients). RESULTS: Early preoperative improvement of abnormal bilateral pupillary widening was significantly more frequent in the study group than in the control group (P < 0.03). The same was true for abnormal unilateral pupillary widening (P < 0.01). Early HDM treatment in the emergency room was also associated with significantly better 6-month clinical outcomes (P < 0.005). The two groups of patients were well matched with respect to diameter of the temporal lobe hemorrhages (approximately 4 cm) as well as timing of clot removal (approximately 2.5 hours after injury). Postoperative physiological findings revealed statistically significant between-group differences, with higher intracranial pressure and lower cerebral extraction of oxygen (global relative cerebral hyperperfusion) in the

control group than in the HDM group. Postoperative global brain ischemia (abnormally low arteriojugular lactate difference values) was rare and was found for less than 3% of the patients in both groups. CONCLUSION: Early preoperative HDM administration in the emergency room was associated with improved clinical outcomes for adult comatose patients with acute, nonmissile, intraparenchymal temporal lobe hemorrhages and associated abnormal pupillary widening. Early improvement of bilateral or unilateral pupillary abnormalities and better postoperative control of intracranial hypertension and associated global relative cerebral hyperperfusion seemed to be relevant factors that were related to improved outcomes.

71. Manley GT, Larson MD., Infrared pupillometry during uncal herniation., J Neurosurg Anesthesiol. 2002 Jul;14(3):223-8.

Infrared pupillary scans have been used extensively as an objective measure of pupillary reflexes during pharmacological studies of human subjects, but no previous scans have documented the pupillary changes during transtentorial uncal herniation. We present infrared pupillary scans from three patients with brain stem compression secondary to expanding intracranial mass lesions. The scans were made with a portable device permitting infrared pupillometry at the patient's bedside. Portable infrared pupillometry records objective measurements of pupillary light reflexes, which provides information useful for diagnosing transtentorial herniation and affords objective measurements of an important endpoint in the management of patients with head trauma or supratentorial mass lesions.

72. Marshman LA., Brain stem blood flow, pupillary response, and outcome in patients with severe head injuries., Neurosurgery. 2002 Sep;51(3):848-9; author reply 849.

No abstract available.

73. Sousa J, Sharma RR, Pawar SJ, Mahapatra A, Lad SD., Long term outcome in patients with severe head injury and bilateral fixed dilated pupils., Neurol India. 2002 Dec;50(4):430-5.

Patients with severe head injury with bilateral dilated unreactive pupils are considered to have a grave prognosis. Hence proper planning and aggressive management becomes mandatory for achieving good results. We present the outcome of consecutive 166 patients with severe head injury, admitted between January 1996 and December 2000 and analysed retrospectively. All the patients had an initial GCS of 8 or less and post resuscitation bilateral dilated unreactive pupils. Our aim was to analyze the long term outcome in these patients and identify the other significant prognostic factors. Of the 166 patients, 42 (25.30%) had a functional outcome (good recovery in 10.24%, moderate disability in 15.06%), and 124 (74.69%) had a poor outcome (death in 58.43% and severe disability in 16.26% of cases). There were 45 patients with polytrauma and 24 of these patients (53.33%) succumbed to the injuries. Obliteration of the basal cisterns and contusion were the common CT scan findings. Factors adversely affecting the survival included age of the patient, polytrauma with shock, initial GCS of 3 or 4, and compression of the basal cisterns on the initial CT scans. At follow up, most of the patients with a functional outcome showed a significant improvement in their motor function but continued to have neuro-behavioral and cognitive deficits.

74. Dubinsky I, Penello D., Can specific patient variables be used to predict outcome of intracranial hemorrhage?, Am J Emerg Med. 2002 Jan;20(1):26-9.

