Neuroprognostication

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KEYWORDS

- Prognostication • Neurocritical care • Uncertainty • Surrogate decision-makers
- Prognosis • Shared decision-making

KEY POINTS

- There are no guidelines to assist clinicians in the formulation or communication of prognostication in the neurocritical care setting; hence, prognostication is highly variable, potentially biased, and often premature.
- Uncertainty is unavoidable in prognostication; families ask for frank acknowledgment of its presence and forthright disclosure of uncertainty by clinicians during prognostication.
- The prognostic communication in the neurologic intensive care unit may be strengthened by focusing on patient- or surrogate-centeredness to foster trust, manage overly optimistic bias, and help surrogate decision-makers arrive at decisions that patients would choose for themselves.

INTRODUCTION

“Prognosis” stems from the Greek words “pro” meaning “before” and “gnosis” meaning “knowledge.”[1] Prognosis therefore means *“knowing something beforehand,”* which is unrealistic in the context of helping families understand a future outlook for their loved one admitted to an intensive care unit (ICU), simply because clinicians cannot predict the future with certainty to claim “knowledge” of the future. On the other hand, “prognostication” stems from the Greek word “prognōstikos,” which means “foretelling," which is exactly what clinicians attempt to do. The undertaking of “prognostication” is using signs, symptoms, or various diagnostic modalities (eg, imaging) to foretell the future.[1] The term “neuroprognostication” relates to prognostication specific to the setting of neurologic illness. Patients with severe acute brain injuries (SABIs), including those with severe acute ischemic strokes, intracerebral hemorrhage, traumatic brain injury (TBI), or hypoxic-ischemic encephalopathy, are

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usually comatose, sedated or encephalopathic and, hence, incapacitated for decision-making. This places the burden of decision-making onto the shoulders of surrogate decision-makers, often family members. As these families grapple with the sudden onset of severe illness, they yearn for prognostication to prepare for the future and decide on treatments or care paths that are best for the patient. Physicians and other care providers also use prognostication to triage, decide on what treatments to offer, and how to communicate with families.

SABIs are extremely common across the globe, with millions of deaths and an even larger number of resulting lifelong disabilities worldwide.[2] Owing to an aging population and increased survival after SABI attributable to advances in medical care, the incidence and prevalence of SABIs have even further increased over the past 30 years.[2] Patients with SABI necessitate rapid treatments to prevent or ameliorate worsening brain injury and irreversible illness. Life-or-death treatment decisions, such as intubation, craniotomy, craniectomy, or other interventions, must be made swiftly to preserve brain function or prevent death.[2] Most patients with SABI survive the first 5 to 10 days in the ICU. To reach the next stage of recovery, SABI patients often need airway and artificial nutrition support, with care by others for their most basic needs for the initial weeks to months, or even years. Thus, while considering the patient's potential for long-term disability and diminished quality of life, surrogates must make the difficult decision about continuation or withdrawal of life-sustaining therapies (WLSTs). Survival following acute injury may be accompanied by higher or lower levels of disability, but at a minimum with a large degree of uncertainty about the degree of recovery. Because of this, it is especially important for neurocritical care providers to prognosticate as accurately as possible while also communicating all possible outcomes and their associated risks as well as the existing uncertainty about the prognosis and uncertainty about recovery to surrogate decision-makers.

CURRENT APPROACHES TO PROGNOSTICATION

Prognostication can be dissected into two components: (1) clinicians' knowledge of the type and severity of the neurologic injury and its anticipated long-term sequalae and (2) communication and disclosure of these aspects to the patient or their surrogate decision-makers. There are limited studies that have examined how clinicians formulate their prognostication for SABI. In a prospective five-center study of intracerebral hemorrhage, researchers qualitatively examined the factors considered by physicians when prognosticating. Physicians described using a wide range of the types and combination of factors, such as age, clinical examination severity, radiological findings, preexisting cognitive impairment, the presence of social support, and etiology of the injury to form their prognosis.[3] A recent study of neurologic prognostication after cardiac arrest used semi-structured interviews with disease experts and general physicians and applied the innovative approach of "mental models" to summarize the cognitive approaches physicians take for neuroprognostication.[4] This study found that all participating physicians, regardless of expert or general physician status, used a similar iterative process of assessment and data collection to continuously formulate their prognoses.[4] For the first time, this study shed light on the cognitive process of how physicians derive their prognostication. Participating physicians formed an initial prognosis and then modified it after considering test results, medical imaging findings, patient age, patient frailty, patient premorbid state, hospital resource availability, and their own optimistic or pessimistic leanings.[4] This study showed the complexity of the cognitive approach to prognostication after one type of SABI (cardiac arrest), although this approach is likely representative for prognostication after all types of SABI.

