

Development of the Korean Academy of Medical Sciences Guideline for Rating the Impairment in the Brain Injured and Brain Diseased Persons with Motor Dysfunction

To develop an objective and scientific method to evaluate the brain injured and brain diseased persons with motor dysfunction, American Medical Association's Guides to the Evaluation of Permanent Impairment was used as an exemplar. After the motor dysfunction due to brain injury or brain disease was confirmed, active range of motion and muscle strength of affected extremities were measured. Also, the total function of extremities was evaluated through the assessment of activities of daily living, fine coordination of hand, balance and gait. Then, the total score of manual muscle test and functional assessment of impaired upper and lower extremity were added, respectively. Spasticity of upper and lower extremity was used as minus factors. Patients with movement disorder such as Parkinson's disease were assessed based on the degree of dysfunction in response to medication. We develop a new rating system based on the concept of total score.

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INTRODUCTION

The permanent neurologic impairments following traumatic brain injury and brain disease is divided into physical and neuropsychological dysfunction (1, 2). Physical impairment is further divided into impairment of upper and lower extremity and impairment of cranial nerves. To secure the rights of disabled people due to brain injury and brain disease, an objective assessment of the permanent impairment and its degree is necessary. Current Korean assessment standards for the impairment evaluation is based on over 30 different laws including Welfare Law for the Disabled, Workers' Compensation Law, etc. However, each standard with different levels of impairment or disability leads to a confusion in which an impairment or disability is diagnosed into different levels (3-5). Also, the compensation of the disability requires different forms of medical certificate for each standards with further inconvenience.

In the United States of America, there is a scientific guideline to the evaluation of permanent impairment, established by the American Medical Association (AMA) (6). Likewise, we need a guideline for rating the permanent physical impairment suitable for our cultural and social background. Thus,

as a part of developing an objective, scientific systemic standard for the assessment of physical impairment of Korea, this study aims to develop an objective and scientific evaluation tool for motor impairment with brain injury and brain disease, based on AMA Guides for Rating the Permanent Physical Impairment.

MATERIALS AND METHODS

A committee of neuro-dysfunction-pain-assessment with neurosurgeon, neurologist, physiatrist, psychiatrist, and anesthesiologist who are experienced at the impairment evaluation of brain injury and brain disease and pain was assembled. This brain injury and brain disease motor dysfunction study team comprise a third party consisting of physiatrists and neurologist. After the analysis of physical impairment assessment standard for central nervous system from *Guides to the evaluation of permanent impairment 5th edition of AMA* (6) in 2001, we planned to develop a motor impairment assessment tool for physical impairment suitable for Korea, based on the American standard. It was set as a principle that the developing physical impairment assessment tool should include

the identification of brain injury and brain disease through clinical symptoms and signs, and diagnostic studies such as brain magnetic resonance imaging, and should only be applied to the dysfunction of upper and lower extremities owing to brain injury and brain disease. In motor dysfunction such as Parkinson's disease, the degree of impairment is assessed in relation to the response to medication.

Assessment of upper extremity impairment due to brain injury and brain disease

To evaluate the upper extremity impairment due to brain injury and brain disease, manual muscle test (Medical Research Council scale) (7) is used to assess the muscle power. Muscles to evaluate include shoulder flexor, extensor, abductor and adductor, elbow flexor and extensor, forearm pronator and supinator, wrist flexor, extensor, abductor and adductor, second to fifth finger flexors, extensors, abductors and adductors, thumb extensor and oppositor. Each muscle power is graded between zero (complete paralysis) to five (normal) points, total of which is 90 points. In cases where the manual muscle test is not possible due to accompanied contracture or manual muscle test needs to be corrected for the limited range of motion, grading system of active range of motion is used. Measured active range of motion of the involved joint is scored as percentage of normal active range of motion. When normal active range of motion is 100%, maximal active range of motion of the joint is 5 point, and 0% of total ankylosis of the joint is 0 point (8). With impairment of both upper extremities, the value of both muscle power added and divided by two is used. With motor impairment of an upper ex-

Table 1. Functional tests of the upper extremity in brain injured persons

Basic activities of daily living	Score	Activities for hand coordination	Score
Feeding		Pull out a newspaper (for lateral grasp)	
Grooming and brushing the teeth		Draw a magazine which made in round (for palmar grasp)	
Care of perineum/clothing at toilet		Buttoning a shirt	
Dress upper body		Pick out coins from a purse	
Dress lower body		Washing the dishes	
Take on & off shoes		Open & close a zipper	
Carry a cup filling of water except balance problem		Count the money or cash	
Lifting a heavy object except balance problem		Tie a thick strap	
Bathing oneself		Wring a towel	
Total score		Total score	

Scores from 1 to 5 (minimum 18, maximum 180).

