Complete Summary

GUIDELINE TITLE

Part II. Early indicators of prognosis in severe traumatic brain injury. In: Management and prognosis of severe traumatic brain injury.

BIBLIOGRAPHIC SOURCE(S)

Brain Trauma Foundation, Inc, American Association of Neurological Surgeons. Part 2: early indicators of prognosis in severe traumatic brain injury. New York (NY): Brain Trauma Foundation, Inc; 2000. 116 p. [235 references]

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Severe traumatic brain injury

GUIDELINE CATEGORY

Evaluation
Risk Assessment

CLINICAL SPECIALTY

Emergency Medicine
Neurological Surgery
Neurology

INTENDED USERS

Physicians

GUIDELINE OBJECTIVE(S)

To identify from the published medical literature those early clinical factors that may be prognostic for outcome; this will then suggest which early factors should be focused on in prospective database research in patients with traumatic brain injury

TARGET POPULATION

Patients with severe traumatic brain injury

INTERVENTIONS AND PRACTICES CONSIDERED

Use of the following parameters as early prognostic indicators in severe traumatic brain injury, including (a) which feature of the parameter is supported by the strongest evidence and has at least a 70% positive predictive value, (b) how each should be measured, (c) when it should be measured, and (d) by whom should it be measured:

1. Glasgow Coma Scale (GCS) score
2. Patient age
3. Pupillary diameter and light reflex
4. Hypotension
5. Computed tomography (CT) scan features

MAJOR OUTCOMES CONSIDERED

- Mortality
- Glasgow Outcome Scale score
- Neurological functional examination
- Recovery (e.g., return to daily activities such as school, employment)
- Sensitivity and specificity of prognostic indicator
- Positive and negative predictive value of prognostic indicator

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Hand-searches of Published Literature (Primary Sources)
Hand-searches of Published Literature (Secondary Sources)
Searches of Electronic Databases
Searches of Unpublished Data

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The literature was searched, using the appropriate rubrics, via a computerized link to the National Library of Medicine in Washington, DC, USA. Additional references were found by examination of reference lists at the end of each journal article and through personal knowledge of the experts participating in the working group.

Glasgow Coma Scale score

The titles and abstracts of approximately 500 journal articles were retrieved using a computerized search of the National Library of Medicine. The MeSH heading "Glasgow Coma Scale" was used to search for articles published since the Glasgow Coma Scale was developed in 1974. The abstracts of all articles were reviewed and those articles that focused on the correlation between the acute Glasgow Coma Scale score (obtained within the first 24 hours) and outcome in patients with severe closed head injuries were selected for review of the entire article. There were 20 articles that dealt primarily with correlation of the Glasgow Coma Scale score and outcome; 8 articles that focused on the use of the initial Glasgow Coma Scale score to predict outcome; and 6 articles describing the reliability of the Glasgow Coma Scale score.

Age

A MEDLINE search was performed between 1966 and 1995 exploring the following subjects: age; human head injury; and prognosis. The search resulted in 44 references that were individually reviewed and classified

Pupillary diameter and light reflex

A MEDLINE search for the period 1980-1995 was done using the key words "pupils", "pupils and prognosis", and "pupils and trauma". The search resulted in the critical review of 19 articles.

Hypotension

A MEDLINE search back to 1966 was undertaken using the following key words: "head injury or brain injury" and "secondary insult or hypotension" and "outcome or prognosis" and "human subject". The search produced 70 references that were individually reviewed for design, content, and relevance.

Computed tomography scan features

A MEDLINE search from 1976 through mid-1998 was undertaken using the following key words: "head injury", "computerized tomography", "prognosis", and "outcome". A search on "head injury", "CT scan", and "prognosis" resulted in 27 articles, and a search on "head injury", "CT scan", and "outcome" in 55 articles. Only English-language literature and papers reporting on adult head injury were reviewed. In total, 31 manuscripts relevant to the prognostic value of the computed tomography scan in the acute stage of head injury were identified. Individual computed tomography characteristics found to be particularly relevant in terms of prognosis were:

a. status of basal cisterns
b. traumatic subarachnoid hemorrhage
c. presence and degree of midline shift
d. presence and type of intracranial lesions

The above subheadings, including "intraventricular hemorrhage", "intracranial lesions", "normal CT", "epidural hematoma", and "subdural hematoma" were then subjected to a second search, combining these with "head injury", "brain injury", "prognosis", and "outcome". This secondary search yielded an additional 18 manuscripts. Cross-referencing and expertise available amongst authors added an additional 14 manuscripts.