Regarding the second aspect of neuroprognostication, its communication to families, very little research has been conducted in SABI or the neuroICU. One recent pilot mixed-methods study of clinician communication in the neuroICUs at seven centers found significant variability between clinicians and specialties regarding clinician approach to prognostication.[5] However, further validation of these findings is necessary in a larger study.

This current state of neuroprognostication has often been described by many researchers as an "art."[6–8] Others, however, have in turn criticized that neuroprognostication should not be an "art," as this implies that individualism and variability by the clinicians formulating the prognostication is acceptable and welcome. Instead, researchers have suggested that neuroprognostication should be performed as "scientifically" as possible.[7] This may include a combination of more precise data with longer outcome assessment periods and the addition of machine learning to allow the inclusion of more variables and an individualized prognostication that also includes the ICU course and trajectory.[9] Additional research into how physicians cognitively derive the prognosis and how to communicate it effectively is certainly necessary to change the current perception of neuroprognostication from being an "art" to it being a "science."

Because prognostication is so important for patients and their surrogates, formalized guidelines have been suggested to guide clinicians and introduce some form of standardization with the hope of ameliorating variability.[10] Recently, a joint guideline on "Disorders of Consciousness" was published by the American Academy of Neurology, American Congress of Rehabilitation Medicine, and the National Institute on Disability, Independent Living and Rehabilitation Research.[11] This document provided guidance on what NOT to do when prognosticating for patients with disorders of consciousness.[11] A strong recommendation was made, stating *"When discussing prognosis with caregivers of patients with a disorder of consciousness during the first 28 days postinjury, clinicians must avoid statements that suggest these patients have a universally poor prognosis."*[11] The American Heart Association has published a scientific statement on the "Standards for Studies of Neurologic Prognostication in Comatose Survivors of Cardiac Arrest" concluding that the "overall quality of existing neurologic prognostication studies is low."[12] This scientific statement provided suggestions to improve the quality of research studies in neuroprognostication, but this document does not, nor was it intended to, fulfill the role of a clinical practice guideline on how to "best" prognosticate.[10–12] With this goal in mind, a clinical guideline examining current published literature is currently underway by the Neurocritical Care Society and German Society for Neurointensive Medicine (Deutsche Gesellschaft für Neurointensivmedizin).[13] Preliminary results have been presented at a recent conference (ANIM 2022[13]) with an anticipated publication year of 2022.

BIAS, HEURISTICS, AND THE SELF-FULFILLING PROPHECY

Clinicians in the neuroICU must make quick medical decisions for their patients as a routine part of clinical practice. Substantial discoveries in psychology have described human judgments, including those for prognostication, are based on either "System-One processes" (fast, automatic, heuristic) or "System-Two processes" (slow, deliberate, analytical)[14] (**Fig. 1**). In medical decision-making, particularly in fast-paced environments such as the emergency department or ICU, System-One processes using heuristics commonly underpin decision-making.[15] Here, clinicians generate solutions to complex problems through pattern recognition and simplifying assumptions.[16]