The study objective was to identify the demographic, physiologic, and anatomic variables associated with outcomes of patients with intracranial hemorrhages. We performed a prospective study of all patients with known or suspected intracranial hemorrhages transferred from a community hospital to the neurosurgical service of tertiary care centers in Toronto. Outcomes measured were patient disposition (admitted v discharged immediately), management (neurosurgical interventions v observation) and survival until discharge v death. Patient variables recorded pre- and post-transfer were analyzed using the statistical programs C.H.A.I.D. and C.A.R.T.(Answer-Tree Software, SPSS Inc.Headquarters, Chicago, IL). Two linear regression trees were constructed to reveal associations with each outcome. Sixty-seven patients between the ages of 24 and 89 were included in the study. Of these, 1 was referred for an epidural bleed, 20 for subdural bleeds, 21 for subarachnoid hemorrhages, and 25 for intracerebral hemorrhages. Thirteen of the patients in the study died or remained with permanent, severe neurological deficits. Of these, none had epidural hemorrhages, 4 had subdural hemorrhages, 5 had subarachnoid hemorrhages, and 4 had intracerebral hemorrhages. The linear regression tree constructed with C.A.R.T. revealed that the most important predictor of outcome was the GCS score of the patient on arrival at the neurosurgical center. Specifically, 71.43% of individuals arriving with a GCS score less than or equal to 7 died or remained with a severe neurological deficit, whereas only 5.66% of individuals arriving with a GCS score greater than or equal to 8 had such an outcome (P<.11). The regression tree constructed using C.H.A.I.D. revealed a similar result. Patients with a GCS score less than or equal to 5 on arrival at the neurosurgical center had a 70% chance of dying or remaining with a severe neurological deficit, whereas those with a GCS score greater than or equal to 13 had a 0% chance of having such an outcome (P <.0001). Furthermore, 100% of patients with post-transfer GCS scores less than or equal to 5 and an absent gag reflex died or remained with a severe neurological deficit compared with only 25% of those with a GCS score less than or equal to 5 with an intact gag reflex (P =.0005). This study also revealed a number of incidental findings. The presence of bilateral unreactive pupils, absent corneal reflex or absent vestibulo-ocular reflex (dolls-eye) independently predicted mortality in 100% of patients (not statistically significant). No patient with any of the following characteristics: any pupillary abnormality or age > 62 with a GCS < 5, achieved a normal functional outcome. Within the population of patients referred from community hospitals to a neurosurgical center for evaluation of intracranial hemorrhage, specific clinical findings are powerful predictors of mortality and poor functional outcome. Patients with a post-transfer GCS score <= 5 and an absent gag reflex had a 100% incidence of death or severe, permanent neurological dysfunction compared with only 25% of those arriving with GCS scores <= 5 with an intact gag reflex (P

=.0005). Additionally, The presence of bilateral unreactive pupils, absent corneal reflex and absent vestibulo-ocular reflex independently predicted mortality in 100% of patients (not statistically significant). Other clinical findings including any pupillary abnormality and GCS <=5 combined with age => 62 negated the possibility of normal functional outcome (not statistically significant). These findings may have wide-ranging implications regarding the transfer and treatment of patients with intracranial hemorrhages, use of resources and counseling of families.

75. Clusmann H, Schaller C, Schramm J., Fixed and dilated pupils after trauma, stroke, and previous intracranial surgery: management and outcome. J Neurol Neurosurg Psychiatry. 2001 Aug;71(2):175-81.

OBJECTIVES: To clarify whether different causative events (trauma, stroke, intracranial surgery), time of intervention, and treatment mode influence outcome, patients with fixed and dilated pupils (FDPs) in a prospective neurosurgical series were evaluated. METHODS: Ninety nine consecutive patients who presented with or developed one or two FDPs, were split into three groups according to the respective aetiology: 46 patients had a trauma, 41 patients a stroke (subarachnoid or intracerebral haemorrhage), and 12 patients had undergone previous elective intracranial surgery. Appropriate therapy was performed depending on the CT findings. Outcome was classified according to the Glasgow outcome scale (GOS). RESULTS: Overall mortality was 75%. In 15% outcome was unfavourable (GOS 2 and 3), and in 10% favourable (GOS 4, 5) at 24 month follow up. No differences in outcome were found between trauma, stroke, and postelective surgery groups. Unilaterally FDP was associated with a better chance of survival (46% v 13%; p<0.01). Age did not correlate with survival, but younger survivors had a significantly better outcome. Patients in whom an intracranial mass was removed surgically had a 42% survival rate, compared with 8% with conservative treatment (p<0.01). Patients with a shorter delay from FDPs to intervention had a better chance of recovery after trauma and previous intracranial surgery (p<0.05). No patient survived better than a vegetative state, if previous FDPs did not become reactive shortly after therapy. If both pupils became reactive on therapy, the chance of survival was 62%. Of these survivors 42% had a favourable outcome. CONCLUSION: Bilateral restoration of pupillary reactivity shortly after therapy is crucial for survival. Surgical evacuation of an intracranial mass, unilateral FDPs, early intervention, and younger age are related to better chances of survival or recovery. The prognosis of patients with FDPs after trauma, stroke, and previous elective intracranial surgery is similar.

