Definition of Initial Grading, Specific Events, and Overall Outcome in Patients With Aneurysmal Subarachnoid Hemorrhage

A Survey

J. van Gijn, MD, FRCPE; J.E.C. Bromberg, MD; K.W. Lindsay, PhD, FRCS; D. Hasan, MD; M. Vermeulen, MD

Background and Purpose
Scientific communication in medicine can be effective only if reports are based on unequivocal criteria for clinical conditions or specific diagnoses.

Methods
We reviewed all articles about subarachnoid hemorrhage published in nine neurosurgical or neurological journals from 1985 through 1992 and assessed the presence and the precision of definitions used for reporting the initial grade, the specific complications of rebleeding, delayed cerebral ischemia, and hydrocephalus, and the overall outcome. We identified 184 articles reporting direct observations in at least 10 patients on one or more of these conditions.

Results
Of 161 articles reporting the initial condition, only 19% used an unequivocal grading system (World Federation of Neurological Surgeons Scale or Glasgow Coma Scale); this proportion did not increase after 1988, when the World Federation of Neurological Surgeons Scale was introduced. The specific outcome events of rebleeding, ischemia, and hydrocephalus (283 instances) were sufficiently defined in only 31% of instances, incompletely in 22%, and not at all in 47%. The proportions were similar when the results were analyzed according to the type of complication, the year of publication, or per study. The four exclusively neurological journals featured suitable definitions for any of the three outcome events in 20% of 209 instances, whereas the five mainly neurological journals published fewer articles about subarachnoid hemorrhage (74 instances of outcome events) but more often with precise criteria (65%). Overall outcome was adequately reported in 63% of all articles, with an increase over the years (54% in 1985 through 1988, 71% in 1989 through 1992).

Conclusions
Reports about subarachnoid hemorrhage require closer scrutiny before publication to ascertain whether the conclusions about specific outcome events are based on unequivocal criteria. (Stroke. 1994;25:1623-1627.)

Key Words • cerebral ischemia • hydrocephalus • stroke outcome

W hen I use a word,” Humpty Dumpty said, in rather a scornful tone, “it means just what I choose it to mean — neither more nor less.”
Lewis Carroll
Through the Looking-Glass

The eventual outcome of patients with subarachnoid hemorrhage is determined by the effects of the initial hemorrhage and often also by newly developing complications, of which rebleeding, delayed ischemia, and hydrocephalus are the most important. This multitude of factors calls for a high degree of accuracy in reports of research dealing with prognosis or with intervention aimed at specific complications. Otherwise, the results of such studies cannot be generalized or compared with other results. First, the initial assessment (or “grading”) should be unambiguous in describing the selection of patients who entered the study because this is an important determinant of outcome. Second, any subsequent complication should be identified, not so much as a measure of outcome in itself but rather to provide an understanding of the pathophysiological chain of events. Third and last, the eventual outcome should be recorded in terms that are not only unambiguous, and therefore consistent between observers, but also relevant from the point of view of the patient.

These methodological requirements are not always met in published studies about the prognosis and management of patients with ruptured aneurysms. To assess the extent of this problem, we performed a systematic review of articles about subarachnoid hemorrhage in nine relevant periodicals published from 1985 through 1992. We studied not only the definitions for the three major complications but also the methods used for grading the clinical condition on admission and for judging the eventual outcome.

Methods
The year 1985 was arbitrarily chosen as the starting point for this survey. By that time, computed tomography (CT) equipment had been installed in all major hospitals, and several publications in international journals of neurology and neurosurgery had stressed the diagnostic importance of serial CT scanning. Up to and including the year 1992, we identified articles about patients with subarachnoid hemorrhage via the annual indexes (using the key words: subarachnoid hemorrhage, hemorrhage, and aneurysm) of the following nine...
The definition of a particular outcome event was normally found in the "Methods" section of a scientific article, but we took account of descriptions anywhere in the text, including figure legends and references to previous publications. Each article was rated according to the grading system on admission and also according to the criteria used for defining rebleeding, delayed cerebral ischemia, acute hydrocephalus, and overall outcome (usually after 3 to 6 months).