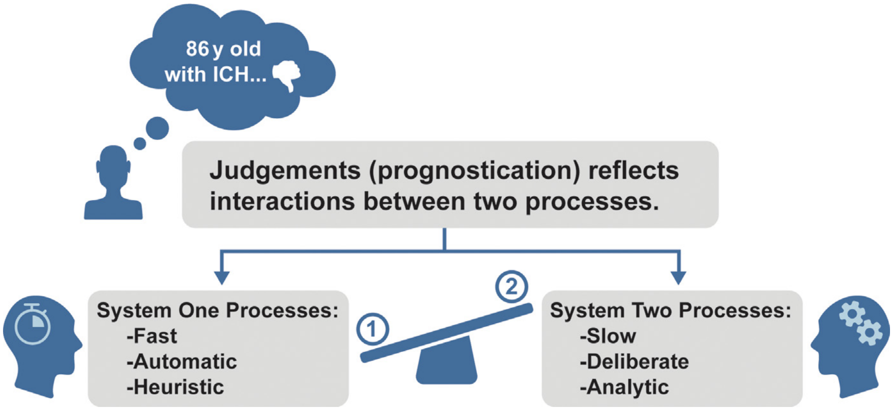

Fig. 1. The balance between System-One and System-Two processes in decision-making. Prognostication requires balancing System-One though processes with System-Two thought processes. System-One processes are fast, automatic, stereotyped, emotional, unconscious, and heuristic. System-Two processes are slow, deliberate, analytical, effortful, conscious, and infrequent. In the presence of uncertainty, heuristics help the clinician generate solutions to complex problems through pattern recognition based on previously acquired knowledge and experience.

Heuristics may be practical using “mental shortcuts,” particularly in the presence of uncertainty; however, when poorly calibrated, clinicians make “bad” decisions based on biases that may result in worse patient outcomes.[17–19] This has been shown in a randomized-controlled trial of emergency room triage of trauma patients and in a systematic review of physician cognitive biases, which found that cognitive biases were associated with diagnostic inaccuracies and medical management errors.[15–18]

Heuristics and clinician bias may potentially also play a role in the known high variability of death from WLST.[20,21] WLST is the leading cause of death after SABI and varies widely by center, with reports ranging from 0% to 96% in stroke and 45% to 87% in severe TBI.[2,20,21,22] Variability persists even after adjusting for epidemiologic patient, surrogate, or provider characteristics.[23] Previous studies have also shown that WLST is more likely when the acute neurologic insult is deemed “more severe” by the clinician.[24–26] This is problematic because several studies have suggested that some clinicians may be overly pessimistic regarding prognosis, leading to clinical nihilism, an “inappropriately pessimistic view of a patient’s outcome and the ability of a patient to benefit from aggressive care.”[24,25,27,28] This in turn can result in a self-fulfilling prophecy of poor prognosis (Fig. 2).[19,29,30]

In the case of prognostication, the self-fulfilling prophecy involves WLST for a subset of individuals who suffered from a devastating neurologic injury, but a subset of WLST patients might have survived otherwise. The resulting mortality of that neurologic injury seems higher than it should.[22] The self-fulfilling prophecy affects prognostic statistical models; poor prognosis leads to WLST and subsequent fatality, which then contributes to poor outcome in the models.[19,22] In an effort to mitigate clinician bias and premature WLST, experts in neurocritical care currently recommend at least a 72-h treatment period before any WLST decisions, although it is uncertain whether this would truly solve the problem of self-fulfilling prophecy.[31] Only studies that do not allow any WLST and follow the trajectory of patients out until at least 1 year after SABI may provide insights into true long-term outcomes of patients.

