

The Mohonk Report



**A Report to Congress
Disorders of Consciousness: Assessment,
Treatment and Research Needs**

*S*ixty-two percent of the American public fears losing their mental capacity.

*N*inety-six percent of the American public thinks it is important to invest in research to prevent, treat and cure disabilities.

Research!America - Non-profit organization for medical research

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National Brain Injury Research, Treatment and Training Foundation

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The task you have before you is complex, but your resolution is of vital importance. The ramifications of your findings will be widespread. A consensus paper on altered states of consciousness will surely be a significant achievement for science and medicine. It also promises to be an invaluable tool for policy makers.

Ten years ago, I was unaware of the enormous impact brain injury has on society. Since that time I have learned that it is truly a silent epidemic. I soon discovered that the lack of awareness about brain injury in Congress was rampant. So in order to give brain injury a voice among my colleagues, I decided to form the Congressional Brain Injury Task Force in 2001.

The goal of the Congressional Brain Injury Task Force is to raise awareness, champion legislation and increase funding for the entire spectrum of issues surrounding brain injury. We now have 107 bicameral members including my friend and dedicated advocate, Congressman Maurice Hinchey, who I understand will join you this evening.

The growing membership of the task force will help ensure that the critical relationship between science and public policy is steeped in reason and sound judgment – regardless of any external political events or pressures that may present themselves. We have seen in the past that passion and ideology can sometimes triumph over reason. To help combat this, a regular, free flow of information is crucial. Indeed, policy based on science, not politics, must always be our objective.

Only through continuing in close collaboration with the various governmental and non-governmental organizations will we make significant progress toward ending the silent epidemic. Brain injury is a unique issue. An epidemic so vast it is almost overwhelming and so personal its effects defy definition.

Only a strong commitment, like yours, will allow us to continue to make incredible scientific, medical and policy advances. I thank you for your continued leadership and support on behalf of persons and families affected by brain injury.

The Congressional Brain Injury Task Force eagerly awaits the results of your work.

Honorable Congressman, William Pascrell
U.S. House of Representatives
Co-Chairman, Congressional Brain Injury Task Force

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Disorders of Consciousness: Assessment, Treatment and Research Needs

A Report to Congress

Public Health Significance

Disorders of consciousness (DOC) include coma, the vegetative state (VS) and the minimally conscious state (MCS). These disorders are among the most misunderstood conditions in medicine and are an important challenge for scientific inquiry. Published estimates of diagnostic error among patients with disorders of consciousness range from 15-43%.¹⁻³ The recent highly publicized case of Terri Schiavo revealed the depth of confusion, misinformation and unfounded speculation concerning these disorders that exists among the public, the media, government officials and healthcare professionals. To some extent, these problems should have been avoidable, because well-accepted definitions, diagnostic criteria, and prognostic parameters concerning coma, VS and MCS are available in the scientific literature. Although all of these disorders involve severe alteration of awareness of self and environment, there is clear and growing evidence that subtle but important clinical differences exist between these states of altered consciousness that impact access to treatment, management decisions, outcomes, family adjustment and cost of care. Failure to recognize these differences may result in misdiagnosis, inaccurate prognosis, inappropriate treatment recommendations and improper management of fiscal and human resources.

The dearth of knowledge regarding DOC has occurred in part because public dissemination of research findings has not kept pace with recent scientific discoveries. New technologies, most notably functional neuroimaging and electrophysiologic procedures, have emerged within the last 5 years and raise new questions about the relationship between brain function and consciousness. The results of these studies, along with well-documented reports of significant late recovery, challenge the long-held view that restoration of function in the severely injured brain is not possible, and that all forms of treatment are futile in this population. Recent evidence shows that patients in MCS, for example, retain large-scale cortical networks responsible for language processing, despite their inability to communicate reliably.⁴ Such studies are expected to improve diagnostic and prognostic accuracy and help guide treatment decisions. The extraordinary case of Terry Wallis further strengthens the mandate for improvement in clinical services and research funding dedicated to individuals with severe brain injury. Mr. Wallis unexpectedly recovered language and motor abilities approximately 20 years after sustaining a severe traumatic brain injury and was subsequently found to have evidence of re-growth of brain fibers.⁵ This case, among others,^{6,7} points to the remarkable plasticity of the human brain and its potential for long-term recovery.

