Variability in physician prognosis and recommendations after intracerebral hemorrhage

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ABSTRACT

Objective: To assess physician prognosis and treatment recommendations for intracerebral hemorrhage (ICH) and to determine the effect of providing physicians a validated prognostic score.

Methods: A written survey with 2 ICH scenarios was completed by practicing neurologists and neurosurgeons. Selected factors were randomly varied (patient older vs middle age, Glasgow Coma Scale [GCS] score 7T vs 11, and presence vs absence of a validated prognostic score). Outcomes included predicted 30-day mortality and recommendations for initial treatment intensity (6-point scale ranging from 1 = comfort only to 6 = full treatment).

Results: A total of 742 physicians were included (mean age 52, 32% neurosurgeons, 17% female). Physician predictions of 30-day mortality varied widely (mean [range] for the 4 possible combinations of age and GCS were 23% [0%-80%], 35% [0%-100%], 48% [0%-100%], and 58% [5%-100%]). Treatment recommendations also varied widely, with responses encompassing the full range of response options for each case. No physician demographic or personality characteristics were associated with treatment recommendations. Providing a prognostic score changed treatment recommendations, and the effect differed across cases. When the prognostic score suggested 0% chance of functional independence (76-year-old with GCS 7T), the likelihood of treatment limitations was increased (odds ratio [OR] 1.61, 95% confidence interval [CI] 1.12-2.33) compared to no prognostic score. Conversely, if the score suggested a 66% chance of independence (63-year-old with GCS 11), treatment limitations were less likely (OR 0.62, 95% CI 0.43-0.88).

Conclusions: Physicians vary substantially in ICH prognostic estimates and treatment recommendations. This variability could have a profound effect on life and death decision-making and treatment for ICH. *Neurology*® 2016;86:1864-1871

GLOSSARY

CI = confidence interval; GCS = Glasgow Coma Scale; ICH = intracerebral hemorrhage; OR = odds ratio.

Substantial heterogeneity has been identified in use of do-not-resuscitate orders and life-sustaining treatments after stroke.¹⁻⁴ There are many potential sources of this observed variability in end-of-life treatment at the patient, physician, and health system level.^{1,5-7} The physician estimation and communication of the patient's prognosis for recovery is a critical first step to setting a treatment plan for patients with severe stroke such as intracerebral hemorrhage (ICH).⁸⁻¹⁰ Many prognostic scores have been developed for ICH,^{11,12} though there has been almost no formal evaluation of the utility and effect of these prognostic scores on physician behavior or patient-level outcomes.^{9,13}

To develop a better understanding of current physician practice patterns for ICH prognostication and treatment recommendations, we conducted a nationwide survey of neurologists and neurosurgeons regarding the management of ICH. The primary objectives of this study were to (1) identify the physician- and patient-level determinants of variability in prognostic

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estimates and treatment recommendations and (2) determine the effect of providing a prognostic score on physician recommendations for intensity of treatment.

METHODS Physician identification and survey distribution. Physicians were identified based on a simple random sample of actively practicing physicians with a specialty of neurology, vascular neurology, or neurosurgery from the American Medical Association Masterfile. Written versions of the survey were sent via US mail along with an introductory letter, \$2 cash incentive, and a prepaid return envelope. Follow-up surveys (no incentive) were sent to nonresponders after approximately 8 weeks. Surveys were distributed on August 27, 2013, and October 23, 2013. Completed surveys were collected and manually double-entered using REDCap electronic data capture tools hosted at the University of Michigan.¹⁴

Case scenarios. Each survey included 2 case vignettes describing a patient presenting with ICH. Each vignette provided a clinical description of symptoms, examination findings, representative slices from a noncontrast CT scan, and an estimate of the total hemorrhage volume. Patient characteristics were randomized within physician including patient age (older vs middle age), race (African American vs Caucasian), and severity of neurologic deficits (severe vs moderate). One case was intended to be of moderate severity, describing a woman (age randomized to 83 or 63 years) on warfarin for atrial fibrillation who presented with right hemiparesis and aphasia, Glasgow Coma Scale (GCS) score of 11 (eye 3, verbal 2, motor 6), and a hemorrhage volume of 45 mL. The other case was more severe, describing a woman (age randomized to 76 or 56 years) who was found minimally responsive and intubated in the emergency department with a GCS of 7T (eye 2, verbal 1T, motor 4), and a hemorrhage volume of 120 mL with intraventricular extension.