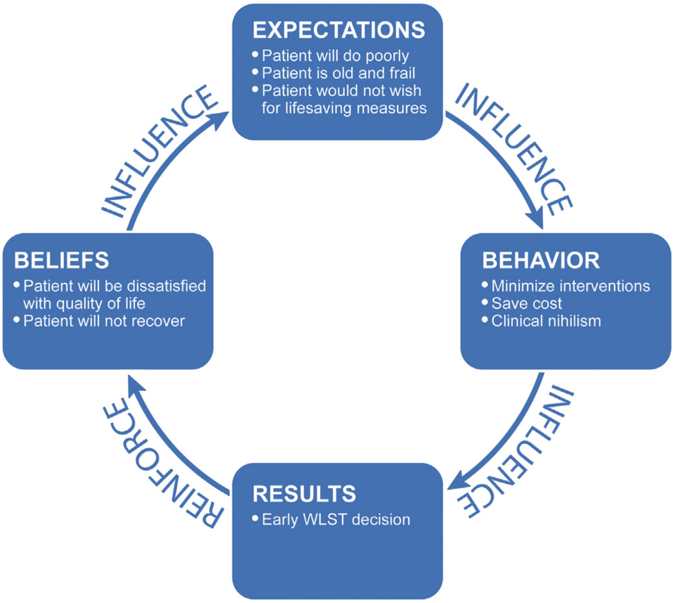

Fig. 2. The self-fulfilling prophecy. This figure demonstrates the cycle of the self-fulfilling prophecy: beliefs and expectations influence clinicians' behavior and results, which in turn reinforce beliefs. For example, a clinician might have biases about a patient's age, preexisting code status, or prognosis. This contributes to the clinician's prognostication and recommended treatments.

Recently, a study from South Korea, a country where WLST is not permitted by law, showed that in their cohort of greater than 1000 cardiac arrest survivors followed for 6 months or longer, awakening occurred in 42% at a median of 30 hours after rewarming, with the longest awakening time at 1415 hours (nearly 59 days).[32] Late awakening (>72 hour after rewarming from therapeutic temperature management) was common and occurred in nearly a quarter (24.3%) of all patients who awakened.[32] Good neurologic outcomes (cerebral performance scale 1–2) occurred in the vast majority (84.5%) of patients who awakened.[32] Insight into the true outcome of patients, when WLST is not permitted, is unique, and repeating such studies for other neurologic emergencies is valuable.

WHAT SURROGATES NEED

Surrogates find prognostication by a physician an important and necessary step in communication with the clinical team.[33,34] Empirical research in general critical care has shown that surrogates use clinicians' prognostication in some part to inform their clinical decisions.[35] Despite this, prognostication only forms a small part of what goes into a surrogate's perception of the patient's prognosis. Only 2% of surrogates reported that they relied on clinician prognostication alone when considering the overall prognosis of a patient.[36] Other factors, including the patient's will to live, physical appearance, and prior medical history, were often coupled with clinician's prognostic input to inform surrogate prognostic impression.[36] Surrogates may be skeptical of the clinicians' ability to prognosticate reliably. In one qualitative study using semi-structured interviews with 50 surrogate decision-makers of critically ill patients without

SABI, 88% of surrogates expressed doubt in the clinicians' ability to prognosticate.[35] Reasons for this were beliefs that God affected the disease course, foretelling the future is inherently inaccurate, prior experiences with inaccurate prognostication, and ongoing experiences with prognostication during the current ICU admission.[35] Nonetheless, hearing the clinician's prognostication was important to all surrogates in this study before making decisions.[35]

Several studies have shown that most surrogates would rather receive exact numeric estimates when discussing prognosis despite clinician reluctance to provide them. In a multicenter qualitative study of surrogate decision-makers of moderate–severe TBI patients and their physicians from across the United States, most surrogates (82%) preferred receiving exact numeric estimates from physicians when discussing their loved one's prognosis, and very few (18%) were satisfied with qualitative prediction statements such as "highly likely" or "unlikely."[34] Although outcome prediction models are available and can produce numerical estimates, many clinicians report mistrust of the statistical derivation data used to produce percentage values, worry about giving false hope, or believe that those models are inappropriate to use on individual patients.[34,37] Clinician reluctance to use quantitative terms when prognosticating may be attributed to lack of training on prognostic communication, reluctance to predict the future, and uncertainty about their own prognostic estimates.[38,39] Experts in risk communication recommend clinicians communicate prognosis with population-based outcome language.[40] For example, instead of saying "there is a very poor prognosis," or "there is a 10% chance of survival," clinicians should say, "If there were 100 patients in your mother's condition, roughly 90 would not survive and 10 would survive."[40]

In addition to quantitative prognostic estimates, surrogates also ask for prognostic information delivered to them quickly, accurately, and without false hope.[41,42] They prefer to receive consistent prognostic estimates from multiple providers to minimize confusion or ideally to meet consistently with the same provider.[35,42,43] Surrogates responded favorably to thorough explanations regarding their loved one's care and treatment options, and they appreciated when clinicians took time to answer questions using simple-to-understand language.[43] Surrogates report feeling that it is the clinicians' duty to prognosticate realistically, but to do so empathetically and with emotional support when the news is bad.[33,41,42]

