

International Variations in Surgical Practice for Spontaneous Intracerebral Hemorrhage

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Background and Purpose—Spontaneous intracerebral hemorrhage is a major cause of death and disability, yet there is no convincing evidence of the benefit of any medical treatment and the role of surgery remains controversial. The international randomized Surgical Trial in Intracerebral Hemorrhage (STICH) provided an opportunity to assess the role of surgery within the centers taking part.

Methods—Screening logs were completed to record details of all patients assessed by the department, whether they were included in the trial, the reasons if they were not included, and whether they underwent surgery.

Results—Logs were returned by 42 centers and cover 704 months. They include details on 1578 patients with characteristics comparable to STICH inclusion criteria. Neurosurgeons were more likely to express clinical certainty about treatment for older patients, patients with a higher Glasgow Coma Scale score, and patients in whom the hematoma was located on the right or in the basal ganglia or thalamus. Patients for whom the neurosurgeon was certain about treatment were more likely to have the hematoma removed if they were younger (62 versus 68 years of age), had a lower Glasgow Coma Scale score (10 versus 13), and had a lobar hematoma (49% versus 40%). The operation rate varied between 74% in Lithuania and 2% in Hungary.

Conclusions—The difference in operation rates could not be explained by differences in patient characteristics alone. This finding demonstrates the need for further evidence to ensure that treatment for intracerebral hemorrhage is not governed by local custom. (*Stroke*. 2003;34:2593-2598.)

Key Words: intracranial hemorrhages ■ multicenter studies ■ physician's practice patterns ■ surgery

Spontaneous intracerebral hemorrhage (ICH) accounts for 9% to 25% of all strokes^{1,2} and has devastating consequences. More than 50% of patients die,² and half of the survivors are left severely disabled. Many studies have shown that the level of disability and mortality after ICH depends on the Glasgow Coma Scale (GCS) score, hemorrhage size, ventricular extension, and patient age.³⁻⁸ Treatment of ICH remains anecdotal and inconsistent. One of the most commonly used clinical indications for surgery is neurological deterioration, but this is also a predictor of poor outcome. Surgery has typically been undertaken in younger patients with worse or deteriorating GCS scores and slightly larger hemorrhages.⁹ There is no convincing evidence of benefit from any medical treatment, and the role of surgery remains controversial.¹⁰ There is no evidence of the extent to which surgery is used around the world.

Several prospective, randomized, controlled clinical trials have been undertaken to compare surgical and medical treatment of ICH, but they have been single center, small, and inconclusive.¹¹⁻¹⁷ A large international multicenter trial is currently being undertaken. The international Surgical Trial in Intracerebral Hemorrhage (STICH) is a prospective, ran-

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domized, controlled trial to determine whether a policy of early surgical evacuation of the hematoma will improve outcome compared with a policy of initial conservative treatment. Patients admitted with a spontaneous supratentorial ICH are suitable for the trial if they meet the inclusion and exclusion criteria and if there is clinical uncertainty as to the need for surgical evacuation. To provide a context for STICH, screening logs were completed by study centers to record all patients with ICH admitted to their center. These logs indicated the types of ICH patients admitted and the treatment decisions made. They also identified the characteristics of patients for whom the neurosurgeon is certain about whether to operate. This information provides some indication for treatment differences that exist between and within countries.

Methods

Neurosurgical units registered with STICH used screening logs to collect anonymous basic admission data about all patients who were admitted to their center and might be suitable for STICH. Patients admitted with a spontaneous supratentorial ICH on CT scan were

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See the Appendix for a complete list of STICH Investigators.

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suitable for the trial if they were within 72 hours of ictus and there was clinical uncertainty as to the need for surgical evacuation. It was suggested that clinical uncertainty was maximal if the GCS score was ≥ 5 and if the clot diameter was >2 cm. Patients were excluded if there was evidence that the hemorrhage was due to an aneurysm or an angiographically proven arteriovenous malformation, if it was secondary to trauma or tumor, or if it was in the cerebellum or extended into the brain stem. Patients were also excluded if there was evidence of severe pre-existing physical or mental disability or severe comorbidity that might interfere with the assessment of outcome at 6 months or if surgery could not be performed within 24 hours.