In half of the surveys, the results from a validated prognostic score (FUNC score¹²) were shown after each case (“One validated predictive model for ICH suggests that patients of similar severity have about a X% chance of returning to functional independence by 90 days,” where X was 0%, 13%, or 66% depending on the age and GCS). Randomization of the prognostic score was performed such that each physician saw the prognostic score for both cases or for neither case to avoid contamination within a survey. This design resulted in a total of 16 versions of the survey. An overview of the randomization of vignettes is shown in figure 1, with full details of the randomization and full text from the case vignettes shown in appendix e-1 and table e-1 on the *Neurology*[®] Web site at Neurology.org.

Outcome measures. After each case, the physicians estimated the patient’s probability of 30-day mortality as well as 90-day return to functional independence (both free text write-in from 0% to 100%). Physicians were then told that the family was uncertain about the level of intensity of treatment to provide, and that the family specifically asked for the physician’s recommendation for the initial intensity of treatment. Physicians then indicated their recommended initial intensity of treatment on a 6-point ordinal scale with anchors of 1 = comfort measures and 6 = full intensive treatment (see appendix e-1 for text of questions and response options).

Physician characteristics. After the cases, additional questions assessed physician demographics, practice setting, optimism,¹⁵ religious salience,¹⁶ religious attendance, religious affiliation, and empathy (“How do you think your patients would rate your level of empathy as

compared to other physicians?” with response options of “I’m much less empathetic,” “I’m a little less empathetic,” “I’m about average,” “I’m a little more empathetic,” and “I’m much more empathetic”).

Statistical analysis. Descriptive statistics were used to summarize the physician characteristics. Repeated measures regression models with robust standard errors were used for all outcomes (linear for mortality and functional independence; ordinal and logistic for treatment recommendations) to account for clustering of responses within physicians. Model covariates were prespecified. All patient characteristics (age, GCS, and race) as well as case order were included in all models. Interaction terms between patient-level variables and case order were explored and retained if significant at $p < 0.10$ to account for order effects. Physician variables included age (quartiles), sex, race/ethnicity (other vs non-Hispanic white), number of ICH cases seen in the prior 12 months (16 or more, none, reference 1–15), surgeon, academic practice, geographic region, empathy, optimism, and religious importance. The presence (vs absence) of the prognostic score was coded as a 5-item categorical variable (no prognosis provided = reference; each of the 4 possible combinations of age and GCS) since the effect of the prognostic score was found to be different for different cases (e.g., the effect of showing a 0% chance of recovery was different than showing a 13% or a 66% chance). This approach allowed the effect of the prognostic score to be evaluated both overall and on a per-case basis. An interaction term between age and severity was forced into all models so that prognostic score could be interpreted adjusting for the joint effects of age and severity.

For the analysis of physician treatment recommendations, the a priori plan was to treat this as a 6-item ordinal variable. An initial ordinal model was created adjusting only for patient factors to allow us to determine the effect of the prognostic score on the full ordinal scale. However, once physician factors were added to the model, the proportional hazards assumption was violated. Therefore, a second logistic model was created where responses were collapsed into 2 categories (responses of 1, 2, or 3 indicating treatment limitations vs 4, 5, or 6 indicating full treatment) and physician characteristics were added. Analyses were conducted with SAS software version 9.3 for Windows (SAS Institute, Cary, NC).

Standard protocol approvals, registrations, and patient consents. This study was approved by the Institutional Review Board of the University of Michigan and determined to be exempt from ongoing review.