The scale used for the initial assessment of the patient was simply tabulated, without qualitative judgment at this stage. For rebleeding, ischemia, and hydrocephalus, we regarded a definition as adequate if it contained a description of the clinical features supplemented by repeated CT scanning, the results of which were compared with a baseline scan. Signs of clinical deterioration are necessary but usually not sufficient for diagnosing any of these three outcome events. For instance, a gradual decrease in the level of consciousness without focal signs may be caused by delayed ischemia but also by hydrocephalus. Loss of consciousness with a sudden onset almost invariably accompanies confirmed episodes of rebleeding but in itself is not sufficient to establish the diagnosis; one third of such episodes have to be attributed to causes other than rebleeding. Only a gradually developing focal deficit is fairly characteristic of ischemia, but unless the patient has been under continuous supervision rebleeding ought to be considered as well. For each possible complication, we considered the following descriptions as precise. (1) Rebleeding was confirmed by angiography or strongly suggested by the pattern of hemorrhage on the CT scan; (2) number of patients 10 or more; (3) follow-up period of at least 1 week; (4) presence of ruptured aneurysm either demonstrated by angiography or strongly suggested by the pattern of hemorrhage confirmed by a CT scan or at autopsy (definite rebleeding); or sudden deterioration and death without the possibility of proof by a CT scan or an autopsy (probable rebleeding). (2) Delayed ischemia was defined as gradual development of focal neurological signs, deterioration in the level of consciousness, or both, with ischemia confirmed by a CT scan or at autopsy (definite ischemia); or gradual development of focal neurological deficit, with or without deterioration in the level of consciousness, in the absence of confirmation by CT or autopsy but with exclusion of other causes of deterioration such as hydrocephalus, electrolyte disorders, or specific surgical complications (probable ischemia). Because the pathogenesis of delayed cerebral ischemia after subarachnoid hemorrhage is multifactorial, we did not include vasospasm or other specific causal factors in the "ideal" definition, even apart from difficulties in demonstrating such factors in any systematic fashion. (3) Hydrocephalus was defined as some measure of ventricular size (often a linear measure such as the bicaudate index), with some threshold of abnormality, preferably the 95th percentile for age.

For outcome we regarded a measure as adequate if it was focused on a simple scale of handicap or degree of dependence. The scale should have proved reliable in interrobserver studies; such studies have been performed for the Glasgow Outcome Scale and the Rankin Scale.

A definition was considered incomplete if only some of the above criteria were met, such that other causes of deterioration were not convincingly excluded. This included, for instance, lumbar puncture for the diagnosis of rebleeding, "ischemic symptoms" for the diagnosis of ischemia, or a personal scale distinguishing "good," "fair," and "poor" in the assessment of outcome. The distinction we proposed between definite and probable ischemia or rebleeding did not affect the way in which the articles were classified. If no criteria at all were given for specific complications or outcome, despite these being mentioned in the "Results" section, we categorized the definition as absent. These judgments were made by two of the authors (J. van G. and J.E.C.B.); disagreements were resolved by discussion.

### Results

We identified 184 articles that fit the inclusion criteria for this study. Twenty articles mentioned only the clinical grading on admission, only the overall outcome, or both. Of the 164 remaining articles, 80 reported only one of the three specific outcome events (rebleeding, delayed ischemia, or hydrocephalus); 49 articles reported two events, and 35 articles reported on all three. A grading system for the clinical condition on admission was used in 161 articles and a measure of outcome in 137.

Table 1 lists the use of different grading systems for each year for the clinical condition on admission. The scale according to Hunt and Hess (or, in some cases, that by Hunt and Kosnik) was by far the most widely used (71%), with the Glasgow Coma Scale or World Federation of Neurological Surgeons (WFNS) Scale used in only a small minority (19%). Over the years some fluctuations occurred but without a consistent tendency to change.

Fig 1 illustrates the precision of the definitions per outcome event for the entire period of 1985 through 1992 and for all nine journals. The proportion of adequate criteria was around 30% for rebleeding, ischemia, and hydrocephalus and 63% for overall outcome. An article with no given definition at all occurred most often for rebleeding (59%) but was only slightly less common for hydrocephalus (47%) and delayed ischemia (40%); overall outcome was almost always defined in some way, although incompletely in 36%.

Fig 2 shows the accuracy of the definitions per journal for the entire study period. We did not include overall outcome in this comparison. Because this definition was adequate in 63%, across the range of journals, inclusion of this item in the comparison between journals would dilute any differences in the definition of specific complications. The four typically neurosurgical journals featured adequate criteria in 20%, and these journals contained by far the most articles (74% of the event assessments). The five journals with a primarily neurological background that contained the remaining 26% of reported events were accurate far more often (65%).

The proportion of adequate definitions per year is shown for the three specific outcome events in Fig 3. It is clear that the rate of 31% for adequate definitions for all three events together is rather stable over the 8 years of the study, with no discernible tendency to change. An analysis per article for one or more of the three specific outcome events showed that the methodological
TABLE 1. Grading Systems Used for Recording the Clinical Condition on Admission of Patients With Subarachnoid Hemorrhage in 161 Articles in Nine Neurosurgical and Neurological Journals According to Year of Publication