Consensus-Based Definitions and Diagnostic Criteria

Coma is a state of unconsciousness during which the eyes remain continuously closed and there is no behavioral evidence of awareness of self or environment.⁸ Individuals in coma lack any sign of alertness and there are no sleep-wake cycles. When occurring as a result of acquired (e.g., traumatic or anoxic) brain injury, coma is an acute or subacute condition that usually evolves to the vegetative state or a higher level of consciousness within 2 to 4 weeks in those who survive.^{8,9}

Vegetative State

In the VS, individuals maintain wakefulness without any behavioral evidence of the capacity to interact with the environment. There are periods of eye-opening that occur either spontaneously or in response to sensory stimulation but no sign of purposeful behavior. The Multi-Society Task Force on the Persistent Vegetative State proposed use of the term *persistent vegetative state* when the condition lasts longer than one month.⁹ This term is even more controversial and confusing because it has been used in a variety of ways, at different time points post-injury or sometimes implying permanence. There is consensus among neurology and neurorehabilitation specialists that the term *persistent vegetative state* should be avoided because of these ambiguities. The Task Force proposed the term *permanent vegetative state* in cases where the probability of recovery from unconsciousness is extremely low. The use of this term also remains controversial as there are some published reports of individuals who recovered consciousness after the time points that define “permanence.”¹⁰ As recommended by the Aspen Workgroup on Vegetative and Minimally Conscious States,¹¹ the term *vegetative state* should be applied when the diagnostic criteria are met and the diagnosis should be accompanied by a description of the type of injury (traumatic or non-traumatic) and the length of time since onset as both of these factors carry prognostic weight.

Individuals in VS may move in a nonpurposeful manner. Smiling, grimacing, tearing, grunting, moaning may occur but may not be indicative of subjective awareness of environmental events, emotional processing or attempts to communicate. Individuals in the VS generally do not visually track or fixate on objects, a capacity requiring some preservation of the cortical-subcortical visual network. Often, fixation and sustained visual pursuit are early signs of the transition to low levels of conscious awareness, such as the MCS.

Minimally Conscious State

The minimally conscious state is a recently defined condition first described by the Aspen Workgroup.¹¹ MCS refers to a condition of severely altered consciousness in which minimal but definite behavioral evidence of awareness of self or environment is demonstrated. MCS usually exists as a transitional state reflecting either neurologic improvement from coma or VS, or neurologic decline as in neurodegenerative conditions such as Alzheimer’s disease. A primary objective of the Aspen Workgroup in recommending this term was to clearly distinguish individuals with some evidence of consciousness from those who demonstrate no evidence of cognition or purposeful behavior (e.g., coma, VS). The diagnosis of MCS is based on the presence of one or more behavioral responses discernible on clinical assessment. These responses are characteristically inconsistent in MCS, but must be shown

to occur on a reproducible or sustained basis. Serial assessment is often required before the diagnosis of MCS can be made because of the degree of response inconsistency associated with this condition.

Emergence from MCS

Criteria for the upper boundary of MCS, distinguishing MCS from higher levels of consciousness, are required to indicate emergence from MCS. This clinical boundary is somewhat more arbitrary because there is no single clinical dimension that easily delineates higher levels of consciousness. The Aspen Workgroup proposed the following operational criteria for emergence from MCS.¹¹ At least one of the following criteria must be present to establish emergence:

- Functional interactive communication using verbalization, writing, signaling or augmentative communication devices. At a minimum, the patient must be able to answer 6 out of 6 basic yes/no questions on 2 separate occasions regarding personal or environmental orientation (e.g., Are you sitting down?) or,
- Functional use of objects (demonstrating the ability to appropriately use 2 different objects on 2 consecutive evaluations, e.g., bringing comb to head or pencil to paper).