Screening logs were used to record age, sex, GCS score, hematoma characteristics, inclusion in the STICH trial (and the reasons if excluded), and whether the hematoma was evacuated. These logs were returned to the trial office in Newcastle at the end of each month. Centers were asked to include all patients with ICH in their screening logs. However, some centers found this too time consuming and included only those patients whom they considered for the trial. For the following analysis, we have excluded all patients who were recorded as having any of the exclusion criteria. We have included only patients who were eligible for the trial and were recruited, those who were eligible and refused, or those who fulfilled other inclusion criteria but were deemed ineligible only because the treating neurosurgeon was certain about the treatment option to follow.

The analysis was carried out with SPSS 7.5 and compared the characteristics of patients for whom the treating neurosurgeon was certain about treatment with those for whom he or she was uncertain. Neurosurgeons may have been certain that the patient required conservative treatment or certain that the patient required surgical treatment. Therefore, the patients for whom the neurosurgeon was uncertain about the most appropriate treatment option formed an intermediate group. This group is composed of the STICH patients and those who were suitable for STICH but for whom consent could not be obtained. Differences were compared by use of χ^2 tests or Kruskal-Wallis tests as appropriate. We then restricted the analysis to only those patients for whom the treating neurosurgeon was certain about treatment. For these patient groups, we reported on differences between centers in the characteristics of admitted patients. Stepwise logistic regression was undertaken to establish which variables independently predict whether a patient had the hematoma evacuated. Then, a variable to indicate country was included in the logistic regression to test whether differences between centers could be explained by differences in patient characteristics.

Results

This analysis concerns the screening logs returned from February 1998 through December 2002. In total, 42 centers returned logs covering 704 months and 3893 patients. After exclusion of patients whose ICH had a minimum diameter <2 cm, whose ICH was in the brain stem or extended into the brain stem, was posttraumatic, or was associated with an aneurysm or arteriovenous malformation, whose bleed had taken place >72 hours previously, who were unsuitable because of their systemic or neurological status (GCS <5), and who had severe comorbidity, the logs covered 1578 patients. Of these, 1036 (66%) were not included in STICH because the treating neurosurgeon was certain about whether to operate.

Table 1 shows, for the countries that returned screening logs, the number of centers within each country, how many months of data were returned, and how many patients the logs concern. The number of patients per month varied between 0 and 17. Centers in Germany, the United Kingdom, Belgium, and Lithuania returned screening logs covering the most

TABLE 1. Volume of Data Recorded in Screening Logs

Country	Centers, n	Months, n	Patients, n	Ineligible, Surgeon Certain, n	Eligible, Surgeon Uncertain, n
Germany	8	119	288	241	47
United Kingdom	5	95	186	143	43
Belgium	1	47	149	136	13
Lithuania	1	23	154	127	27
South Africa	2	40	94	13	81
Macedonia	1	23	91	26	65
Russia	1	33	80	29	51
Spain	3	55	71	42	29
Japan	1	15	68	56	12
Hungary	1	22	63	57	6
Latvia	1	22	62	4	58
Czech Republic	3	30	58	41	17
Poland	2	25	43	22	21
India	1	27	40	8	32
Sweden	2	37	38	30	8
Greece	1	36	24	8	16
Singapore	1	4	20	16	4
Switzerland	1	8	11	11	0
United States	1	6	11	6	5
Turkey	1	20	15	12	3
Italy	2	13	9	9	0
Ukraine	1	2	3	0	3
Malaysia	1	1	1	0	1

patients, with a total of >100 patients in 1 center from each country. The proportion of patients for whom the surgeon was certain varies considerably between centers and between countries. In South Africa, Latvia, India, and Macedonia, the neurosurgeons are more likely to express uncertainty.