76. Zhao D, Weil MH, Tang W, Klouche K, Wann SR., Pupil diameter and light reaction during cardiac arrest and resuscitation., Crit Care Med. 2001 Apr;29(4):825-8.

OBJECTIVE: Traditionally, both pupil diameter and reaction to light have been examined to confirm the diagnosis of death. In the present study, we investigated quantitative changes in pupil diameter and light reaction for assessing the efficacy of cardiopulmonary resuscitation (CPR) and as a predictor of outcome. DESIGN: Controlled experimental study. SETTING: Animal research laboratory at a university-affiliated research institute. SUBJECTS: Fifteen domestic male pigs weighing between 33 and 40 kg. INTERVENTIONS: Ventricular fibrillation was induced with an alternating current delivered to the right ventricular endocardium. After 7 mins of untreated ventricular fibrillation, chest compression and mechanical ventilation were initiated and maintained for 6 mins. Restoration of spontaneous circulation then was attempted by electrical defibrillation. MEASUREMENTS AND MAIN RESULTS: Spontaneous circulation was reestablished in 9 of 15 animals. Pupils were fully dilated, and pupillary reaction to light was absent in 7 of the 9 resuscitated animals during untreated cardiac arrest. Progressive decreases in pupil diameter were observed together with restoration of light reaction during CPR, in each animal that was successfully resuscitated. When the pupils remained dilated and unreactive after 6 mins of CPR, resuscitation efforts were uniformly unsuccessful. A highly significant linear correlation between coronary perfusion pressure generated during precordial compression and pupil diameter was documented. Both were predictive of outcome. CONCLUSIONS: Dynamic changes of pupil diameter and reactions to light during cardiac arrest and resuscitation were correlated with coronary perfusion pressure, and both predicted the likelihood that spontaneous circulation and cerebral function would be restored.

77. [No authors listed], The Brain Trauma Foundation. The American Association of Neurological Surgeons. The Joint Section on Neurotrauma and Critical Care. Pupillary diameter and light reflex., J Neurotrauma. 2000 Jun-Jul;17(6-7):583-90.

The pupillary diameter and the pupilloconstrictor light reflex are the two parameters that have been studied extensively in relation to prognosis. Accurate measurement of pupil diameter or the constrictor response or the duration of the response has not been performed in studies on traumatic brain-injured individuals--for lack of a standardized measuring procedure. The following is recommended: 1. Pupillary light reflex for each eye should be used as a prognostic parameter. 2. The duration of pupillary dilation and fixation should be documented. 3. A pupillary size of >4 mm is recommended as the measure for a dilated pupil. 4. A fixed pupil should be defined as no constrictor response to bright light. 5. Right or left distinction should be made when the pupils are asymmetric. 6. Hypotension and hypoxia should be corrected before assessing pupils for prognosis. 7. Direct orbital trauma should be excluded. 8. Pupils should be reassessed after surgical evacuation of intracranial hematomas.

78. Ritter AM, Muizelaar JP, Barnes T, Choi S, Fatouros P, Ward J, Bullock MR., Brain stem blood flow, pupillary response, and outcome in patients with severe head injuries., Neurosurgery. 1999 May;44(5):941-8.

OBJECTIVE: Acute pupillary dilation in a head-injured patient is a neurological emergency. Pupil dilation is thought to be the result of uncal herniation causing mechanical compression of the IIIrd cranial nerve and subsequent brain stem compromise. However, not all patients with herniation have fixed and dilated pupils, and not all patients with nonreactive, enlarged pupils have uncal herniation. Therefore, we have tested an alternative hypothesis that a decrease in brain stem blood flow (BBF) is a more frequent cause of mydriasis and brain stem symptomatology after severe head injury. We determined the relation of BBF to outcome and pupillary response in patients with severe head injuries. METHODS: One