Prognosis

Prognosis in DOC depends on the cause of brain injury and the length of time since onset. Outcomes of interest typically include recovery of consciousness (specific to individuals in VS) and the nature and degree of long-term functional disability (VS and MCS). Following an exhaustive review of the world literature, the Multi-Society Task Force calculated the probability of recovery of consciousness at various time points across the first year post-injury in individuals with traumatic (e.g., falls, motor vehicle accidents) and non-traumatic (e.g., cardiorespiratory arrest, intracranial hemorrhage) injury to the brain.⁹ Approximately 35% of individuals who remain in VS for 3 months following traumatic brain injury will recover consciousness by 12 months post-injury. Among this group, roughly 20% will be left with severe disability while the remaining 15% will achieve moderate to good outcomes. In those who fail to recover consciousness by 3 months, 35% will die and the remaining 30% will still be in VS at 1 year post-injury. Outcomes are significantly less favorable for individuals in VS due to non-traumatic causes. At 3 months, the probability of subsequent recovery of consciousness is typically less than 10%. Approximately 50% of this group will die during the ensuing 9 months and the other half will remain in VS.

Informed by the Task Force report, the American Academy of Neurology (AAN) published a practice guideline¹² that established temporal parameters for determining when VS should be considered permanent:

<u>Etiology</u>	<u>Temporal Criterion</u>
Traumatic brain injury	After 12 months
Non-traumatic brain injury	After 3 months
Congenital malformations	After 3 to 6 months
Metabolic disease	After 1 to 3 months
Degenerative disease	After 1 to 3 months
Anencephaly	At birth

There is a growing body of evidence that suggests that individuals in MCS, relative to those in VS, have a longer window for recovery and may achieve more favorable outcomes by one year post-injury.¹³⁻¹⁵ The table below compares the degree of functional disability at one year post-injury between individuals diagnosed with traumatic and non-traumatic VS and MCS following admission to an acute rehabilitation center. The values represent the percentage of individuals within each diagnostic subgroup that fall within the disability severity categories of the Disability Rating Scale.¹² As can be seen from the table, individuals in MCS due to TBI generally have better recoveries.

<u>Level of Disability</u>	<u>VS TBI</u>	<u>MCS TBI</u>	<u>VS NTBI</u>	<u>MCS NTBI</u>
None to moderate	4	27	0	
0				
Moderate to extremely severe		53	50	33
70				
Vegetative to extremely vegetative	33	0	60	10
Dead	10	0	7	
20				

Key: VS TBI = traumatic vegetative state; VS NTBI = non-traumatic vegetative state; MCS TBI = traumatic minimally conscious state; MCS NTBI = non-traumatic minimally conscious state.

Incidence and Prevalence of Vegetative State (VS) and Minimally Conscious State (MCS) in the U.S.

Accurate estimates of the incidence and prevalence of disorders of consciousness are challenging to obtain for several reasons. First, it is difficult to find persons with these disorders across the many different locations where they receive care, and to follow them over time to see if they improve. In addition, the lack of International Classification of Diseases (ICD) diagnostic codes for MCS makes it difficult to track the number of cases using currently available data. Finally, the prevalence of both the VS and MCS is influenced by survival, which is dependent upon access to care, quality of care and decisions to withdraw care.

As a result of these challenges, knowledge of the epidemiology of DOC is extremely limited. It is estimated that at least 4,200 new individuals with the VS are diagnosed each year in the US.¹⁷ The incidence of new cases of MCS, including the number of persons who transition from VS to MCS, has not been determined. Regarding the prevalence, published estimates suggest that approximately 315,000 Americans are living with a disorder of consciousness, including 35,000 in VS⁹ and 280,000 in MCS.¹⁸ An estimated 40 percent of persons with DOC are children.¹⁸ These figures most likely under-represent the frequency of occurrence of VS and MCS because of the lack of surveillance in subacute settings in which most of these individuals reside. Detailed information about persons with VS and MCS by age, sex, and cause of the disorder has not been reported.

Consequences of the Current System of Care and Barriers to Improving Knowledge and Practice

The structure of the existing healthcare system does not adequately address the complexity or chronicity of problems that impact patients with very severe brain injury and their families. This situation negatively impacts the quality of clinical care and constrains much-needed research in this area. Moreover, rules and regulations governing access to care, scope of services and duration of benefits vary considerably state to state preventing a coherent approach to the investigation and treatment of brain injury.