5, Complete independence or able to do very well; 4, Able to do but sometimes need an assistive device or observation; 3, Sometimes need a helper; 2, Almost need a helper; 1, Unable to do by oneself and totally dependent.

tremity, grasp power and fine coordination of hand are evaluated.

The total function of an upper extremity is assessed with 18 criteria of activities of daily living (ADL) (Table 1). The assessment of minute activities of daily living using both arms contains 9 criteria including feeding with spoon while fine coordination of both hand is assessed. Each criterion is assessed with scales of one to five. It is scaled as one (totally dependent or unable to do by oneself) when independent activity is impossible, and as five (totally independent or able to do very well) when capable of independent activity. The degree of spasticity due to brain injury and brain disease is assessed with modified Ashworth scale (9) and, when the functional impairment is exacerbated with spasticity, it is applied as a minus factor.

Assessment of lower extremity impairment due to brain injury and brain disease

To evaluate the lower extremity impairment due to brain injury and brain disease, manual muscle test (Medical Research Council scale) (7) is used to assess the muscle strength. Muscles to evaluate include hip flexor, extensor, abductor, adductor, internal and external rotator, knee flexor and extensor, ankle dorsiflexor, plantar flexor, invertor and evertor, and toe flexors and extensors. Each muscle power is graded between zero to five points, total of which is 70 points. Like the impairment of upper extremity, in cases where the manual muscle test is not possible due to accompanied contracture or manual muscle test needs to be corrected for the limited range of motion, grading system of active range of motion is used. With impairment of both lower extremities, the value of both muscle strength added then divided by two is used. The total functional assessment of lower extremity includes changing position and maintaining balance, walking and moving outside and otherwise (Table 2). When orthosis is necessary for gait, the kind of orthosis and the degree of dependency are

Table 2. Functional mobility tests of the lower extremity in brain injured persons

Functional mobility items	Score
Sit up	
Rise to standing position	
Rising from the floor	
Transfers	
Walking on inside level surface	
Walking on outside level surface	
Standing on one leg	
Go up stairs and/or ramps	
Go down stairs and/or ramps	
Use transportation	
Total score	

Scoring system (1-5) is the same as tests of the upper extremity (minimum 10, maximum 50).

evaluated. Also, when the muscle spasticity of lower extremity with brain injury and brain disease exacerbates the disability, it is applied as a minus factor.

RESULTS

Timing of disability evaluation for the brain injured persons

The primary assessment of motor dysfunction due to brain injury and brain disease is performed at least one year post-injury when the functional improvement is not noted even after six or more months of rehabilitation treatment. With severe brain injury, impairment assessed within one year of injury needs to be re-evaluated after two years. For patients with Parkinson's disease or motor dysfunction, drug-on state maintained over 50% of a day with adequate (best) medication is used as the assessment state.

Criteria for rating the motor impairments of upper extremities relating to central impairment

As a criterion for impairment of upper extremity in brain injury and brain disease, the basic normal score is total 180 points with 90 points of muscle test and 90 points of functional test. With both upper extremities impairment, muscle power for each upper extremity is added and divided into two. Impairment rating is divided into four levels like the standard for AMA. Level one is very severe upper extremity impairment of 18-73 points with 0-34% of normal function remaining and level four is minimal upper extremity impairment of 98-109 points with 80-99% of normal function remaining.

Table 3. Criteria for impairment of upper extremities in brain injured persons

Selection criteria	Total scores
Muscle strengths of upper extremities	90
Active ROM scores of upper extremities for only persons with joint contractures*	90
Spasticity grade of upper extremities*	-10
Complex functions of upper extremities	90
Maximal normal values of upper extremities	180

*, Optional test.

ROM, range of motion.