RESULTS The survey was mailed to 4,000 randomly selected physicians. Completed surveys were received from 816, with 273 returned as undeliverable or ineligible, for a response rate of 816/3,727 (22%). Of the 816, another 74 had missing data on one or more key descriptive variables, leaving 742 available for full analysis. Cases excluded for missing data did not differ on responses for the study outcome measures. The characteristics of the study population are shown in table 1.

The distribution of predicted 30-day mortality by patient age and GCS is shown in figure 2, demonstrating a wide range of responses within each clinical scenario. The multivariable model for physician-predicted 30-day mortality is shown in table 2. Older (vs middle) patient age increased the mortality estimate by 7–10 percentage points, while the effect of higher severity (GCS 7T vs 11) ranged from 18 to 29 percentage

Figure 1 Randomization of case vignettes

Demonstration of the format of the different survey versions resulting from randomization of prognostic score, patient age, clinical severity, and race. Note that case order (whether the moderate or severe case was shown first) was also randomized, but this is not shown in the figure for clarity.

points. Patient race had no effect on mortality predictions. Providing a prognostic score altered the physicians' predictions of mortality ($p = 0.001$). This effect was seen primarily in the case of the 63-year-old patient with a GCS of 11, where the prognostic score (66% chance of independence) resulted in a 5-point decrease in the mortality estimate ($p < 0.001$).

Several physician factors were associated with mortality estimates (table 2), with surgeons providing a lower mortality estimate by 10 percentage points than nonsurgeons. Number of ICH cases seen in the prior 12 months also had an effect, with physicians who saw 16 or more ICH cases tending to predict a higher mortality by 4 percentage points than those who saw 1 to 15 cases. Physicians in the Northeast and Southern regions of the United States predicted a higher chance of death than those in the Western United States. Overall, the within-physician correlation in responses was 0.26, suggesting that physician factors were responsible for 26% of the outcome variance. The final

model R^2 was 0.32 (i.e., the model explained 32% of the variability in physician responses).

Results for the physician estimates of 90-day recovery are detailed in appendix e-2 and table e-2. Providing physicians with a prognostic score affected physician predictions ($p < 0.001$), with favorable prognostic score (66% predicted independence) associated with increased physician estimates of good outcome, while a poor prognostic score (0% predicted independence) decreased physician estimates of good outcome. The only physician-level variable associated with prediction of 90-day recovery was geographic region ($p = 0.02$).

Results for the multivariable models investigating treatment recommendations are shown in table e-3, with the effect of the prognostic score shown in figure 3. When treatment recommendations were investigated as a 6-point ordinal variable, providing a prognostic score changed physicians' recommendations ($p < 0.001$). This effect varied depending on what probability of recovery was shown by the prognostic

Table 1 Descriptive characteristics of the population (n = 742)

Characteristics	No. (%) unless specified
Mean age, y (SD)	52.4 (11.1)
Female	129 (17)
Race-ethnicity	
White	554 (75)
African American	14 (2)
Asian	129 (17)
Hispanic/Latino of any race	37 (5)
Other	8 (1)
No. of ICH patients seen in prior 12 mo	
None	78 (11)
1–15	362 (49)
16 or more	302 (41)
Level of experience	
Resident	17 (2)
5 or fewer y in practice	82 (11)
6–10 y in practice	87 (12)
11–15 y in practice	112 (15)
16 or more y in practice	444 (60)
Specialty ^a	
Neurology	428 (58)
Neurocritical care	39 (5)
Vascular neurology	75 (10)
Neurosurgery	239 (32)
Other	90 (12)
Surgeon (includes any surgical specialty)	241 (32)
Academic practice setting	199 (27)
Geographic region	
Northeast	156 (21)
Midwest	181 (24)
South	258 (35)
West	147 (20)

Abbreviation: ICH = intracerebral hemorrhage.