Table 2 shows the characteristics of patients within each of the 3 groups. Patients for whom the neurosurgeons express certainty that the hematoma should be evacuated tended to have a lower GCS score and have a hematoma that was more likely to be lobar, to be closer to the cortical surface, and to be larger. Patients who received conservative treatment were likely to be older, to have a higher GCS score, and to have deeper basal ganglia hematoma of smaller size. Patients for whom the treating neurosurgeon was uncertain formed an intermediate group, except they were more likely to have been admitted 5 hours later than those for whom the neurosurgeon was certain (median, 13 versus 7 hours) and were more likely to have a left-sided hematoma.

Overall, the operation rate for patients for whom the neurosurgeon was certain was 32%, but there were large differences between centers, with the center in Lithuania operating on 74% of these patients and that in Hungary operating on 2% (the Figure).

To make comparisons between centers, only those countries that recorded >20 patients for whom the neurosurgeon was certain about treatment are included. Because whether a

TABLE 2. Characteristics of Patients in “Certain” Group Having Surgery or Not and of Patients in “Uncertain” Group

	Operated (n=336)	Uncertain (n=542)	Not operated (n=700)	P
Age, median (quartiles), y	62 (53, 70)	63 (54, 70)	68 (58, 75)	<0.0001*
Male sex, %	58	56	55	0.778†
Time from ictus, – median (quartiles), h	6 (3, 14)	13 (6, 26)	7 (4, 18)	<0.0001*
GCS, median (quartiles)	10 (7, 13)	11 (8, 14)	13 (10, 15)	<0.0001*
Side of ICH, % right	57	47	53	0.006†
Site of ICH, %				
Lobar	49	50	40	<0.0001†
Basal ganglia	45	43	59	
Both	6	7	1	
Depth of hematoma (quartiles), cm	1.0 (0.0, 2.0)	1.5 (0.5, 2.2)	2.0 (1.0, 3.5)	<0.0001*
Size of hematoma, %				
<2.5 cm	6	19	32	
<3.0 cm	22	30	37	<0.0001†
<4.0 cm	38	28	19	
>4.0 cm	34	23	12	

*Comparison made with Kruskal Wallis U test.

†Comparison made with Pearson’s χ^2 test.

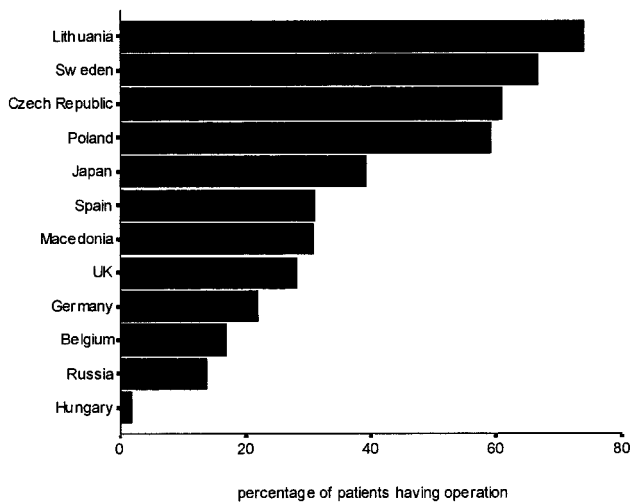
patient undergoes an operation is dependent on clinical characteristics and the characteristics of the hematoma, the differences in operative rate between the different countries may just be a reflection of differences in the characteristics of the patients admitted to the individual neurosurgery departments.

Table 3 shows the differences in characteristics of these patients across the centers. The countries are ordered according to their operative rates, with the country with the highest rate on the left and that with the lowest rate on the right. There are significant differences between centers in patient

age, with patients in Poland being 20 years younger than patients in Belgium. There are also wide differences between centers in the time from ictus to admission, with a median of 3 hours in Japan but a median of 24 hours in Russia, where the center is in a large city but draws from a very large, sparsely populated area. In the United Kingdom, the median time from ictus to admission is 18 hours, which may also reflect the policy of locating neurosurgery in larger centers and the need to refer patients from distant nonspecialist departments. In Germany, the median time is 6 hours.