The following section describes the typical course of treatment that follows severe brain injury and identifies inherent problems that compromise clinical care:

Clinical care

Following injury, patients are initially admitted to a trauma center or acute care hospital where life-saving measures are implemented. The length of stay in these settings is usually between 7 and 14 days.

Problems:

- The focus of treatment is primarily on medical stabilization, often to the exclusion of less urgent problems which may negatively impact subsequent recovery of function.
- Trauma center and acute care staff often have limited training in diagnostic and prognostic assessment, yet, they are responsible for establishing the initial diagnosis and prognosis which heavily influence treatment decisions in the short and long-term.

Subsequent to medical stabilization, patients are transferred to one of three care settings, depending on prognosis, insurance coverage, hospital admission criteria and bed availability.

In many cases, transfer to an acute inpatient brain injury rehabilitation center is recommended after completion of the acute care stay. The focus of treatment in this setting is twofold: to promote recovery of cognitive, behavioral and social function and to prevent injury-related complications.

Problems:

- Few rehabilitation facilities exist that specialize in the assessment and treatment of patients with DOC.
- There are increasingly stringent federal and local criteria for authorization of acute inpatient brain injury rehabilitation. For example, some insurance policies state that patients must be conscious and/or able to actively participate in treatment in order to qualify for rehabilitation services.
- The typical length of stay in acute rehabilitation settings is 4-5 weeks. This time frame is too short to establish a reliable prognosis, conduct systematic treatment trials and adequately educate and train family members.
- There are no recognized standards to guide the nature or schedule of assessment. Consequently, patient evaluations may be inadequate and formal assessment procedures may be discontinued prematurely.
- There are no available treatment guidelines because of the lack of sufficient research concerning the effectiveness of rehabilitation.

Patients who are not authorized or accepted for acute inpatient rehabilitation are frequently transferred from the acute care setting directly to a skilled nursing (SNF) or long-term care (LTC) facility. Lengths of stay vary ranging from a few months to many years. The general aim of treatment in these settings is to manage long-term care needs although there may be some ongoing emphasis on promoting recovery of function if continued recovery can be documented.

Problems:

- SNF's and LTC's have a broad mix of patients with disparate treatment needs resulting in limited focus on the unique needs of patients with brain injury.
- Most clinical staff do not have specialized training in assessment and treatment procedures required for management of patients with severe BI.
- Patients may experience significant changes in clinical status which may go undetected once expert assessment is unavailable.
- Such facilities are typically unable to provide frequent and intensive medical oversight or rehabilitation therapies due both to level of reimbursement and level of staff expertise.
- There is no mechanism to allow patients to move back and forth between different levels of care as new treatment needs arise. For example, a patient in a skilled nursing facility who requires a short-term stay to address a particular diagnostic or treatment question at a specialized brain injury center may lose his/her bed, if transferred.

Many patients eventually return home following discharge from the settings described above. In some cases, facility-based care is discontinued within weeks of the injury and family members are forced to assume the burden of care. This is particularly problematic as severe brain injury is associated with dramatic medical, emotional, social and economic stressors.

Problems:

- Access to specialized professionals/care may be completely lost. Hospital follow-up rarely extends beyond 12 months and there is no coordinated mechanism that allows family members, professionals and facilities to maintain communication and address new issues across the life span.
- Significant changes in clinical status and treatment needs commonly occur outside of a hospital setting and may go undetected.
- The burden and cost of care engenders unexpected changes in family routines and roles often leading to divorce and disintegration of the family unit.

Research

The current system of care also presents significant obstacles to research. The pace of research has been hampered by numerous logistical problems while policy-related barriers prevent the study of some important research questions entirely. Impediments to research ultimately impact the clinical care of all patients who sustain severe brain injury.

Two recent evidence-based reviews of the effectiveness of treatments utilized in patients with DOC concluded that there is insufficient data to recommend for or against the use of any particular treatment intervention.¹⁹⁻²⁰ Some of the systemic factors that limit the extent and quality of research are listed below:

- Scientific expertise is centralized in academic centers and not in SNF or LTC centers where most patients of research interest are located.