UNCERTAINTY

For all prognostication, especially in SABI, uncertainty is inherently present and unavoidable. Research shows that both clinicians and surrogates are frustrated by the presence of prognostic uncertainty.[33,34,43,44] Uncertainty can take a psychological toll on surrogates; in one qualitative study in severe TBI, surrogates acknowledged feeling unprepared for uncertainty during prognostication meetings and struggled to come to terms with it for months after the meeting.[34] This was made worse when quantitative estimates were withheld, and some surrogates confessed to feeling suspicious of providers who refused to give numeric estimates.[34] A more dated study from 1998 found that the most of the physicians (92%) were uncomfortable communicating uncertainty to patients and were reluctant to prognosticate at all when faced with uncertainty.[39] Surrogates, however, found that more information provided by the clinician lessened their own feelings of uncertainty even when uncertainty was explicitly discussed.[43]

Clinicians sometimes attempt to resolve uncertainty by generating and analyzing more data, often in the form of additional imaging and tests.[4,45] Although surrogates find these helpful, these cannot totally eliminate uncertainty from prognostication.[45] Prognostication for SABI patients occurs in the critical care setting, usually just days after injury and often too early for the outcome to be accurately predicted.[25,46] Clinicians must extrapolate their prognoses from variables studied in a much smaller subset of the general population.[45] Certain clinical or radiographic findings have been identified as markers of poor prognosis (eg, intracerebral hemorrhage: hematoma volume >60 mL, hydrocephalus, and intraventricular hemorrhage[25]), but patients with many of those findings have been known to survive with a spectrum of residual disability.[25] Clinicians might avoid mentioning uncertainty at all due to concerns about being wrong, undermining their own authority as a doctor, the fear of causing false hope in families, or emotionally disturbing families with the uncertainty.[34,37,43,47] Finally, some clinicians might be ambiguous about uncertainty or avoid talking about it altogether.[43,45,48] Surrogates report that uncertainty affects their decision-making, causing them to err on the side of giving the patient more time before deciding.[43] The "wait and see" approach can occasionally lead to the resolution of uncertainty, but it also might waste valuable time or prolong the dying process.[45]

How should uncertainty be approached in the neuroICU? **Box 1** summarizes recommendations for prognosticating for SABI in the presence of uncertainty. Some clinicians choose to approach uncertainty by projecting absolute certainty to avoid giving false hope; although this removes the uncertainty from the conversation, it has the effect of increasing the optimistic bias surrogates have regarding patient prognosis and forging mistrust and suspicion regarding the clinician's prognosticating capabilities.[43,44,49] Clinicians and surrogates in a multicenter qualitative study in critically ill TBI patients both found that acknowledging uncertainty explicitly reduced frustration.[43] In the same cohort, surrogates reported an unfulfilled need for clinicians to acknowledge the association between uncertainty, hope, and optimism.[48] Offering a time-limited trial during a challenging medical decision can help reduce uncertainty for family members[50]; here, the clinician and surrogates decide together to continue treatment for a defined period of time to explore if the patient improves or worsens. This option has several advantages: it preserves hope that a patient might respond to treatment, allows family members to remain involved with treatment decisions, and reduces conflict between the clinical team and family.[50]

Box 1
Summary of recommendations for prognosticating for severe acute brain injuries

This box shows recommendations for practicing family- and patient-centered prognostication in the presence of uncertainty.