NUMBER OF SOURCE DOCUMENTS

The number of source documents included in the evidence tables on each of the following topics:

Glasgow Coma Scale Score: 15

Age: 20

Pupillary diagnosis and light reflex: 19

Hypotension: 9

Computed tomography scan features:

- 4 on abnormal computed tomography scan and outcome
- 4 on computed tomography classification and outcome
- 10 on basal cisterns and outcome
- 11 on traumatic subarachnoid hemorrhage and outcome
- 14 on midline shift and outcome
- 15 on intracranial lesions and outcome

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

References were qualitatively evaluated according to criteria intended to establish study strength, which included:

1. Twenty-five or more patients in the series with complete follow-up
2. Outcomes measured—Glasgow Outcome Scale or Mortality—at six months or more
3. Data gathered prospectively, although retrospective examination from a database creating an ongoing cohort of patients could be used
4. Glasgow Coma Scale score measured within 24 hours
5. Appropriate statistics (e.g., multivariate analysis) used to include adjustment for prognostic variables

The working group decided that papers evaluated by the above methodology could be classified as follows:

Classification of Evidence on Prognosis

Class I: Those papers containing all of the above (1-5) characteristics.

Class II: Those papers containing four out of the five characteristics, including prospectively collected data.

Class III: Those papers containing three or fewer of the above characteristics.

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

The working group produced a model in which pertinent literature was qualitatively evaluated. With the data taken from appropriate articles, characteristics of sensitivity, predictive values, and where applicable, likelihood ratios can be estimated. To be able to calculate sensitivity, specificity, positive and negative predictive value, and where applicable, likelihood ratios, a 2 X 2 Bayesian table was constructed in which the following values were tabulated:

Prognostic factor present and patient dead = a

Prognostic factor present and patient alive = b

Prognostic factor absent and patient dead = c

Prognostic factor absent and patient alive = d

Sensitivity: is calculated as a/a+c and is represented by the following clinical question: if a trauma patient reaches a certain outcome, how likely is she or he to have had a given prognostic indicator?

Specificity: is calculated as d/b+d and is represented by the following clinical question: if a trauma patient does not reach a certain outcome, how likely is she or he to have not had a given prognostic indicator?

Positive predictive value: is calculated as a/a+b and is represented by the following clinical question: if a trauma patient has a given prognostic indicator, how likely is she or he to reach a certain outcome?

Negative predictive value: is calculated as d/c+d and is represented by the following clinical question: if a trauma patient does not have a given prognostic indicator, how likely is she or he to reach a certain outcome?

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Not stated

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Not stated

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Not applicable

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

Glasgow Coma Scale Score

When considering the use of the initial Glasgow Coma Scale score for prognosis, the two most important problems are the reliability of the initial measurement, and its lack of precision for prediction of a good outcome if the initial Glasgow Coma Scale score is low. If the initial Glasgow Coma Scale score is reliably obtained and not tainted by prehospital medications or intubation, approximately 20% of the patients with the worst initial Glasgow Coma Scale score will survive and 8%-10% will have a functional survival (Glasgow Outcome Scale 4-5).

A. Which feature of the parameter is supported by Class I evidence and has at least a 70% positive predictive value?

   There is an increasing probability of poor outcome with a decreasing Glasgow Coma Scale (GCS) score in a continuous, stepwise manner.

B. Parameter measurements:
   1. How should it be measured?
      - It should be measured in a standardized way.
      - It must be obtained through interaction with the patient (e.g., application of a painful stimulus for patients unable to follow commands).
   2. When should it be measured for prognostic purposes?
      - Only after pulmonary and hemodynamic resuscitation.
      - After pharmacologic sedation or paralytic agents are metabolized.
   3. Who should measure it?
      - The Glasgow Coma Scale can be fairly reliably measured by trained medical personnel.

Age

Age is a strong factor influencing both mortality and morbidity. Despite some contradictions, most literature supports children faring better than adults who have severe brain injury. The significant influence of age on outcome is not explained by the increased frequency of systemic complications or intracerebral hematomas with age. Increasing age is a strong independent factor in prognosis with a significant increase in poor outcome above age 60 years of age.

A. Which feature of the parameter is supported by Class I evidence and has at least a 70% positive predictive value?

   There is an increasing probability of poor outcome with increasing age, in a stepwise manner.

B. Parameter measurement for prognosis

   Age is not subject to observer measurement variability. Age should be obtained on admission, preferably with documentation.

Pupillary Diameter and Light Reflex

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 measure 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 greater than 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.

A. Which feature of the parameter is supported by Class I evidence and has at least a 70% positive predictive value?

   Bilaterally absent pupillary light reflex

B. Recommendations for parameter measurement for prognosis:
   1. How should it be measured?
      - A measurement difference of 1 mm or more is defined as asymmetry.
      - A fixed pupil shows no response (< 1 mm) to bright light.

- A pupillary size of > 4 mm is recommended as the measure for a dilated pupil.
- The duration of pupillary dilation and fixation should be recorded.