hundred sixty-two patients with a Glasgow Coma Scale score of 8 or less underwent stable xenon computed tomographic blood flow determination at the level of the superior colliculus, and this blood flow was correlated with pupillary features, intracranial pressure, computed tomographic scan pathology, and outcome. RESULTS: A BBF of less than 40 ml/100 g/min was significantly associated with poor outcome (P < 0.009). In patients with bilaterally nonreactive pupils, the BBF was 30.5+/-16.8 ml/100 g/min, and in those with normally reactive pupils, the BBF was 43.8+/-18.7 ml/100 g/min (P < 0.001). Intracranial pressure and the presence of a brain stem lesion observed on the computed tomographic scan did not correlate with BBF, pupillary size, or reactivity. Unfavorable outcome at 12 months was directly related to age (P = 0.062) and inversely related to pupillary responsiveness (P = 0.0006), pupil size (P = 0.005), and BBF of less than 40 ml/100 g/min (P = 0.009). CONCLUSION: These findings suggest that pupillary dilation is associated with decreased BBF and that ischemia, rather than mechanical compression of the IIIrd cranial nerve, is an important causal factor. More important, pupil dilation may be an indicator of ischemia of the brain stem. If cerebral blood flow and cerebral perfusion pressure can be rapidly restored in the patient with severe head injury who has dilated pupils, the prognosis may be good.

79. Morris GF, Juul N, Marshall SB, Benedict B, Marshall LF., Neurological deterioration as a potential alternative endpoint in human clinical trials of experimental pharmacological agents for treatment of severe traumatic brain injuries. Executive Committee of the International Selfotel Trial., Neurosurgery. 1998 Dec;43(6):1369-72; discussion 1372-4.

OBJECTIVE: A recently improved understanding of the pathophysiological features of head injuries has led to the development of new drug therapies. Accurate human clinical trials remain necessary to document the efficacy and safety of new agents. It would be helpful to decrease the time from drug development to clinical use and general availability for drugs found to be effective. Conversely, ineffective agents could be abandoned in a timely fashion. RATIONALE: A new endpoint measure, defined as neuroworsening (NW), is an objective observable event that is identifiable during hospitalization. This may enable the efficacy of drugs to be demonstrated or disproved much earlier than with 6-month outcome assessments. The prospective, double-blind, multicenter trial of the N-methyl-D-aspartate receptor antagonist Selfotel was used to acquire data on the efficacy of NW in predicting neurological outcomes. The 6-month Glasgow Outcome Scale scores, which were the primary endpoints of that trial, were compared with the frequency of NW. NW was an observable event that could be objectively defined after head injuries. Patients who suffered one or more episodes of NW demonstrated significantly higher morbidity and mortality rates than did patients who did not. CONCLUSION: Future trials should consider the use of NW as an outcome measure that can be included with more traditional measures in the study design. If the strong correlation demonstrated between NW and 6-month Glasgow Outcome Scale scores can be prospectively demonstrated in a successful trial, the time to approval of future agents could be decreased.

80. Schwarz S, Jauss M, Krieger D, Dörfler A, Albert F, Hacke W., Haematoma evacuation does not improve outcome in spontaneous supratentorial intracerebral haemorrhage: a case-control study. Acta Neurochir (Wien). 1997;139(10):897-903; discussion 903-4.

Surgical intervention in supratentorial intracerebral haemorrhage (ICH) is still controversial. We assessed the value of haematoma evacuation with a case-control study. 145 consecutive patients with supratentorial spontaneous ICH without tumour or vascular abnormalities were analysed. Haematoma evacuation was performed in 24 patients. Age, sex, Glasgow Coma Scale (GCS), level of consciousness, pupillary reaction on admission, localisation, aetiology and volume of the haematoma, presence of ventricular blood, and Glasgow Outcome Scale (GOS) on discharge were analysed. From statistical analysis 40 patients > 80 years and with haematoma volume < 10 ml, who were always treated conservatively, were excluded. Prognostic factors retained from a multiple regression model with the dichotomised GOS scale (GOS 1-3, 4 + 5) as response variable were GCS, haematoma volume and location. The only difference between all medically treated and "operated" patients was haematoma volume, which was larger in the "operated" patients. All 24 evacuated cases could be matched to a medically treated control regarding age, haematoma volume and location, GCS, and pupillary reaction. Significant differences between the two groups could not be detected. Outcome was not different between the two groups. After separating the sample into patients with and without ventricular haemorrhage, there was no different outcome between the two groups either. We conclude that haematoma evacuation did not improve outcome in supratentorial spontaneous ICH. Since haematomas were evacuated mainly in clinically deteriorating patients, our data suggest that the only effect of haematoma evacuation is to stop progressive deterioration rather than to improve overall clinical outcome.

