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What We Learned from The History of Multiple Sclerosis Measurement: Expanded Disability Status Scale

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ABSTRACT

Multiple Sclerosis (MS) is often seen in young adults and known to cause both physical and cognitive disability, and it is quite important to make an objective assessment of the physical-cognitive disability status of the patients. The first scale that assesses the physical disability in MS cases, the Disability Status Scale (DSS) elaborated in 1983 and transformed into the Expanded DSS (EDSS). It has been in use since 1983 without much change, which is one of its most significant advantages. It includes all functional systems (although with some shortcomings) that may be affected in MS and reflects the clinical status as a number, which is quite valuable. Although there may be differences between EDSS practitioners, it has been in use for more than 30 years and it can objectively display the difference between a patient's clinical picture 20 years ago and today, which can be said for only a small number of scales. This shows the importance of using the same scale for diseases that require long-term monitoring such as MS. In conclusion; it is a consensus that EDSS will not undergo major changes so that its greatest advantage can be preserved. Also, the consensus in the available literature is that EDSS will never lose its value.

Keywords: Expanded disability status scale, multiple sclerosis, physical disability, progression

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INTRODUCTION

As suggested by the World Health Organization, outcomes of a chronic disease should be addressed in three fundamental aspects. The first aspect relates to the damage caused by the disease, which means abnormal neurological findings in case of neurological diseases. The second aspect is the assessment of the physical and cognitive disability caused by the disease. Lastly, a chronic disease should be studied in terms of its effects on the patient, patient's relatives, and even the community, which is usually ignored.

Multiple Sclerosis (MS) is a chronic neurological autoimmune disease which presents with both axonal injury and demyelination, often with attacks, but sometimes with progression from onset. MS is often seen in young adults and known to cause both physical and cognitive disability, and it is quite important to make an objective assessment of the physical-cognitive disability status of the patients. In this sense, there are certain points that need to be considered when creating or developing a physical disability scale for MS. First of all, it is crucial to have a comprehensive understanding about the role of MS in neurological function. The changes in neurological functions must be reflected in a comprehensive/all-round manner. A physical disability scale must associate the physical status with the disease in question. It should be able to exclude findings which are not related to MS and describe the general status for each patient. Although this applies to all scales, achieving a standard in terms of being easy to use for anyone, repeatable, and applicable is one of the vital criteria for MS, which is sometimes difficult to monitor.

The first scale that assesses the physical disability in MS cases, the Disability Status Scale (DSS), was developed by Kurtzke in 1954 to study the effects of the isoniazid therapy in the treatment of MS (1.2). In 1955, Kurtzke suggested that DSS is used as a disability scale in MS cases (3). The original scale consisted of 8 functional groups. Later, the term functional groups was replaced with functional systems (FS). These 8 functional systems include Pyramidal (P), Cerebellar (CII), Brain Stem (BS), Sensory (S), Bladder-Bowel (BB), Visual (V), Cerebral or Mental (Cb), and Other (O). For each functional system, "0" indicates normal neurological examination results, while the worst score is "5", which reflects neurological injury. Only the Other (O) category is not scored numerically; "0" indicates the absence and "1" indicates the presence of a particular issue. In 1965, the worst score "5" was replaced with "6" and the ceiling score for the Bladder-Bowel system was re-defined (4).

Functional Systems

Functional systems defined within the Disability Status Scale consist of 8 categories (Table 1). Functional systems are defined by categorizing abnormal findings in neurological examination and exclude non-MS-related causes of disability as much as possible. Essentially, FS involves coding the neurological examination in a disease like MS, which sometimes has quite complex examination findings, in order to express the neurological status of the patient with a number. Functional systems were first defined in a way that they would cover the entire neuroanatomy of MS by using consecutive examinations of 300 MS patients (pyramidal,

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cerebellar, brain stem, sensorial) (5).

Fundamentally, functional systems were developed to form an opinion about the frequency, spread, and severity of clinical involvement in MS cases based on neurological examination. Created in a very comprehensive manner based on the knowledge that MS plates are present in clinically silent areas as well, functional systems were later used in clinical studies and became significant measurement tools in the monitoring of the treatment process (5). Although they went through minor revisions, they maintained their place.