The following pupillary exam should be noted with L (left) or R (right) distinction and duration:

- Evidence of direct orbital trauma
- Asymmetrical response to light
- Asymmetry at rest
- Fixed pupil (one or both)
- Dilated pupil (one or both)
- Fixed and dilated pupils (one or both)

2. When should it be measured?
   - After pulmonary and hemodynamic resuscitation
3. Who should measure it?
   - Trained medical personnel

Hypotension

Hypotension, occurring at any time from injury through the acute intensive care course, has been found to be a primary predictor of outcome from severe head injury for the health care delivery systems within which prognostic variables have been best studied. Hypotension is repeatedly found to be one of the five most powerful predictors of outcome and is generally the only one of these five that is amenable to therapeutic modification. A single recording of a hypotensive episode is generally associated with a doubling of mortality and a marked increase in morbidity from a given head injury. The estimated reduction in unfavorable outcome that would result from the elimination of hypotensive secondary insults is profound.

A. Which feature of the parameter is supported by Class I evidence and has at least a 70% positive predictive value?

   A systolic blood pressure less than 90 mm Hg was found to have a 67% positive predictive value for poor outcome and, when combined with hypoxia, a 79% positive predictive value.

B. Parameter measurements:
   1. How should it be measured?
      - Systolic and diastolic blood pressure should be measured using the most accurate system available under the circumstances. Monitoring by arterial line, when free of signal artifact, provides data that is both accurate and continuous and is the method of choice. Methods that do not determine the mean arterial pressure are less valuable.
   2. When should it be measured?
      - Blood pressure should be measured as frequently as possible. The incidence and duration of hypotension (systolic blood pressure < 90 mm Hg) should be documented by direct blood pressure values.

3. Who should measure it?
    - Blood pressure should be measured by trained medical personnel.

Computed Tomography Scan Features

Abnormalities on Computed Tomography

- Initial computed tomography examination demonstrates abnormalities in approximately 90% of patients with head injury.
- Prognosis in patients with severe head injury with demonstrable pathology on initial computed tomography examination is less favorable than when the computed tomography is normal.
- In patients with a normal computed tomography on admission, outcome is primarily related to concomitant extracranial injuries.
- The absence of abnormalities on computed tomography does not preclude the occurrence of raised intracranial pressure, and significant new lesions may develop in 40% of patients.

Computed Tomography Classification of Head Injury and Its Prognostic Significance

- A strong correlation exists between the worst intracranial Abbreviated Injury Score (AIS) severity code of the initial computed tomography in severe head injury and outcome at six months.
- The Traumatic Coma Data Bank (TCDB) computed tomography classification is strongly correlated to outcome.

Individual Computed Tomography Scan Characteristics

Basal Cisterns

- Compressed or absent basal cisterns indicate a threefold risk of raised intracranial pressure.
- Status of basal cisterns is related to outcome.
- Mortality is increased two- to threefold in the presence of compressed or absent basal cisterns.
- Strong association exists between the status of the basal cisterns and pupil reactivity.
- Some association of the status of the basal cisterns is reported with Glasgow Come Scale score, presence of focal lesions, or early hypoxic and hypotensive insults.

Traumatic Subarachnoid Hemorrhage

- Traumatic subarachnoid hemorrhage is a frequent occurrence in severe head injury (26%-53%).
- Most frequent location is over the convexity.
- Mortality is increased twofold in the presence of traumatic subarachnoid hemorrhage.

- Presence of blood in the basal cisterns carries a positive predictive value to unfavorable outcome of approximately 70%.
- Extent of traumatic subarachnoid hemorrhage is related to outcome.
- Traumatic subarachnoid hemorrhage is a significant independent prognostic indicator.

Midline Shift

- Presence of midline shift is inversely related to prognosis; however, interaction with the presence of intracranial lesions and other computed tomography parameters exists.
- Class I evidence shows a positive predictive value of 78% to poor outcome in the presence of shift greater than 5 mm in patients over 45 years of age.
- Class II evidence shows a positive predictive value of 70% to unfavorable outcome at midline shift greater than 1.5 cm.
- Presence of midline shift is indicative of increased intracranial pressure. The degree of midline shift has not been well studied and authors report widely differing values.
- The value of shift seems less important than other computed tomography parameters, because the degree of shift is also influenced by the location of intracerebral lesions and the presence of bilateral abnormalities. Moreover, the presence and degree of midline shift as seen on the admission computed tomography scan can be significantly altered on subsequent investigations, following the evacuation of mass lesions.