^aResponses for this item do not sum to 100% as participants could select more than one answer.

score. For the cases where the chance of recovery was shown to be 13%, the prognostic score had no effect on treatment recommendations. However, if the prognostic score suggested a 0% chance of functional recovery (76-year-old patient with GCS 7T), the likelihood of treatment limitations was increased (adjusted odds ratio [OR] 1.61, 95% confidence interval [CI] 1.12–2.33, $p = 0.01$, adjusted for patient age, race, GCS, case order, age $\times$ GCS, and order $\times$ GCS). Conversely, if the score suggested a 66% chance of recovery (63-year-old patient with GCS 11), the likelihood of

treatment limitations was decreased (adjusted OR 0.62, 95% CI 0.43–0.88, $p = 0.008$, adjusted for same factors as above). Patient race was not associated with treatment recommendations in the ordinal model (adjusted OR 1.00, 95% CI 0.85–1.17, $p = 0.99$).

When treatment recommendations were collapsed into 2 categories (limited vs full treatment) to allow the exploration of physician characteristics, none of the investigated physician factors was associated with recommendations. Physicians recommended a lower treatment intensity (response of 1, 2, or 3 on the 6-point scale) in 32% of cases. The prognostic score remained associated with treatment recommendations, with a similar pattern of responses as the ordinal model (e.g., 66% chance of independence decreased treatment limitations, while a 0% chance showed a trend toward increased treatment limitations, see table e-3). African American patient race was not associated with physician recommendations for treatment limitations (adjusted OR 0.82, 95% CI 0.66–1.03, $p = 0.09$) in the binary model, adjusted for patient and physician characteristics.

DISCUSSION We identified substantial variability in physician prognostic estimates and treatment recommendations for cases of moderate to severe ICH. This variability existed despite providing sufficient clinical data to estimate chances of death or recovery based on commonly used ICH prognostic models.^{12,17} We also found that physician recommendations for initial treatment intensity were altered when they were provided with a validated prognostic score. If the prognostic score suggested a poor outcome (0% chance of 90-day independence), physicians were more likely to recommend treatment limitations compared with no prognostic score. If the prognostic score suggested a favorable outcome (66% chance of 90-day independence), physicians were less likely to recommend treatment limitations.

These findings have several implications. First, they suggest that prognostic information provided to a family about an ICH patient may vary depending on the particular physician involved in the case. Given the widespread variability seen in ICH end-of-life treatment seen across institutions,¹ it is likely that differences in physician prognostication and recommendations play at least some role in unwanted variability in ICH treatment. Overly optimistic and overly pessimistic prognostic estimates can both have deleterious effects. Overly optimistic recommendations can lead to continuation of futile treatments and leave family members unprepared for death or poor outcome, while overly pessimistic predictions can lead to early treatment limitations and death in individuals who may have had a chance for recovery.

Figure 2 Distribution of 30-day mortality estimates by case characteristics

(A–D) Presented patient ages and Glasgow Coma Scale (GCS) scores.

Our results also suggest that increased use of validated prognostic scores may alter physician treatment recommendations in certain cases. While encouraging use of prognostic scores could be seen as a way to reduce unwanted variability in ICH treatment, there was still a wide range of treatment recommendations even when physicians were provided with a prognostic score. Furthermore, the prognostic score had no effect on treatment recommendations in the 2 cases with intermediate prognosis (13%) for functional recovery. Despite the wide availability of prognostic models for ICH,^{12,17} few are currently used in practice. Reasons for this are complex and likely due to multiple factors including lack of physician trust in models, difficulty in applying population average estimates to individual patients, and a belief that numbers may be misinterpreted by families.¹⁸ Physicians tend to be reluctant to provide numeric prognostic estimates, and yet studies of surrogate decision-makers suggest that the majority of surrogates understand and accept the inherent uncertainty in these estimates and still want numeric estimates if they are available.^{18,19} Existing prognostic models for ICH may also be biased as they have been developed in cohorts with frequent decisions to limit life-sustaining treatments, which were in part based on prognostic variables incorporated into the scores.^{20,21} Since chart documentation of an ICH severity score is now an emerging quality metric

for ICH and use of prognostic scores is likely to increase,²² more formal study of the effect of these scores on patient outcomes seems warranted.¹³