- There is no organized method of surveillance to document and track incidence, prevalence, treatment efficacy, cost of care or long-term functional outcomes.
- The patient population is too widely-dispersed to “capture” potential subjects for epidemiologic and longitudinal outcomes research.
- Research grants are often insufficiently funded to cover the costs of “holding” beds occupied by patients in SNF/LTC’s while study protocols are carried out in academic centers. Moreover, the routine care costs of such patients while enrolled in research are typically not covered by health insurance and are beyond the budgetary scope of most research grants.
- There are strong disincentives for non-academic centers to participate in research (e.g., loss of bed revenue for transferred patients, no guarantee that center will be credited for participation in publications and press releases).

The imperfect prevalence data summarized above highlight the urgent need for epidemiological studies to accurately determine the incidence and prevalence of VS and MCS, to identify where, how, and at what cost these individuals are being cared for, and to monitor clinical changes over time. It is especially important to know how many individuals are in MCS and have a “life of the mind,” but are misdiagnosed as being in VS.²¹ The prospect of such individuals harboring consciousness but being misidentified or simply ignored because of the perceived futility of additional longitudinal assessment is ethically untenable. Lack of access to specialists and specialized care centers also perpetuates the historic disregard of this marginalized population.²²

Because there are no current standards to guide the timing or nature of clinical assessment and treatment, prognostic error is influenced by the extent to which clinicians can systematically distinguish MCS from VS. This problem is compounded when patients are transferred from acute care centers to long-term residential facilities that are ill-equipped to track their condition as it evolves. Identifying the scope of need is the first step in the rational allocation of clinical and research resources for these individuals and their families. Epidemiologic and treatment research is required to inform recommendations regarding appropriate assessment procedures (e.g., which, if any, ancillary technologies should be used to support the clinical diagnosis) and can help determine who is qualified to conduct these assessments. Providing the opportunity for ongoing reassessment accomplishes multiple objectives and affirms “neuro-palliative” goals of care.²³ Periodic reassessment allows for timely modification of rehabilitative interventions, provides updated diagnostic and prognostic information that can help surrogates make critical treatment decisions^{24, 25} and facilitates enrollment in clinical trials. Such determinations are the purview of families in light of the patient’s values and preferences and consistent with applicable law as determined in *Cruzan* and the Patient Self-Determination Act of 1991.²⁶

It is critical that sufficient funding be made available to support a translational research agenda. Advancing this agenda will require the collaboration of neuroscientists, rehabilitation specialists and others, and points to the critical need to foster and develop relationships between rehabilitation facilities, nursing homes and academic medical centers. Incentives which foster such collaborations through grants, requests for proposals, or graduate medical education funding should be incorporated into novel healthcare policies that encourage linkages across these venues. Mechanisms for obtaining surrogate consent should also be considered so that research involving this vulnerable, decisionally-

incapacitated population can proceed.²⁷ Caretakers and practitioners should also have free access to training venues and expert consultation to develop a better understanding of diagnosis, prognosis and treatment indications.

Recommendations: Improving Health-Related Outcomes and Advancing the State of the Science

The current healthcare system for individuals with DOC, as described above, is fragmented, and the concentration of expertise about these conditions is located far from the concentration of the patients themselves. Moreover, as discussed, there is little communication among components of the system, and barriers are present that hinder patient movement among system components. The current clinical infrastructure is an obstacle to effective patient care as well as to rigorous research. We propose to create a structured network of institutions involved in the care of individuals with DOC, in which communication and dissemination of expertise is enhanced, necessary patient care is provided with movement among appropriate facilities, and research is facilitated. The proposed network can immediately facilitate research to improve the state of diagnosis, prognostication, and treatment. This network can also support clinical demonstration projects that address the appropriate site of care for such individuals in terms of both outcomes and costs. In other words, the network infrastructure created for research will simultaneously support clinical demonstration projects. The proposed network allows the impact of these demonstration projects to be evaluated so that future policies affecting the organization and financing of care can be evidence based. Below we describe the key elements of the proposed system, the benefits it can be expected to provide, and how it should be financed and overseen.