Suggestions for Neuroprognostication

- Acknowledge uncertainty when prognosticating
- Give numeric estimates if possible and use population-based language
- Avoid using prognostic scales for individual prognostication
- Practice prompt and consistent communication with families and surrogate decision-makers; use shared decision-making; elicit and include patient values and preferences
- Include expert knowledge from the entire clinical team (neurocritical care plus neurosurgery, neurology, oncology, and so forth)
- Offer emotional and family support to surrogates at all times, but particularly after "bad" news has been shared; continue to support families even after WLST
- Provide at least a 72-h treatment period before WLST decisions
- Use a time-limited trial in instances where uncertainty is high

STATISTICAL PREDICTION MODELS FOR PROGNOSTICATION

Many statistical prediction models derived from large patient populations have been developed to aid prognostication for SABI. These established and usually validated outcome prediction models, which are often scale-based, are simple to apply, disease-specific, and can offer quantitative outcome predictions based on variables pertaining to the individual patient. Despite these tempting advantages, many clinicians are hesitant to use such prediction scales because of the lack of specificity for individual patients, never including all individual detail about a patient, concern about their accuracy because they have been derived from large populations and ignore outliers, and fear of creating “false hope” when using numerical estimations.[34,37] Some have suggested that quantitative models should supersede “eyeballing” prognosis in the clinical setting because clinician judgment is subject to bias and error.[7] Although few studies have examined how outcome prediction models compare against clinician judgment in the clinical setting, one 5-center study in intracerebral hemorrhage found clinician judgment (attending physician and ICU nurses) to be more accurate than the statistical models in predicting outcome 3 months after the insult.[30] Outcome prediction scales also carry other disadvantages that make them unsuitable for use in individual patients in a clinical setting. In TBI, for example, the IMPACT model only uses admission information to estimate outcomes and does not factor in the patient’s clinical course after ICU admission, which is often prolonged.[37] In the case of stroke outcome prediction models, many were formulated before reperfusion therapies were widely used, were calibrated specifically on Western populations, and may not reflect a wider population or the efficacy of more recent advances in medicine.[7] Many investigators of prediction models caution against their use in a clinical setting for decision-making, especially around WLST, in individual patients.[51–53]

BARRIERS TO COMMUNICATION

Poor communication during prognostication was shown to exacerbate psychological distress and led to value-discordant care and prolonged the dying process.[54–56] One earlier study found that 50% of the families of ICU patients experienced breakdowns in communication with physicians.[56] Families report finding the surrogate decision-making process intense, difficult, and traumatic, and the resulting psychological distress was found to persist for months or even years in up to one-third of surrogates.[57] Poor communication also hindered the surrogates’ understanding of the diagnosis, prognosis, and treatment options for a patient and also caused mistrust and conflict between the surrogate and the clinical team.[56] **Fig. 3** outlines the downstream effects from the breakdowns in communication in the ICU, especially related to prognostication.

Although timely and effective communication is critical to prognostication, there are barriers to prognostication that affect the quality of communication offered. Clinicians must find the time and space to hold a detailed and complex conversation about the patient’s medical status and prognosis which must be translated into language the patient’s family can understand. If there are language barriers, translators must be found and used. Cross-cultural communication requires additional skill and training to manage sensitively. If multiple providers are involved with care, they should discuss their opinions regarding prognosis with each other in advance and agree on a unified message to share with the family. Whenever possible, representatives from all teams should be present during family meetings. Finally, the circumstances surrounding a family meeting are often stressful, as is the process of surrogate decision-making,