We identified relatively few physician characteristics associated with outcome predictions, and we found no factors predictive of physician treatment recommendations. The physician characteristic with the largest effect on mortality estimates was surgical specialty, with surgeons providing an estimate that was 10 percentage points lower (more favorable) than nonsurgeons. We did not have sufficient sample size to investigate possible effects of various subspecialties such as neurocritical care or vascular neurosurgery. Physician experience with ICH and geographic region were also associated with physician outcome predictions, though the effect sizes were relatively small (less than 5–6 percentage points for mortality estimates), and it is uncertain if these findings truly represent clinically meaningful differences. The majority of the variability in mortality estimates remained unexplained (model R^2 of 0.32) despite inclusion of physician demographics, practice characteristics, and personality traits. The lack of physician factors associated with responses suggests that targeting specific physician groups for additional training in neurologic prognostication is unlikely to be beneficial.

Physicians recommended a lower intensity of treatment (1, 2, or 3 on the 6-point ordinal scale) in approximately 1/3 of cases, despite national guidelines recommending against early treatment limitations in ICH.²³ This may be reflective of a general pattern of clinical nihilism that has been described in ICH.²⁵ An American Heart Association Scientific Statement has suggested that physicians should be aware of their own potential biases when making recommendations and attempt to limit the effect of these biases on treatment recommendations.⁹ Physicians may also make recommendations to limit life-sustaining treatment in an attempt to spare the patient from survival with disability^{24,25} and limit the surrogate's burden²⁶ of making such a difficult decision. This approach, however, may be problematic in situations where the prognosis is uncertain, or if the surrogate has not explicitly stated a desire to cede decision-making authority to the physician.²⁵ A study from a general ICU population showed that the majority of surrogates preferred to maintain the final decision-making authority for life-sustaining treatment,²⁷ suggesting that this paternalistic approach without first attempting to determine how involved the surrogate wants to be in decisions may be inappropriate.²⁵

We did not identify any consistent effect of patient race on physician treatment recommendations, which may seem in contrast to prior work suggesting racial and ethnic differences in use of life-sustaining treatments after ICH.^{7,28} However, it

Table 2 Effect of prognostic score and patient and physician characteristics on physician-predicted mortality

	Estimate ^a	Lower 95% CI	Upper 95% CI	p Value
Intercept	20.4	14.5	26.4	<0.001
Patient-level variables				
Patient age × severity interaction				0.37 ^b
Age effect with GCS 11	9.8	5.9	13.7	<0.001
Age effect with GCS 7T	6.6	1.6	11.6	0.01
Race × order interaction				0.06 ^b
Race effect for first case	2.9	−0.3	6.0	0.07
Race effect for second case	−1.9	−5.0	1.2	0.24
Severity × order interaction^c				0.002 ^b
Severity effect for first case	21.0	15.9	26.1	<0.001
Severity effect for second case	28.7	23.8	33.6	<0.001
Effect of providing a prognostic score				0.001
Age 63 y, GCS 11, 66% independence	−5.2	−8.1	−2.3	<0.001
Age 83 y, GCS11, 13% independence	−1.0	−5.8	3.8	0.69
Age 56 y, GCS7T, 13% independence	−3.9	−9.1	1.2	0.14
Age 76 y, GCS 7T, 0% independence	1.8	−2.9	6.4	0.45
Score not provided	Reference			
Physician-level variables^d				
Surgeon	−10.7	−13.6	−7.8	<0.001
Region				0.02
Midwest	3.2	−0.8	7.1	0.11
Northeast	6.0	1.9	10.0	0.004
South	4.8	1.1	8.4	0.01
West	Reference			
ICH cases seen in past 12 mo				0.008
16 or more	4.4	1.6	7.2	0.002
None	2.1	−2.2	6.5	0.34
1–15	Reference			
Academic practice	−2.5	−5.3	0.3	0.08

Abbreviations: CI = confidence interval; GCS = Glasgow Coma Scale; ICH = intracerebral hemorrhage.