The scoring of DSS based on the functional systems can be seen in Table 2. Accordingly, "0" indicates normal neurological examination (1 point from cognitive functions does not affect the DSS score), while "10" indicates death due to MS, and the score increases in increments of 1. It is necessary to note that if all criteria for a grade is not met fully, the grade one below is used, which applies to both functional systems and DSS.

Shortcomings of The Disability Status Scale and Other Disability Scales

Although specific to MS, the Disability Status Scale has certain shortcomings. First of all, although the patient's status is clinically well defined, it is limited when it comes to demonstrating the severity of MS. Ambulation is not sufficiently emphasized and illuminated. Also, upper extremity functions and cognitive status are not adequately assessed. Various scales were developed in time to assess the physical disability. These include the Environmental Status Scale (6), Incapacity Status Scale (7), Ambulation Index, Scripps Neurological Rating Scale (8), Illness Severity Scale (9), Guy's Neurological Disability Scale (10), Functional Independence Measure, Cambridge MS Basic Score (11), and Expanded DSS (EDSS) (5).

Developed in 1982 and revised in 1983, the Environmental Status Scale consists of 7 parameters; actual work status, financial and economic status, personal residence or home, personal assistance required, transportation, community services, and social activity (12, 13). Each parameter is scored from 0 to 5. "0" indicates no issues, while "5" is defined as maximum support is required. The maximum score is 35. However, ESS has several significant limitations. It mostly displays the effect of MS on social life; it is insufficient in terms of demonstrating the physical restrictions of the patient, and contains many items which may influence each other. Also, it does not include an item which assesses the cognitive status.

The Incapacity Status Scale (revised in 1983): This scale consists of 16 items. The first 12 items assess the physical function, the 13th item assesses the psychological function, the 14th item assesses the cognitive function, the 15th item assesses fatigue, and the 16th item assesses the sexual function (Table 3). Each items is scored from 1 to 4. "1" indicates that the patient is slightly affected; "2" indicates that mechanical assistance is required, "3" indicates that professional assistance is required, and "4" indicates that function is lost completely. ISS has disadvantages such as it shows the disability independent from the cause, the content is non-specific, and measurement and assessment are problematic. Also, major changes in lower extremity functions are not adequately reflected in the score. In a study conducted in 1984 to compare the ESS and ISS, both of which assess disability in MS cases, validity and reliability of ESS and ISS items were found to be appropriate, while the number of items in the 16-item USS was recommended to be reduced for compatibility with statistical methods (14).

Developed by Sharrack et al. in 1996, the Guy's Neurological Disability Scale (GNDS) (10) assesses 12 areas; memory and concentration, mood and emotion, vision, speech and communication, swallowing, use of arms and hands, mobility, bladder function, bowel function, fatigue, sexual function and other problems. Each area is assessed by asking 8 "yes or no" questions to the patient. The areas of memory, mood, speech, and mobility include questions to be answered by the patient's relative or caregiver as well. Each area in GNDS is scored from "0" indicating no problem to "5" indicating severe problem. The total score varies from 0 to 60. Also, GNDS was found to be highly correlated with the Barthel index (15) which has been in use for a long time and is quite informing about the patient's daily activity (16).

Considering some aspects of DSS such as its wide assessment range and limitations related to ambulation, the 10-category DSS was elaborated in 1983 and transformed into the 20-category Expanded DSS (EDSS) (5).

The Expanded Disability Status Scale (EDSS)

Widely used to assess multiple sclerosis cases and considered to be a well-defined scale, the total score in EDSS is based on the interview held by the clinician and neurological examination. Founded upon the foundation of DSS, EDSS consists of 20 steps with increments of 0.5 (Table 4). "0" indicates normal neurological examination, while "10" indicates death due to MS. In EDSS, the score increases corresponding to the deterioration in MS and the fist score after 0 is not 0.5, but 1. After 1, the score increases with increments of 0.5 to express the clinical deterioration. While the EDSS score depends on FS between 1.0–4.0, it indicates ambulation between 4.0–8.0., and one point that should be remembered is that the EDS score cannot be lower than the score of a single FS (except for visual, mental, and bladder-bowel).