81. Cohen JE, Montero A, Israel ZH., Prognosis and clinical relevance of anisocoria-craniotomy latency for epidural hematoma in comatose patients., J Trauma. 1996 Jul;41(1):120-2.

OBJECTIVE: To determine whether the time between onset of anisocoria and surgery for hematoma evacuation in the head-injured patient is a useful prognostic variable for outcome in the comatose patient with an acute epidural hematoma. DESIGN: Prospective. MATERIALS AND METHODS: Twenty-one patients with an acute traumatic epidural hematoma and an admission Glasgow Coma Scale score of less than 8 were analyzed. RESULTS: Anisocoria was present in 14 (67%) patients. Mortality rate was three times higher in this group than in the patients without anisocoria; however, this difference was not statistically significant (p = 0.21, Fisher's exact test). None of the patients with an anisocoria-craniotomy latency of 70 minutes or less died and all of these patients had a good or reasonable outcome. Analysis of the anisocoria-craniotomy latency in ten patients revealed that a lapse of more than 90 minutes was associated with a greater mortality compared with patients with a latency of less than 90 minutes (p = 0.0238, Fisher's exact test). CONCLUSIONS: In patients with an acute epidural hematoma, reducing the anisocoria-surgery interval below 90 minutes is significantly associated with a better outcome (p = 0.0238, Fisher's exact test).

82. Fletcher GC, Asbury AJ, Brown JH., Pupil changes during cardiopulmonary bypass., Br J Anaesth. 1996 Jan;76(1):20-2.

Pupil diameter is used during anaesthesia to assess depth of anaesthesia and indicate cerebral hypoxia. This is especially so during cardiac bypass when other autonomic signs cannot be monitored. We have used a pupillometer to determine the effect of cardiopulmonary bypass on the pupil. We have also investigated if any effect was caused by washout of opioid from the central nervous system by allocating patients to one of two groups: in one the bypass pump was preloaded with fentanyl, in the other with 0.9% saline. Cardiopulmonary bypass caused pupil dilatation of between 17% and 53%, which was unaffected by preloading the bypass pump with fentanyl. This effect lasted for the duration of the study, which ended 30 min after the start of cardiopulmonary bypass. Sympathetic nervous system reflexes and hypothermia may account for this observation, but further research is necessary to exclude other contributory factors.

83. Larson MD, Muhiudeen I., Pupillometric analysis of the 'absent light reflex'., Arch Neurol. 1995 Apr;52(4):369-72.

OBJECTIVE: To measure the "absent light reflex" with an infrared pupillometer. SETTING: Intensive care unit of the Moffitt-Long Hospitals at the University of California-San Francisco. SUBJECTS: Three patients lacking a pupillary light reflex early in the postresuscitation period and a consecutive sample of comatose patients in the intensive care unit in whom clinical (penlight) examination demonstrated an absent light reflex. INTERVENTIONS: A portable infrared pupillometer was moved to the bedside of patients thought to have an absent light reflex, and a series of individual scans were averaged to detect the presence or absence of a light reflex. MAIN RESULTS: The study of patients in the intensive care unit was prompted by the observation of three postresuscitation patients whose pupillary light reflex was thought to be clinically absent but found to be present, although small, with infrared pupillometry. All patients in the intensive care unit with known brain death had an absent light reflex, whereas four of nine of those without brain death but with dilated nonreactive pupils had a small light reflex detectable by the infrared pupillometer. This reflex was characterized by a low maximum constriction velocity and low amplitude of constriction. CONCLUSION: Infrared pupillometry can sometimes reveal the presence of midbrain function that might otherwise be missed in paralyzed patients.

84. Chesnut RM, Gautille T, Blunt BA, Klauber MR, Marshall LE., The localizing value of asymmetry in pupillary size in severe head injury: relation to lesion type and location., Neurosurgery. 1994 May;34(5):840-5; discussion 845-6.