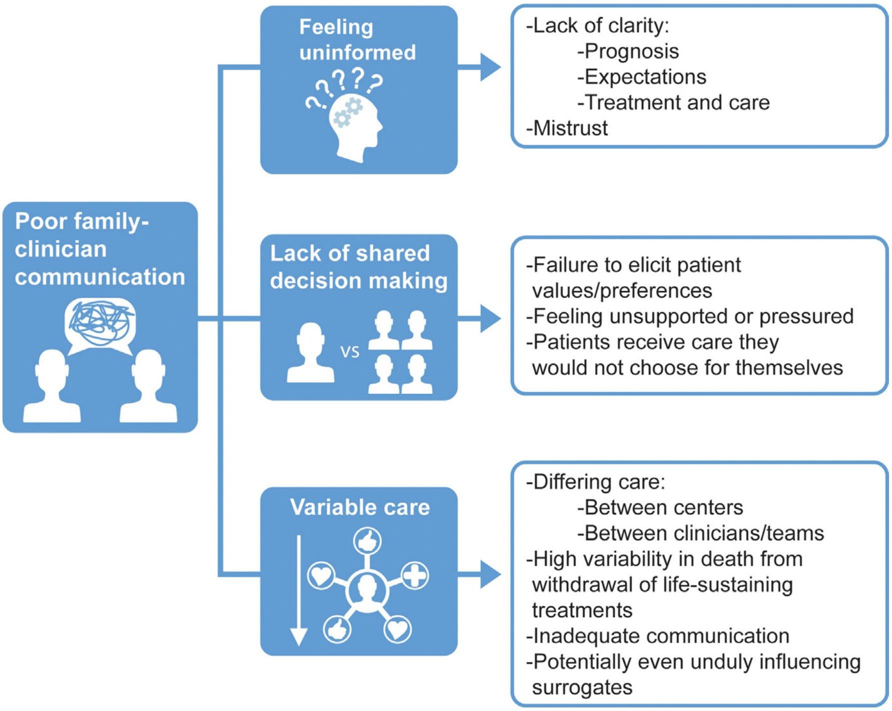

Fig. 3. Breakdowns in communication are very common in ICUs and have important downstream effects. The downstream effects of poor family-clinician communication, particularly about prognosis, are detrimental. The most important downstream effects include families feel unformed, lack of shared decision-making, and variability of care and decisions that are not related to patient or family values.

which can hinder the family's ability to understand and react to the information being provided by the clinicians.[58] Ongoing research in the developing field of neurocritical care continues to study and improve clinician-family communication in the neuro-ICU.

SHARED DECISION-MAKING AND PROGNOSTICATION

The American College of Critical Care Medicine and American Thoracic Society recommend using shared decision-making (SDM) as a guide for communication with all critically ill patients and their surrogates.[59,60] Ideally, the surrogate and clinicians work together under the SDM paradigm, which is a collaborative effort between the clinical team and patient's family to arrive at a decision that reflects the patient's values. Professional critical care societies strongly recommend SDM as it enables the surrogate to make informed decisions together with the clinician[60]. Research has shown that when SDM does not occur, it can result in value-discordant care for the patient and detrimental psychological impacts for surrogate decision-makers.[61,62] Studies of audio-recorded meetings in primarily non-neuro-ICUs have provided valuable insight about ways prognostication might be improved during family meetings. These studies have shown that family conferences generally do not meet criteria for comprehensive SDM in goals of care decisions, and sometimes do not even include discussions of long-term survival prognosis.[63–66]

SUMMARY

Owing to the devastating nature of SABI, patients are left incapacitated, placing the immense burden of decision-making on their surrogate decision-makers. Currently, there are no formally published guidelines for how prognostication should occur in the setting of neurocritical care. As a result, neuroprognostication is still considered an “art” with too much room for individual clinician interpretation and biases.[7,10,22] Further research is needed to move from art to science to uncover effective strategies of neuroprognostication in the neuroICU. If the goal of neuroprognostication is to provide patient- and surrogate-centered care, then it is important to consider what surrogates want and need from clinicians. This would include honest, concrete, consistent, and compassionate prognostication that leaves room for hope.[33–35,41,43] Although surrogates desire quantitative language from clinicians, statistical prediction models should be used judiciously when applied to individual patients and explained with population-based language and a frank acknowledgment of residual uncertainty.[7,53] Formalized guidelines may help clinicians limit bias and uncertainty during prognostication in the future.

CLINICS CARE POINTS

- Patients and their surrogates rely on clinicians for accurate prognostication. Clinicians have a duty to provide accurate and sensitive information regarding prognosis to their patient and surrogates to facilitate shared decision-making regarding goals of care decisions.
- Clinicians should refrain from prognostication for at least a 72-hour treatment period to mitigate the influence of bias and heuristics.
- Early neuroprognostication within the first 28 days following neurological injury should avoid statements that suggest patients have a universally poor prognosis.
- When possible, using numeric estimates and population-based outcome language is more patient-and surrogate-centric than qualitative prediction statements.
- All communication with SABI patients and their surrogates should utilize shared decision-making. Failure to utilize SDM leads to value-discordant care and negative psychological impacts for surrogate decision makers.

DISCLOSURE

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