EDSS and ambulation

The ability to walk without aid is considered to be the main factor that determines the quality of life in MS cases. EDSS indicates ambulation without aid until 5.5 (500 m without aid=EDSS 4.0; 300 m without aid=4.5; 200 m without aid=5.0; 100 m without aid=5.5). According to Noseworthy, an increase of 1 point in EDSS should be considered significant when the EDSS score is below 5.5. However, Francis advocates that an increase of 1.5 points in the EDSS score is significant (17). That being said, the consensus is that an increase of 0.5 is significant when the EDSS is above 5.5 and an increase of 1 is significant when the EDSS score is equal to or more than 5.5. EDSS serves as an ambulation index at high scores. For example, EDSS 5.5 indicates a patient who can walk without aid, while a patient with an EDSS score of 6 needs unilateral help when walking, which considerably affects the patient's quality of life. Therefore, a smaller increase in cases with EDSS >5.5 is considered significant.

The assessment of ambulation in EDSS depends on the best performance of the patient without excessive effort. In clinical practice, the walking distance is usually assessed based on the patient's report and the estimation of distance varies considerably. This negatively affects the reliability of EDSS. Also, one of the important significant matters is possible differences between clinicians examining the patient in terms of EDSS assessment (18). Because some steps of EDSS are known to vary depending on the physician assessing the patient. For this reason, Amato et al. stated for the first time in 1988 that there were differences between the practitioners of EDSS and it had low reliability (19). In a later study conducted in 1991 with two institutions, the agreement between the physicians was found to be mild when the EDSS score was below 5.5, the agreement level between the physicians was found to be quite high in steps where physical disability became more easily observable (EDSS ≥5.5). It was also reported in this same study that the agreement was low for particularly sensory and mental functions. This may be explained by the subjective nature of sensory complaints and the difficulty of assessing the cognitive status objectively and in detail. In general, the difference was not more than 1 point and the rate of 0.5-point disagreements was 29% in one of the centers and 22% in the other, while the rate of 1-point

Table 1. The Disability Status Scale –functional systems

1) Pyramidal Functions; 0. Normal. 1. Abnormal signs without disability. 2. Minimal disability. 3. Mild or moderate paraparesis or hemiparesis. 4. Marked paraparesis or hemiparesis; moderate quadriparesis; or monoplegia. 5. Paraplegia, hemiplegia, or marked tetraparesis. 6. Quadriplegia. *V. Unknown.*
2) Cerebellar Functions; 0. Normal. 1. Abnormal signs without disability. 2. Mild ataxia. 3. Moderate truncal or limb ataxia. 4. Severe ataxia, all limbs. 5. Unable to perform coordinated movements due to ataxia. *V. Unknown.* *X. Used throughout after each number when weakness (grade 3 or more on pyramidal) interferes with testing.*
3) Brain Stem Functions; 0. Normal. 1. Signs only. 2. Moderate nystagmus or other disability. 3. Severe nystagmus, marked extraocular weakness, or moderate disability of other cranial nerves. 4. Marked dysarthria or other marked disability. 5. Inability to swallow or speak. *V. Unknown.*
4) Sensory Function (revised in 1982); 0. Normal. 1. Vibration or figure-writing decrease only in one or two limbs. 2. Mild decrease in touch or pain or position sense, and/or moderate decrease in vibration in one or two limbs; or vibratory (c/s figure-writing decrease alone in three or four limbs. 3. Moderate decrease in touch or pain or position sense, and/or essentially lost vibration in one or two limbs; or mild decrease in touch or pain and/or moderate decrease in all proprioceptive tests in three or four limbs. 4. Marked decrease in touch or pain or loss of proprioception, alone or combined, in one or two limbs; or moderate decrease in touch or pain and/or severe proprioceptive decrease in more than two limbs. 5. Loss (essentially) of sensation in one or two limbs; or moderate decrease in touch or pain and/or loss of proprioceptive for most of the body below the head. 6. Sensation essentially lost below the head. *V. Unknown.*
5) Bladder-Bowel Functions (revised in 1982); 0. Normal. 1. Mild urinary hesitancy, urgency or retention. 2. Moderate hesitancy, urgency, retention of bladder or bowel, or rare urinary incontinence. 3. Frequent urinary incontinence. 4. In need of almost complete constant catheterization. 5. Loss of bladder and bowel function. *V. Unknown.*
6) Visual (Optical) Functions; 0. Normal. 1. Scotoma with visual acuity (corrected) better than 20/30.2. Worse eye with scotoma with maximal visual acuity (corrected) of 20/30 to 20/59.3. Worse eye with large scotoma, or moderate decrease in fields, but with maximal visual acuity (corrected) of 20–60 to 20–99 4. Worse eye with marked decrease in fields and maximal visual acuity (corrected) of 20/100–20/200; grade 3 plus maximal acuity of better eye 20/60 or less. 5. Worse eye with maximal visual acuity (corrected) less than 20/200; grade 4 plus maximal acuity of better eye of 20/60 or less. 6. Grade 5 plus maximal acuity of better eye of 20/60 or less. *V. Unknown.* *X. Added to grades 0 to 6 for presence of temporal pallor.*
7) Cerebral (Cognitive) Functions; 0. Normal. 1. Mood alteration only (does not affect DSS score). 2. Mild decrease in mentation. 3. Moderate decrease in mentation. 4. Marked decrease in mentation (chronic brain syndrome-moderate). 5. Dementia or chronic brain syndrome-severe or incompetent. *V. Unknown.*
8) Other Functions; 0. None. 1. Any other neurologic findings attributed to MS (specify). *V. Unknown.*