<table>
<thead>
<tr>
<th>Year of Publication</th>
<th>No. of Articles</th>
<th>Hunt and Hess Scale(7) (or Hunt and Kosnik)</th>
<th>Glasgow Coma Scale(8) or WFNS Scale (*)</th>
<th>Other System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>1985</td>
<td>13</td>
<td>7</td>
<td>54</td>
<td>3</td>
</tr>
<tr>
<td>1986</td>
<td>14</td>
<td>12</td>
<td>86</td>
<td>1</td>
</tr>
<tr>
<td>1987</td>
<td>25</td>
<td>19</td>
<td>76</td>
<td>2</td>
</tr>
<tr>
<td>1988</td>
<td>30</td>
<td>23</td>
<td>77</td>
<td>4 (2)*</td>
</tr>
<tr>
<td>1989</td>
<td>16</td>
<td>7</td>
<td>44</td>
<td>6 (1)*</td>
</tr>
<tr>
<td>1990</td>
<td>16</td>
<td>13</td>
<td>81</td>
<td>2 (0)*</td>
</tr>
<tr>
<td>1991</td>
<td>20</td>
<td>15</td>
<td>75</td>
<td>5 (3)*</td>
</tr>
<tr>
<td>1992</td>
<td>27</td>
<td>18</td>
<td>67</td>
<td>7 (4)*</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>114</td>
<td>71</td>
<td>30</td>
</tr>
</tbody>
</table>

WFNS indicates World Federation of Neurological Surgeons.

standards were slightly higher than average for studies that concentrated on a single outcome event. Of the 80 articles reporting on one outcome event, 33 (41%) used adequate criteria; an additional 27 (34%) applied other, though incomplete, definitions.

Table 2 lists the proportion of adequate assessments of outcome over the years of the study. In this case there does seem to be a clear trend toward better definitions over the course of time. This change reflects the widespread adoption of the Glasgow Outcome Scale.

Discussion

It is disquieting that two thirds of the studies of subarachnoid hemorrhage published in the last 8 years had incomplete or even no criteria for classifying patients' initial condition or for defining subsequent outcome events (rebleeding, ischemia, and hydrocephalus). Such ambiguity occurred regularly more than once in the same article. It is of no less concern that we failed to find any sign of improvement over the years except for the Glasgow Outcome Scale, which has become a widely accepted measure for the overall outcome of patients with subarachnoid hemorrhage.

Our survey is not without its limitations. First, we did not include every neurosurgical and neurological journal in the world. Nevertheless, the periodicals we selected have the largest circulation and are most often cited by authors in the field of neurosurgery and neurology; the wide readership is reflected in a relatively high journal impact factor. Therefore, any selection bias in the literature reviewed is likely to be in the direction of good articles rather than poor articles.

Second, the emphasis in our review was not on articles by guest on April 13, 2017 http://stroke.ahajournals.org/ Downloaded from
as a whole but on the sets of criteria used for defining initial condition, specific outcome events, and overall outcome. Most articles contained reports on more than one of these states or events, on average slightly more than three per article. One might argue that multiple definitions within the same article are more likely to be of the same quality than single definitions from different articles. We analyzed this per article for the three specific outcome events and found that the rate of adequate definitions was only slightly higher in articles describing single events (41%) than in those reporting multiple events (31% with precise definitions). In addition, it would have been difficult to apply weighting to multiple events (31% with precise definitions). In addition, the interobserver agreement in the use of the Glasgow Coma Scale has been proved good, as has the agreement between nurses and physicians.22 It is sobering that in the subsequent 4 years the rational approach embodied by the WFNS scale has not perceptibly replaced the traditional scale.

The description of specific complications is at least as important as grading the initial condition. Rebleeding, delayed ischemia, and hydrocephalus each require completely different therapeutic measures. As we pointed out in “Methods,” there are many pitfalls in distinguishing between these events, and serial CT scanning is mandatory. These difficulties are compounded because some interventions aimed at preventing or abating one specific complication can induce another. For example, prevention of rebleeding with antifibrinolytic drugs increases the risk of ischemic complications;5 and similar dangers may exist with early surgery.23 Similarly, the benefits of ventricular drainage aimed at relieving acute

---


<table>
<thead>
<tr>
<th>Year of Publication</th>
<th>No. of Articles</th>
<th>Adequate Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>1986</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>1987</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>1988</td>
<td>30</td>
<td>19</td>
</tr>
<tr>
<td>1989</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>1990</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>1991</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>1992</td>
<td>23</td>
<td>17</td>
</tr>
</tbody>
</table>

---

as the results of this overview are to some degree based on circular reasoning. However, given that the 80 studies focusing on single rather than multiple outcome events after subarachnoid hemorrhage can be regarded as most typically representing the “state of the art,” our group contributed only 8 of the 33 articles with precise definitions. Of the 25 other articles with complete definitions of single issues, as many as 18 were published in neurosurgical journals, which indicates that the use of our standards for definitions is not confined to the neurological community.