Reliable Assessment of the probability that a head injury patient harbors a surgical intracranial lesion is critical to both triage and treatment. The authors analyzed data from 608 patients with severe head injuries (Glasgow Coma Scale score, < or = 8) in the Traumatic Coma Data Bank to assess the reliability of pupillary asymmetry in predicting the presence and location of an intracranial mass lesion. Of 210 patients with pupillary asymmetry of > or = 1 mm, 63 (30%) had intracranial mass lesions, 52 (25%) of which were extra-axial in location, 38 (73%) of these located ipsilateral to the larger pupil. Of 51 patients with asymmetry of > or = 3 mm, 22 (43%) had intracranial mass lesions, 18 (35%) of which were extra-axial in location, 14 (64%) of these located ipsilateral to the larger pupil. For both asymmetry categories, strong interactions were found with age and mechanism of injury, the highest incidence of extra-axial lesions occurring in older patients injured other than as occupants of motor vehicles. The authors developed regression equations that provide a graphic means to predict the presence of an intracranial hematoma using data on pupillary asymmetry, age, and mechanism of injury. This predictive model, interpreted in a hospital- and patient-specific fashion, should be of significant use in directing triage, activating diagnostic and therapeutic resources, and evaluating the utility of exploratory trephination.

85. Schynoll W, Overton D, Krome R, Wesolowski D, Wang AM, Wilson A, Coffey M., A prospective study to identify high-yield criteria associated with acute intracranial computed tomography findings in head-injured patients., Am J Emerg Med. 1993 Jul;11(4):321-6.

We conducted a multicenter, prospective study of head-injured patients to identify high-yield clinical criteria for acute intracranial injuries. Emergency patients with a history of blunt head trauma occurring within 2 weeks and who underwent nonenhanced cranial computed tomography (CT) were entered onto the study during a 12-month period. Of the 264 patients, 32 (12%) had abnormal CT findings. Nine high-yield variables were associated with abnormal CT findings: alcohol use before injury, antegrade amnesia, prolonged loss of consciousness, anisocoria and/or fixed and dilated pupils, abnormal Babinski reflex, focal motor paralysis, cranial nerve deficit, Glasgow coma scale score of less than 15, and clinical signs of basilar skull fracture. Patients 2 years old or younger or older than 60 years of age showed a significantly greater prevalence of abnormal CT findings than patients of other ages.

86. Meyer S, Gibb T, Jurkovich GJ., Evaluation and significance of the pupillary light reflex in trauma patients., Ann Emerg Med. 1993 Jun;22(6):1052-7.

The pupillary light reflex is an important component of the neurologic examination of the trauma victim. Although the normal reflex can be predictably altered by specific head injuries, a variety of other factors common to trauma patients such as alcohol, illicit drugs, narcotics, paralyzing agents, hypothermia, and orbital or ophthalmic injury can confound the evaluation of the pupillary light reflex. This report reviews the anatomy and neurophysiology of the pupillary light reflex and discusses the impact these confounding variables may have on this key component of the initial trauma evaluation.

87. Ishiguro T, Tamagawa S, Ogawa H., Changes of pupil size in brain death patients, Seishin Shinkeigaku Zasshi. 1992;94(9):864-73.

The representative criteria of brain death in Japan is Takeuchi Criteria (Koseisho Criteria), which is the definition of irreversible loss of brain function (functional brain death). The 3rd item of that criteria is "fixed pupil" and pupil size more than 4 mm. The 4th item is loss of the brain nerve reflexes including the light reflex. Three cases of brain death by whole brain destruction (organic brain death) who showed slow changes of pupil size were reported. Except fixed pupil, one case fulfilled Takeuchi Criteria. Other two cases fulfilled all items of Takeuchi Criteria, showing the same pupil size accidentally at the first and the second judgements. But, they changed their pupil size slowly and continuously after the examinations, showing tendencies toward mydriasis and/or miosis, repeatedly. They never decreased their pupil size less than 4 mm. The changes of pupil size were so slow that we could recognize them only after several hours or several days, and they were quite different from the light reflex. They did not receive any influences from turnover of day and night, darkness of the room, dopamine, etc. For the changes of pupil size were observed in the cases of organic brain death, it was elucidated that they were not due to the brain nerve activity. Then, it was considered that the changes of pupil size in the cases of functional brain death should be the same phenomena, because brain nerve function was lost.(ABSTRACT TRUNCATED AT 250 WORDS)

88. Ropper AH., The opposite pupil in herniation., Neurology. 1990 Nov;40(11):1707-9.

I serially examined the pupil opposite the one already enlarged from transtentorial herniation in 13 patients. The main abnormalities, stereotyped in most patients, were an initially diminished light reaction with a 2.5- to 4-mm-diameter pupil, followed by slight reduction in size, and then reenlargement to greater than original size, all with preserved roundness. Subsequent deterioration varied among patients, but a transitional oval shape was infrequent and oculomotor function was preserved until both pupils were enlarged and fixed. Once the pupil on the side of a mass enlarges, heralding herniation, subsequent deterioration can be appreciated through changes in reactivity and size of the opposite pupil.