Table 4. Criteria for rating impairments of upper extremities relating to central impairment

Classification	Impairment of upper extremities points (% of normal)	Rating impairments of whole persons		
		One hand (%)		Both hands (%)
		Dominant	Nondominant	
Class 1	18-73 (0-34%)	40-60%	30-45%	80% and over
Class 2	74-114 (35-59%)	25-39%	15-29%	40-79%
Class 3	115-154 (60-84%)	10-24%	5-14%	20-39%
Class 4	155-178 (85-99%)	1-9%	1-4%	1-19%

ment of 155-178 points with 85-99% of normal function remaining. Impairment rating of dominant hand, non-dominant hand, and both hands impairment in relation to whole body is decided based on the principles of the AMA Guides (Table 3, 4).

Criteria for rating the motor impairments of lower extremities relating to central impairment

For impairment of lower extremity with brain injury and brain disease, the basic normal score is total 120 points with 70 points of muscle test and 50 points of functional test. Impairment rating is divided into four levels, ranging from one to four like the standard for AMA. Level one is very severe lower extremity impairment of 10-42 points with 0-29% of normal function remaining, and level four is minimal lower extremity impairment of 98-109 points with 80-99% of normal function remaining. Since the impairment rating for lower extremity due to brain injury and brain disease is lower

Table 5. Criteria for impairment of lower extremities in brain injured persons

Selection criteria	Total scores
Muscle strengths of lower extremities	70
Active ROM scores of lower extremities for only persons with joint contractures*	70
Spasticity grade of lower extremities	-10
Complex functions of lower extremities	50
Maximal normal values of lower extremities	120

*, Optional test.

ROM, range of motion.

Table 6. Criteria for rating impairments of lower extremities relating to central impairment

Classification	Impairment of lower extremities points (% of normal)	Rating impairments of whole persons (%)	
		This study	AMA Guides
Class 1	10-42 (0-29%)	50-70%	40-60%
Class 2	43-73 (30-57%)	30-49%	25-39%
Class 3	74-97 (58-79%)	15-29%	10-24%
Class 4	98-109 (80-99 %)	1-14%	1-9%

AMA, American Medical Association.

than other impairments, it was up-regulated than the AMA Guides (Table 5, 6).

DISCUSSION

Physical impairment is a state of functional or structural impairment of health in a person. Thus, impairment is a medical concept that needs medical evaluation. Also, the permanent physical impairment means the state in which the symptom and sign are fixed after enough time needed for treatment and any further treatment would be futile in changing the current state of health. This impairment limits a person in activities of daily living, and the degree of functional restraint is expressed as impairment rate (3).

In Korea, the compensatory disability rating standard in relation to occupation is the estimation of loss of efficiency. It is well established in McBride's disability evaluation (10) that it is used as the standard in the fields of law enforcement and insurance-related compensatory work. However, McBride's disability evaluation was enacted in 1963 that is different from current state of Korea. Also, it is not adequate to be used as the standard for impairment rating for brain injury and brain disease related motor dysfunction (3, 11). The Guides to the Evaluation of Permanent Impairment of AMA uses medically established impairment rate with high objective and scientific reliability (6).

In this study, the scientific and rational guideline for impairment rating of AMA is used as an exemplar to evaluate motor dysfunction of the brain injury and brain disease. For more objective evaluation of motor dysfunction, functional assessment tools as well as basic physical examination and neurophysiological assessment are used. The impairment rating of upper extremity after brain injury or brain disease is divided into four levels like that of AMA Guides. The AMA Guides evaluates the functional limitations of upper extremity due to diseases of central nervous system according to its influence on the activities of daily living (6). It is believed that the basic tasks of everyday living depend on dexterous use of the dominant upper extremity. The impairment rating level is determined from neurological examination of motor strength, coordination, and dexterity. Functional activities such as buttoning a shirt, lacing shoes, writing, and performing a pegboard task can assess abilities needed for daily activities (6). Also, impairment of lower extremity relating to the injury of central nervous system is assessed as station and gait impairment (6). In other words, the degree of independent standing, independent gait, walking inside and outside, climbing stairs and station and gait function of legs is evaluated to assess its impairment. However, the problem with criteria for rating impairment of upper and lower extremity relating to central impairment in AMA Guides is that each standard without specific explanation may lead to different conclusion of impairment rate, depending on the eval-

uator (3, 4, 11).