The proposed network includes 3 types of participating institutions or care sites. At the first level are the sites in which most individuals in long-term VS and MCS reside: skilled nursing facilities and private homes using family and community health care resources (we use SNFs hereafter to stand for the both of these residences). The second level consists of acute rehabilitation centers (ARCs) with demonstrated expertise in brain injury rehabilitation and experience in clinical research. The third level consists of specialized research institutions (Centers of Research Excellence - COREs), frequently linked to academic medical centers, which have access to cutting edge research technology and advanced expertise in research design. Each ARC in the network would be linked to multiple SNFs, such that it is linked with approximately 50 patients with DOCs. This nationwide network of care would consist of three to five COREs, 10 – 15 rehabilitation centers, and their linked SNFs and private homes.

The Network's Support of Research

The ARCs would be responsible for longitudinal data collection on the patients in the linked SNFs, using a core database shared by all network centers. The database would contain basic clinical descriptors of the patients, periodic standardized functional assessments, and data on care provided, medical complications, and costs. Additional research would be built onto this infrastructure, making use of the database to identify appropriate research candidates. This additional research could be proposed by any member of the network and

occur where the patient resides, or after transfer to the ARC or CORE. The COREs, in particular, may often need to transfer patients to their sites for study because of the limited portability of many of the sophisticated neurophysiologic tools employed. Such a system allows for the collection of long-term outcome data on a large sample of patients with DOCs, as well as their efficient recruitment into research protocols related to rehabilitation services, family coping, and/or the impact of emerging technologies on patient care.

The following illustrate some of the research themes that could be addressed by such a network:

- Incidence and predictors of late recoveries from VS and MCS
- Neurophysiologic heterogeneity within VS and MCS patients (as revealed by emerging technologies) and its relevance to diagnosis, prognosis, and response to treatment
- Regional and institutional variations in the care provided
- Medical complications experienced and costs incurred
- Factors that contribute to family decisions about continuation vs. withdrawal of care

The Network's Support of Clinical Demonstration Projects

The proposed system is ideal to support not only the conduct of clinical demonstration projects, but also the evaluation of their impact, in support of informed policy decisions. Each participating ARC would be required to have substantial expertise and capacity to provide assessment, treatment, clinical consultation, and staff and family training, through a combination of in-person consultation and telemedicine. SNFs would have the incentive to participate in the network because it would allow them to access these training and support services, and also because the adverse financial impacts of patient transfers for clinical consultation or research would be softened (see below). ARCs would have an incentive to participate because it would facilitate their ability to follow patients with DOCs, and admit them for needed services without undue financial risk (again, see below).

The specific nature of the clinical demonstration projects would be based on merit review. The following are examples of likely demonstration project models, which would be evaluated in terms of their impact on costs, clinical outcomes, and family adaptation:

- Providing an initial period of intensive medical and functional evaluation in a high-intensity rehabilitation environment, prior to placement in a SNF
- Providing a periodic expert reevaluation on a standardized schedule, coupled with a structured review with family members of updated diagnostic and prognostic information
- Providing routine clinical consultation and staff training within the SNFs and private homes

The large number of participating SNFs in the network, and the ongoing data collection regarding clinical outcomes, costs, and medical complications, allow rigorous evaluation of the impact of proposed demonstration projects. Any of these interventions could be

implemented randomly in some but not all SNFs, or in a staggered fashion, so that their costs and outcomes can be compared to “standard care.”

Financing the Networks

The proposed networks would be financed through 3 separate funding mechanisms. First, we propose that NIDRR and NCMRR be charged with supporting the basic research infrastructure funding for these networks, through a center grant mechanism. Institutions would apply for CORE funding, based on their track record in the study of DOC, their expertise in research design, and their access to emerging technology. Each CORE would also be required to contain expertise in the ethical and social science issues that are so critical in this population. CORE funding would support an interdisciplinary administrative and scientific structure, and basic work to refine the methods related to applying these emerging technologies to patients with DOC. ARCs would be required to demonstrate substantial expertise in DOC and brain injury rehabilitation, prior experience with effective management of data collection, and to document agreement from a critical mass of SNFs of their willingness to collaborate. Their infrastructure funding would support collection and analysis of the standardized data described above from their linked SNFs. Thus, for both the COREs and rehabilitation centers, the primary requirement for funding would be demonstrated clinical and research capacity. The funding required to support this research and clinical infrastructure is estimated at \$25 million/year.