^aPositive estimates can be interpreted as the number of percentage points that the factor increased the predicted mortality (i.e., more pessimistic prediction), while a negative estimate can be interpreted as the number of percentage points that the factor decreased the predicted mortality (i.e., more optimistic prediction).

^bp Value is for the interaction term.

^cEffects shown are only valid for the younger-aged cases due to the interaction terms. Effects for the older-aged cases would be smaller by an absolute difference of approximately 3 percentage points.

^dOther physician variables kept in the model all had $p > 0.10$ including physician age (quartiles), physician sex, nonwhite race, empathy, religious importance, and revised life orientation test (quartiles).

is worth noting that in the current study, the patient's stated treatment preferences were held constant across race (see appendix e-1 for details of preference statement). Since the effect of race-ethnicity on life-sustaining treatments is likely explained in part by differences in patient or family preferences, it is not necessarily surprising that there were no racial differences observed in treatment recommendations. Alternatively, describing race in a text scenario (rather than with pictures or videos) may not have been a strong

enough trigger for physicians to consider the effect of race on their responses.

This work has limitations. It is possible that the survey scenarios and responses may not reflect the complexities of actual practice, and that physicians may be able to make better prognostic estimates and treatment recommendations when able to interact with the patient and family. However, given the infrequent use of advance directives and widespread misdiagnosis of patient preferences in other conditions,^{9,29} it is unlikely

Figure 3 Effect of providing a model prognostic estimate on physician treatment recommendations

Physicians indicated their recommended initial intensity of treatment on a 6-point ordinal scale with anchors of 1 = comfort measures and 6 = full intensive treatment. Numbers inside each bar represent the percentage of cases where each level of treatment intensity was selected. In each panel (A-D), the top bar represents the responses where no prognostic score was provided, and the bottom bar is the responses when physicians were provided a prognostic score that gave the probability of functional independence at 90 days (with options of 0%, 1.3%, or 66%, depending on the case characteristics). Note that the largest differences in recommendations are observed in panels A and D. GCS = Glasgow Coma Scale.

that our results are explained fully by the hypothetical nature of these scenarios. The study design does not allow us to determine if the prognostic score caused any individual physician to change his or her treatment recommendations, as the score was only randomized between physicians, and there was no within-physician assessment of responses before and after viewing the score. Another limitation is the relatively low response rate (22%), which is a well-known problem in physician surveys.³⁰ However, the age, race/ethnicity, and proportion in academic practice is similar to that reported in a recent American Academy of Neurology member census.³¹ Eighty-nine percent of respondents reported recent involvement in the care of ICH patients, suggesting that the results of this survey are representative of current clinical practice.

We identified substantial variability in physician prognosis and treatment recommendations for ICH. Few physician factors were identified that predicted responses and much of the variability in responses remained unexplained. Increasing use of an accurate formal prognostic score may be one way to standardize physician prognostic estimates. Given the potential for a prognostic score to either increase or decrease the recommended intensity of treatment, careful study

of the effect of these scores and how best to implement their use in clinical settings is warranted.

AUTHOR CONTRIBUTIONS

D.B. Zahuranec: study concept or design, obtaining funding, statistical analysis, analysis or interpretation of data, study supervision, drafting/revising the manuscript for content. A. Fagerlin: study concept or design, drafting/revising the manuscript for content. B.N. Sánchez: statistical analysis, analysis or interpretation of data, drafting/revising the manuscript for content. M.E. Roney: study concept or design, study coordination, acquisition of data, drafting/revising the manuscript for content. B.B. Thompson: interpretation of data, drafting/revising the manuscript for content, interpretation of data. A. Fuhrel-Forbis: study concept or design, study coordination, acquisition of data, drafting/revising the manuscript for content. L.B. Morgenstern: study concept or design, drafting/revising the manuscript for content.

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