This study aims to develop a physical impairment assessment tool to resolve such problems. After thorough evaluation of muscle power, range of motion, spasticity, activities, and whole function of upper and lower extremities in brain injury and brain-diseased people with motor dysfunction, the result labelled as points to determine each impairment level. To further assess the impairment of upper extremity in detail, basic activities of daily living are divided into specific criteria. For the evaluation of fine coordination of hands, several functional assessment tools are included. The total function of lower extremity assessment is based on the specific details of balance and gait function. In addition, with respect to the Korean culture, standing up from floor, using public transportation criteria are added (12). Each assessment criteria is given five-point scale according to the performance. National pension impairment assessment provision attached chart #1 (13) is used after considerable change to increase the reliability of criteria in assessing upper and lower extremity function, since it is described as the functional assessment tools of national pension rules of disability judgement attached chart #1 enacted according to the Law of National Pension #58 and its Enforcement Ordinance #41-4. Each of total points of muscle power in upper and lower extremity as well as that of functional assessments is used to decide rating impairment. According to the rules of degree of disability in the Law of Welfare of Disabled People (14), this grading system is reverse to AMA Guides. Impairment class one is severe impairment with less than 34% of normal function remaining for upper extremity and less than 42% of normal function remaining for lower extremity. Impairment class four indicates minimal impairment with 85-99% of normal function remaining for upper extremity and 80-99% of normal function remaining for lower extremity.

The advantage of newly developed physical impairment assessment standard in this study is that more objective and rational determination of rating impairment in motor dysfunction of upper and lower extremity is possible. Also, while the AMA Guides divided impairment into four classes, the newly developed class of impairment is expressed in percentage and can be classified into six to eight levels of impairments.

The time of evaluation of impairment due to brain injury and brain disease is when the symptom and sign are fixed after enough treatment. The guides to the evaluation of permanent impairment of AMA states that the maximal medical improvement should be done when the change of impairment rate is less than three percent despite further treatment of one year (5). By this period, the impairment is assumed to be permanent. Current national pension rules of disability judgement in the Law of Korean National Pension (13) states this maximal medical improvement as the recovery date of impairment. This period varies depending on the brain injury and brain disease, however, except for vegetative states, it is to be at least 12 months in most of the cases, after the

initial date of medical examination (13). In the rules of degree of disability in the Law of Welfare of Disabled People (14), the maximal medical improvement is to be more than six months after developing the injury or disease which is shorter than that of AMA Guides. There is a complementation of a re-evaluation after 2 yr so that the possible change after 6 months of injury or disease can be confirmed. It is to give more faster welfare benefit to the disabled people. Nevertheless, it has in reality been the cause of many problems in defining the impairment level. It should be stated in all forms of physical impairment assessment standards that the period of maximal medical improvement should be assessed after 6 months of enough rehabilitation since early rehabilitation and the period of rehabilitation can make difference. In patients with movement disorders including Parkinson's disease, response to medication can be variable. If performance efficiency is more than 50% greater in medication on-state than off-state, physical impairment should be made when the drug response is maximal (15).

For one upper extremity impairment due to the dysfunction of central nervous system, dominant and non-dominant upper extremity function is separately assessed to estimate impairment rate in the AMA Guides (6). However, this has problems. First, it is difficult to define a dominant hand after the brain injury. Second, it might work as a factor to decrease the effect of rehabilitation, even though activities of daily living can be improved with enough rehabilitation treatment. But, considering the nature of Korean culture in which using left hand is regarded as a disability and most people tend to use the right hand as the dominant one, the up-regulation of the impairment rate of dominant upper extremity is decided.

Limitations to further application of this physical impairment assessment are as follows. First, the effectiveness might be compromised since the time needed to evaluate increases when many fields of assessment are included. Second, it is necessary to educate the disability evaluating specialists for more efficient evaluation of the impairment and/or disability. However, in case of general hospitals with physical and occupational therapists, brain disease and brain injury impairment evaluating specialists can colligate the result after the initial assessment is done by the therapists with minimal problem. Third, verification steps for this assessment tool are required. To resolve these problems, further studies on the correlations between late physical impairment assessment tools and newly developed physical impairment assessment standard and between late impairment level of AMA Guides and new impairment assessment standard would be helpful.

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