Table 2. Scoring of the Disability Status Scale

0	0 from all FS (normal neurological examination, cerebral 1)
1	1 point from any FS or more than one FS
2	2 from one or two FS, 0 or 1 from other FS (2+0+0+.... . /2+1+0+...)
3	• 3 from two FS (3+3) • 3 from one FS and 2 from one or two FS (3+2+1+ .../3+1+1+....) • 2 from three FS (2+2+2) • 2 from four FS (2+2+2+2) • 2 from five FS (2+2+2+2+2)
4	Able to walk without aid for 300 m (More than 3 from multiple FS)
5	Limited mobilization without aid; FS is usually over 4
6	Able to walk with aid, FS is usually over 3
7	Restricted to wheelchair
8	Restricted to bed, multiple FS are 4
9	Confined to bed, most FS are 4
10	Death due to MS

FS, functional system; MS, multiple sclerosis.

Table 3. The incapacity status scale

1	Stair climbing
2	Ambulation
3	Toilet/chair/bed transfer
4	Bladder function
5	Bowel function
6	Bathing
7	Dressing
8	Grooming
9	Eating
10	Vision
11	Speech and hearing
12	Medical problems
13	Mood and thought disturbances
14	Mentation
15	Fatigue
16	Sexual functions

disagreements was 52% in one of the centers and 33% in the other. In one of the centers, the agreement level between the assessors was considerably higher for EDSS ≥5 and there was at least 1 point difference between EDSS scores of 33% of the patients (20). To summarize, the assessment of FS used to calculate low EDSS scores is subjective and the assessment of FS may sometimes be quite complex as well. When the EDSS score is equal to or more than 5.5, the need for aid and being restricted to wheel chair or bed become more significant determinants than the walking distance and the assessment is naturally more objective at these levels. In this case, one of the most important questions is; "How acceptable is the difference between assessments?" Essentially, the most important determinant is for what purpose the change in EDSS is used. Because while the most important advantage of EDSS is that it has been used for many years without revision, it should be remembered that it should not be used as the sole indicator when changing the treatment or assigning the patient from RRMS to SPMS. Additionally, Bowen et al. conducted a study in 2001 where both clinicians and patients themselves assessed the disease status using EDSS and found that particularly in EDSS steps between 4 and 6.5, i. e where the ambulation is assessed, the correlation between the assessment of two groups was quite strong (21).

Whether or not EDSS could indicate the daily life activity of a patient with MS was studied for the first time in 1993 and researchers investigated the relationship between EDSS and a 42-item activities of daily living (ADL) scale. ADL consists of 7 categories: mobility (10 items), communication (4 items), self-care (5 items), daily activity (18 items), educational status (1 item), work status (1 item) and social activity (3 items). Each item is scored from 1 to 3 and a higher score indicates higher disability. This study showed a strong correlation between EDSS and ADL and as expected, EDSS was found to be very strongly correlated with mobility items. The researchers emphasized that the greater focus of EDSS on lower extremity functions and its limitations in terms of cognitive assessment. The authors also stated