Intracranial Lesions

- Extracerebral and intracerebral lesions occur frequently in comatose patients with head injury.
- Presence of mass lesions has a positive predictive value of 78% to unfavorable outcome (Class II).
- Presence of mass lesions in patients over 45 years of age carries a positive predictive value of 79% to poor outcome as defined by the categories dead and vegetative.
- Mortality is higher in acute subdural hematoma than in extradural hematoma.
- Outcome is more favorable in patients with severe head injury and an epidural hematoma and less favorable in acute subdural hematoma in comparison to patients wit diffuse injuries.
- Hematoma volume is correlated to outcome.
- Intraparenchymal lesions are ill defined.

A. Which feature of the parameter is supported by Class I and strong Class II evidence and has at least a 70% positive predictive value in severe head injury?
    a. Presence of abnormalities on initial computed tomography examination
    b. Computed tomography classification
    c. Compressed or absent basal cisterns
    d. Traumatic subarachnoid hemorrhage (tSAH)
        - Blood in the basal cisterns
        - Extensive traumatic subarachnoid hemorrhage
B. Parameter measurement:
    1. How should it be measured?

- Compressed or absent basal cisterns measured at the midbrain level.
- Traumatic subarachnoid hemorrhage should be noted in the basal cisterns or over the convexity.
- Midline shift should be measured at the level of the septum pellucidum.

2. When should it be measured?
    - Within 12 hours of injury.
    - The full extent of intracranial pathology, however, may not be disclosed on early computed tomography examination.
3. Who should measure it?
    - A neuroradiologist or other qualified physician, experienced in reading computed tomography scans of the brain.

CLINICAL ALGORITHM(S)

None provided

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

An evidentiary table appears at the end of each major section of the guideline document, which classifies each citation based on the quality of the evidence (Class I-III; see "Rating Scheme" above). A table at the end of each section in the guideline document describes the studies according to classification criteria.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Information about prognosis and predictive statements can be useful in a number of ways. From the start, concern about outcome is often foremost in the mind of the relative of severely brain-injured victims and realistic counseling is preferable to over pessimism -- characterized as "hanging crepe" -- or the raising of false hopes. An assessment of prognosis is crucial in research studies, both in determining the appropriate target population and in deciding if a given intervention has produced an outcome different from that which would have been expected.

POTENTIAL HARMS

The place of prognosis in making decisions about the management of individual patients remains controversial. While many neurosurgeons acknowledge that it is an important factor in decision making, others relegate prognosis to a minor or even nonexistent role, reflecting a range of attitudes arising from cultural and ethical differences as much as clinical convictions.

Although there are concerns that estimation of prognosis may be used to allocate (and in particular to withdraw) resources, and that this might worsen the outcome in some cases, this was not substantiated in a formal study.

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

The information contained in the guideline reflects the current state of knowledge at the time of publication, February 2000. The information is designed to provide accurate and authoritative information in regard to the subject matter covered. In view of the fact that there will be future developments in scientific information and technology, it is anticipated that there will be periodic review and updating of these guidelines. These guidelines are distributed with the understanding that the Brain Trauma Foundation, the American Association of Neurological Surgeons, and the other organizations that have collaborated in the development of these guidelines are not engaged in rendering professional medical services. If medical advice or assistance is required, the services of a competent physician should be sought. The recommendations contained in these guidelines may not be appropriate for use in all circumstances. The decision to adopt any particular recommendation contained in this guideline must be made by a treating physician in the light of all the facts and circumstances surrounding each particular case and on the basis of the available resources.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Brain Trauma Foundation, Inc, American Association of Neurological Surgeons. Part 2: early indicators of prognosis in severe traumatic brain injury. New York (NY): Brain Trauma Foundation, Inc; 2000. 116 p. [235 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

2000

GUIDELINE DEVELOPER(S)

American Association of Neurological Surgeons - Medical Specialty Society
Brain Trauma Foundation - Disease Specific Society

SOURCE(S) OF FUNDING

The Brain Trauma Foundation (BTF) financially supports and maintains these guidelines in a cooperative agreement with the American Association of Neurological Surgeons (AANS).

GUIDELINE COMMITTEE

Head Injury Guidelines Task Force

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Task Force Members: Randall M. Chestnut, MD; Jamshid Ghajar, MD; Andrew I.R. Maas, MD; Donald W. Marion, MD; Franco Servadei, MD; Graham M. Teasdale, MD; Andreas Unterberg, MD; Hans von Holst, MD; Beverly C. Walters, MD

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

An update is not in progress at this time.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the Brain Trauma Foundation Web site.

Print copies: Available from the Brain Trauma Foundation, 523 East 72nd Street, New York, NY 10021, USA; Fax: 212-772-0357. An order form is also available on the Brain Trauma Foundation Web site.

AVAILABILITY OF COMPANION DOCUMENTS

None available

PATIENT RESOURCES

None available

NGC STATUS

This NGC guideline summary was completed by ECRI on July 9, 2002. The information was verified by the guideline developer on July 31, 2002.

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