The variation in the GCS scores for these patients is also wide, with a median of 8 in Macedonia and 15 in Russia. This latter figure suggests that in Russia most patients who the neurosurgeons are certain should receive initial conservative treatment have a GCS score of 15, whereas those for whom they have clinical uncertainty have a GCS score <15. Significant differences in hematoma site vary from 70% lobar in Sweden to 0% in Russia and 4% in Japan. Similarly, in the Czech Republic the hematomas in patients for whom the neurosurgeons are certain about treatment tend to be large, whereas in Russia the hematomas for whom the neurosurgeons are certain tend to be small.

Logistic regression was used to produce a model to explain whether the decision to operate is based on patient characteristics. This model showed that the decision is based on GCS score ($P<0.0001$), hematoma size ($P<0.0001$), patient age ($P<0.0001$), hematoma site ($P=0.007$), and depth from cortical surface ($P<0.0001$). However, a significant improvement in the fit of the model to the data can be obtained by including country ($P<0.0001$). This finding suggests that patient characteristics are not sufficient to explain which patients undergo evacuation of their hematoma and that there are other factors involved in the decision that differ between centers.



Operation rate for each country for patients for whom the neurosurgeon was certain about treatment option. Each country is represented by 1 center, except the United Kingdom (85% are from 1 center; the rest are from 3 other centers), Germany (62% are from 1 center; the rest are from 7 other centers), and Spain (3 centers with 26%, 34%, and 40% of patients).

TABLE 3. Differences Between Countries in Type of Patients for Whom the Neurosurgeon Is Certain About Treatment

	Lithuania (n=127)	Sweden (n=30)	Czech Republic (n=41)	Poland (n=22)	Japan (n=56)	Spain (n=42)	Macedonia (n=26)	United Kingdom (n=142)	Germany (n=241)	Belgium (n=136)	Russia (n=29)	Hungary (n=57)	<i>P</i>
Median age (quartiles), y	62 (54, 71)	60 (52, 68)	65 (58, 73)	51 (44, 64)	65 (58, 74)	68 (54, 74)	57 (51, 68)	65 (55, 73)	69 (60, 75)	72 (63, 78)	56 (50, 63)	67 (61, 76)	<0.0005
Male sex, %	55	70	61	50	46	62	54	55	57	59	41	49	<0.520
Median time (quartiles), h	7 (4, 15)	11 (6, 24)	4 (3, 10)	8 (2, 27)	3 (2, 5)	8 (3, 17)	10 (4, 24)	18 (8, 30)	6 (4, 10)	5 (3, 12)	24 (15, 50)	4 (2, 12)	<0.0005
Median GCS (quartiles)	11 (7, 13)	12 (8, 14)	10 (8, 14)	9 (6, 14)	12 (7, 14)	11 (9, 14)	8 (6, 11)	13 (10, 14)	13 (9, 15)	13 (9, 15)	15 (14, 15)	12 (9, 15)	<0.0005
Right side, %	54	63	61	57	61	57	46	48	60	49	48	42	0.224
Site, %													
Lobar	12	70	49	59	4	62	31	57	47	60	0	49	
Basal	78	30	51	23	96	36	69	41	52	39	100	51	<0.0005
Median depth (quartiles), cm	1.4 (0.5, 2.3)	0.3 (0.0, 2.0)	2.0 (0.0, 2.5)	1.7 (0.4, 3.0)	3.3 (1.6, 4.0)	1.8 (0.5, 2.5)	2.0 (0.8, 3.0)	0.5 (0.0, 2.0)	2.0 (1.0, 4.0)	1.0 (0.0, 3.0)	3.0 (2.0, 3.8)	1.0 (0.3, 2.8)	<0.0005
Size, %													
<2.5 cm	16	7	15	31	20	19	23	30	25	21	45	25	<0.002
<3.0 cm	25	33	32	23	34	50	27	34	33	28	38	42	
<4.0 cm	33	33	19	23	21	19	23	23	26	24	14	21	
>4.0 cm	26	27	34	23	25	12	27	13	16	27	3	12	
Operated, %	74	67	61	59	39	31	31	28	22	17	14	2	<0.0005