89. Huet RC, Karliczek GF, Coad NR., Pupil size and light reactivity in hypothermic infants and adults., Intensive Care Med. 1989;15(3):216-7.

No abstract available.

90. Choi SC, Narayan RK, Anderson RL, Ward JD., Enhanced specificity of prognosis in severe head injury., J Neurosurg. 1988 Sep;69(3):381-5.

Data from 523 patients admitted to the Medical College of Virginia with severe head injury and known 6-month outcomes were analyzed in order to determine the optimal combination of early-available prognostic factors. Twenty-one prognostic indicators noted in the emergency room at admission were used to predict outcomes into four categories: good, moderately disabled, severely disabled, or vegetative/dead. A combination of the patient's age (in years), the best motor response (graded in the usual six-point scale), and pupillary response (in both eyes) was found to be the most accurate indicator. The model correctly predicted outcome into one of the four outcome categories in 78% of cases ("specifically accurate predictions"). If predictions into an outcome category adjacent to the actual outcome were accepted, this model was accurate in 90% of cases ("grossly accurate predictions"). A set of three simple graphs based on this model can be used for rapid early estimation of probable outcome in a severely head-injured patient at admission.

91. Wilson SF, Amling JK, Floyd SD, McNair ND., Determining interrater reliability of nurses' assessments of pupillary size and reaction., J Neurosci Nurs. 1988 Jun;20(3):189-92.

Pupil changes provide vital information related to the cause and location, and at times, severity of disease processes which alter level of consciousness. Size and reactivity are sensitive to a variety of influences including local eye damage, functional state of brainstem, local systemic drugs, seizures and anoxia. Therefore, accurate measurement of pupillary size and reactivity is essential. The purposes of this study were to determine if pairs of nurses (1) achieved the same measurement of pupil sizes with and without an objective measure, and (2) selected the same descriptor for pupillary reaction to light. Sixty-eight pairs of nurses employed in adult and pediatric units of a large teaching hospital participated in the study. Interrater reliability of pupillary assessment of 136 nurses was determined. There was no significant difference in the reliability of nurses assessing pupillary size regardless of whether they used a penlight pupil gauge to measure or used observation without a pupil gauge. Agreement among the nurses on the pupillary size was high. Agreement on the pupillary reaction, however, was poor to good.

92. Marshall LF, Barba D, Toole BM, Bowers SA., The oval pupil: clinical significance and relationship to intracranial hypertension., J Neurosurg. 1983 Apr;58(4):566-8.

No abstract available.

93. Spencer JA, Czarnecki JSC, The Pupil in Stroke. Can J Ophthalmol Vol 18, no 5, 1983.

Pupil sizes were assessed in 100 patients admitted to an intensive care stroke unit over a 1-year period to determine if differences existed and if anisocoria might help in diagnosis. From life-size photographs the pupil diameters were measured accurately, and clinical information compiled by the neurology staff was studied. Of the 19 patients with anisocoria 13 had a final diagnosis of stroke. This incidence of anisocoria, 16%, is similar to

that in a normal population (20%). The side of the mydriasis was unrelated to the site of the lesions except when the stroke was due to a brainstem infarction; then ipsilateral Horner's syndrome occurred.

94. Browne AO, Browne HI, Phillips J., Head injury and the dilated pupil., Ir Med J. 1983 Jan;76(1):31-2.

No abstract available.

95. van den Berge JH, Schouten HJ, Boomstra S, van Drunen Littel S, Braakman R., Interobserver agreement in assessment of ocular signs in coma., J Neurol Neurosurg Psychiatry. 1979 Dec;42(12):1163-8.

There is interobserver agreement in the assessment of various ocular signs found in coma patients. As measure for observer agreement the parameter kappa (K) was determined for (in-)equality of pupils, reaction of pupils, spontaneous eye movements, and oculocephalic responses. The agreement in the assessment of the pupils to light and in the assessment of (in-)equality of pupils appeared to be satisfactory, but more disagreement occurred in assessing spontaneous eye movements and oculocephalic responses.