A second layer of funding, also provided by NIDRR and NCMRR, would be available to support specific research projects conducted within the network infrastructure. Investigators within any of the participating network institutions would be eligible to apply for project funding on a competitive basis, to address focused scientific questions. These could include basic science studies of underlying brain function in these disorders as well as studies of the efficacy of rehabilitation treatment interventions. The funding required for specific projects is estimated at \$10 million/year. In addition, other federal agencies including CDC, NIDRR, NCMRR and other NIH institutes (e.g., NINDS, NINR) would be encouraged to provide funding to support additional projects that can benefit from the existence of the infrastructure supported by NIDRR/NCMRR. It is recommended that the Interagency Committee on Disability Research (ICDR) be charged on an ongoing basis with examining how each participating agency can contribute to, and benefit from, the proposed network.

The third layer of funding would be provided by CMS to support clinical demonstration projects (including both the cost of the currently non-approved care, and the cost of evaluating its impact), and also to reduce the financial risks faced by both SNFs and acute rehabilitation centers and COREs associated with research-related patient transfers. Specifically, this should involve payments to SNFs for maintaining a bed for patients who are temporarily at another institution for clinical evaluation or research, as well as payments for the basic clinical care required by such patients while they reside at rehabilitation centers or COREs for research participation (e.g., basic nursing care, maintenance therapy as needed, required medications and tube feedings, etc.). Supporting clinical demonstration projects and supporting the clinical care of research subjects is estimated to require \$15 million annually.

The proposed network can address many of the obstacles to progress itemized above. It assembles a critical mass of patients for study, despite their decentralized locations. It makes available more advanced rehabilitation and research expertise by linking patients in SNFs and private homes with greater expertise, treatment intensity, and technology. And it allows for the temporary payment for services that are not currently reimbursed (as well as removing financial disincentives to participating clinical sites), in order that cost effectiveness can be systematically evaluated.

Conclusions

Disorders of consciousness have profound social, ethical, and economic consequences. However, research on this topic is insufficient to support rational treatment or fully informed ethical decision-making. Moreover, clinical expertise and well-organized systems to care for individuals suffering from DOC are lacking, leading to misdiagnosis, inadequate treatment, medical complications and insufficient research.

The proposed network of clinical and research facilities for this patient population will evaluate the quality and cost impacts of an organized system of clinical care and follow up— a system that can be replicated more widely if its benefits are demonstrated. By conducting a range of basic and applied research, these networks will also increase the base of evidence on which diagnostic, treatment, and ethical decision-making rest.

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Appendix

Diagnostic Criteria

Coma

All of the following criteria must be evident on bedside examination:

- No eye opening and absence of sleep-wake cycles on EEG;
- No evidence of purposeful motor activity;
- No response to command;
- No evidence of language comprehension or expression; and
- Inability to discretely localize noxious stimuli.

Vegetative State

All of the following criteria must be evident on bedside examination:

- No evidence of awareness of self or environment
- No evidence of sustained, reproducible, purposeful, or voluntary behavioral responses to visual, auditory, tactile, or noxious stimuli
- No evidence of language comprehension or expression
- Intermittent wakefulness manifested by the presence of sleep-wake cycles
- Sufficiently preserved hypothalamic and brain-stem autonomic functions to permit survival with medical and nursing care
- Bowel and bladder incontinence
- Variably preserved cranial-nerve reflexes and spinal reflexes

Minimally Conscious State

At least one of the following criteria must be *clearly* evident on bedside examination:

- Simple command-following;
- Gestural or verbal yes/no responses;
- Intelligible verbalization;
- Movements or affective behaviors that occur in contingent relation to relevant environmental stimuli and are not attributable to reflexive activity. Any of the following examples provide sufficient evidence for this criterion:
 - Pursuit eye movement or sustained fixation that occurs in direct response to moving or salient stimuli.
 - Episodes of crying, smiling, or laughter in response to the linguistic or visual content of emotional but not neutral topics or stimuli;
 - Vocalizations or gestures that occur in direct response to the linguistic content of comments or questions;
 - Reaching for objects that demonstrates a clear relationship between object location and direction of reach;
 - Touching or holding objects in a manner that accommodates the size and shape of the object.