Discussion

Neurosurgeons are less likely to express clinical uncertainty about whether to operate for older patients, patients with a higher GCS score, and those in whom the hematoma is located on the right or in the basal ganglia or thalamus. In their survey of British neurosurgeons, Fernandes and Mendelow¹⁸ found that 81% expressed surgical uncertainty. Neurosurgeons were less likely to be uncertain if the patient was deteriorating (in which case they were more likely to operate), if the neurological deficit was minor (in which case they were less likely to operate), and if the hematoma was lobar (in which case they more likely to operate).

The indications for operation have been given by Broderick et al.¹⁹ The characteristics of patients in our study for whom the neurosurgeons express certainty that evacuation of the hematoma is the appropriate treatment follow the guidelines in that they have lower GCS scores and have a hematoma that is lobar, closer to the cortical surface, and larger.

The differences in operation rates between countries reflect differences in patient populations either because there are differences in the criteria for clinical uncertainty or because there are differences in referral or admission policies. In some centers, only patients deemed suitable for surgery are admitted to the neurosurgery department and assessed; in others, the neurosurgery and neurology departments are more closely linked, and all patients admitted to the joint department are assessed.

However, differences in patient population do not totally explain the differences in operation rate, which suggests that there are differences in the criteria for operation in the different centers. These differences express local surgical custom and training handed down over the years. Differences in the approach to treatment of ICHs in different centers have not been addressed in the past. This variation in practice is unsatisfactory, and the international STICH trial should

clarify the indications for surgery and explain these remarkable national differences.

Appendix

Management Team

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Editorial Comment

International Variations in Surgical Practice for Spontaneous Intracerebral Hemorrhage

The international randomized surgical trial for spontaneous intracerebral hemorrhage (STICH) is nearing completion. This article, concerning variations in surgical practice among the countries that participated in the trial, is one of the first of several to emerge from the study headed by Prof David Mendelow. The project has been under way for several years, funded by the Medical Research Council of Great Britain. It involves more than 70 countries including participants from Europe, India, the Far East, North America, and the United Kingdom.

One of the criteria for entry into the study as a participating institution was an agreement to include all patients with intracerebral hemorrhage admitted to hospital, documented on screening logs and submitted monthly to the organizers in Newcastle. However, some centers found this too time-consuming and included only patients they considered "appropriate" for the trial. Thus, rules for participation were not always followed. Those that did keep logs and submitted them faithfully (42 centers) provided data that are the basis for the study reported here.

One lesson emerging from this study is that patient characteristics such as the Glasgow Coma Scale, the size of the hematoma, the patient's age, the site of the hematoma, and the depth from the cortical surface are not sufficient to explain which patients had surgery and which did not. "Other factors" were involved in the decision to operate or not. The authors conclude that differences in the criteria for operation probably were influenced by local custom and surgical training handed down over the years.

Differences in the treatment of intracerebral hemorrhage in different countries have not been studied in the past. Thus, the STICH trial is already valuable because it has uncovered a bias that exists throughout the world concerning the management of spontaneous intracerebral hemorrhage. Which patients should have surgery and which should not is, therefore, a question that will not really be possible to answer, given a study design that cannot account for customs and traditions.

The lessons learned from this publication indicate that future studies will not be valid until customs and practice guidelines are virtually identical among participating centers. It is probable that, even within specific countries such as the United States, Great Britain, and Japan, current treatments for ICH will vary widely from region to region within the same country based on local custom and "training handed down over the years." In fact, attitudes toward the treatment for ICH vary within communities and even within departments in the same hospitals. Solving the ICH riddle will not be easy.

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