The initial assessment of the patient’s condition was most often recorded (in two thirds of the studies) on the scale proposed in 1968 by Hunt and Hess.17 Although hallowed by tradition, this 25-year-old scale has important drawbacks. These were highlighted by two studies of observer variability.18,19 Both were published before 1985, the first year of our review. When experienced trainees and neurosurgical specialists were asked to grade 15 patients with subarachnoid hemorrhage, considerable variation existed with up to four different grades being selected for the same patient. A similar variation occurred when written summaries of these 15 patients were submitted to a group of observers from 11 centers throughout Europe, all with a declared interest in the management of subarachnoid hemorrhage.20 The second study addressed the interobserver variability in assessing the separate clinical features from which this and similar scales were derived (headache, neck stiffness, hemiparesis, level of consciousness). Grading the severity of headache caused most variability. The consistency was almost as poor for grading the level of consciousness, which might be expected in view of the vague terms in which this feature is described in the Hunt and Hess scale (eg, “drowsiness” and “stupor”).21 Moreover, a preliminary analysis of the data from 3521 patients entered into the International Study on the Timing of Aneurysm Surgery showed that, in the presence of a normal level of consciousness, headache or neck stiffness did not relate to outcome.22 This evidence prompted an ad hoc committee of the WFNS to propose a more reliable and valid grading system in 1988. This WFNS Scale is based on the Glasgow Coma Scale for the assessment of consciousness level23 in combination with the presence or absence of focal signs.20 The interobserver agreement in the use of the Glasgow Coma Scale has been proved good, as has the agreement between nurses and physicians.22 It is sobering that in the subsequent 4 years the rational approach embodied by the WFNS scale has not perceptibly replaced the traditional scale.

---

**FIG 3. Bar graph showing definition of specific outcome events after subarachnoid hemorrhage (rebleeding, ischemia, and hydrocephalus) in 184 articles published in nine neurosurgical and neurological journals according to year of publication. n indicates number of times an event was reported.**
Definitions in Subarachnoid Hemorrhage

hydrocephalus are offset by an excessive risk of rebleeding.7,24 It is therefore a cause for concern that these three events were adequately defined in less than a third of all instances without any sign of improvement over the years. Of course, the rating of published definitions as “adequate” or “inadequate” is slightly subjective. If anything, we have been too liberal in the classification of articles. For instance, we accepted relevant clinical features in combination with CT scanning as sufficient for the diagnosis of rebleeding or delayed ischemia even if authors did not specify whether or not a baseline CT scan was available for comparison. Moreover, no definition at all was given in almost half of all instances in which events were reported, a fact that cannot be misinterpreted. The lack of precise criteria was slightly worse for rebleeding than for hydrocephalus or delayed ischemia, but these differences were relatively minor.

A much more striking contrast is that between neurosurgical and neurological journals. The four neurosurgical journals reported 209 of the 283 events (74%) with adequate definitions in only 20% of instances, whereas the remaining quarter of events, recorded in journals with a predominantly neurological readership, were based on adequate criteria in 65%. Apparently reviewers and editors of neurosurgical journals are much more prepared than their neurological colleagues to accept such diagnoses on trust and to forego explicit definitions.

On a more optimistic note, we found increasing use of a reliable scale for overall outcome: 54% in the period of 1985 through 1988 versus 70% in 1989 through 1992 (Table 2). In most of these cases the Glasgow Outcome Scale was used.11 This is a five-point scale, initially developed for the follow-up of patients with head injury and aimed primarily at categorizing the degree of independence in daily life. Such a global level of measurement can be applied to different categories of disease and reflects the patient’s quality of life far better than disease-specific impairment scales.10 A very similar scale is the modified Rankin scale (alternatively called the Oxford Handicap Scale).13 Both scales have proved reliable in interobserver studies.12,14

Our survey has uncovered frequent shortcomings in the precision of reporting on patients with subarachnoid hemorrhage. Leaders of research groups as well as reviewers and editors of scientific journals should see that future articles contain precise definitions of states and events. This will help to ensure that the conclusions are based on observation rather than opinion.

Acknowledgments

The authors are indebted to G.J.E. Rinkel, MD, and to L.J. Kappelle, MD, for their valuable comments on earlier drafts of this article.

References


16. Institute for Scientific Information. Science Citation Index—Journal Citation Reports. Philadelphia, Pa; ISI Press; 1991.


Definition of initial grading, specific events, and overall outcome in patients with aneurysmal subarachnoid hemorrhage. A survey.

J van Gijn, J E Bromberg, K W Lindsay, D Hasan and M Vermeulen

*Stroke*. 1994;25:1623-1627

doi: 10.1161/01.STR.25.8.1623

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Copyright © 1994 American Heart Association, Inc. All rights reserved.

Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:

http://stroke.ahajournals.org/content/25/8/1623