Table 4. The Expanded Disability Status Scale

1.0	No disability, minimal signs in one FS
1.5	No disability, minimal signs in more than one FS
2.0	Minimal disability in one FS
2.5	Mild disability in one FS or minimal disability in two FS
3.0	Moderate disability in one FS, or mild disability in three or four FS. No impairment to walking
3.5	Moderate disability in one FS and more than minimal disability in several others. No impairment to walking
4.0	Significant disability but self-sufficient and up and about some 12 hours a day. Able to walk without aid or rest for 500 m
4.5	Significant disability but up and about much of the day, able to work a full day, may otherwise have some limitation of full activity or require minimal assistance. Able to walk without aid or rest for 300 m
5.0	Disability severe enough to impair full daily activities and ability to work a full day without special provisions. Able to walk without aid or rest for 200 m
5.5	Disability severe enough to preclude full daily activities. Able to walk without aid or rest for 100 m
6.0	Requires a walking aid-cane, crutch, etc. –to walk about 100 m with or without resting
6.5	Requires two walking aids-pair of canes, crutches, etc. –to walk about 20 m without resting
7.0	Unable to walk beyond approximately 5 m even with aid. Essentially restricted to wheelchair; though wheels self in standard wheelchair and transfers alone. Up and about in wheelchair some 12 hours a day
7.5	Unable to take more than a few steps. Restricted to wheelchair and may need aid in transfering. Can wheel self but cannot carry on in standard wheelchair for a full day and may require a motorised wheelchair
8.0	Essentially restricted to bed or chair or pushed in wheelchair. May be out of bed itself much of the day. Retains many self-care functions. Generally, has effective use of arms
8.5	Essentially restricted to bed much of day. Has some effective use of arms retains some self-care functions
9.0	Confined to bed. Can still communicate and eat
9.5	Confined to bed and totally dependent. Unable to communicate effectively or eat/swallow
10.0	Death due to MS

FS, functional system; MS, multiple sclerosis.

that EDSS and ADL could be used together and highlighted the importance of a more detailed monitoring of the patient's disability (22).

In addition to the differences between EDSS scores found by different practitioners, there may also be differences between two or more measurements performed for the same patient by the same practitioner. A study from 2001 showed fluctuations in EDSS scores of patients (23). The fluctuation was more apparent particularly for EDSS scores between 4 and 5.5 and the researchers suggested that this could be discussed in three aspects. First of all, the patient's success in displaying the maximum performance in the fist try and the risk of reaching exhaustion limit may lead to reduced performance of compensatory mechanisms in later trys. Secondly, it should be remembered that the patient may be affected by external factors (e.g. temperature change), which may cause performance changes. Thirdly and lastly, the fatigue associated with MS may vary during the day in general performance assessment and this may affect the maximum walking capacity. Also, it is a confusing factor that there is no study showing the variability in walking capacity of healthy individuals. However, while walking performance is expected to decrease when the personal stress threshold is passed, it would not be surprising to see that not only the walking performance, but also cognitive functions are affected by stress in MS cases. Therefore, there are two more factors that may impair the walking performance in MS cases: stress and cognitive dysfunction. The correlation between cognitive status and walking capability is already known. In the same study mentioned above, the increase in the maximum walking performance for 4 consecutive days was associated with improved motivation and learning/practice observed in many tests. However, this improvement was shown to decrease between the 2nd day and the 4th day in 45% of the patients, which leads to the idea that practice is not that effective.

The walking performance has two components: walking speed and ability to maintain walking performance. It was previously shown that the walking performance could vary from day to day (23). As a matter of fact, the first and last 1.5 m sections of the 10-meter test were not included in the assessment to minimize the fluctuation. This is recommended to exclude the exhaustion (the exclusion of the final section of the distance) and achieve standardization in terms of reaching a constant walking speed (the exclusion of the initial section) (23). In conclusion, it should always be remembered that the walking distance, which is the main determinant in assessment of higher steps of EDSS, may vary within the day or between consecutive days and confusing factors should be ruled out as much as possible.

Another limitation of EDSS in terms of assessing the walking distance is its inability to make a long-distance assessment of the walking distance without aid and rest. That is to say, when an MS patient reports that they used to be able to walk 5000 m without aid and rest, but this distance is maximum 2000 m in recent months, this does not correspond to anything in EDSS. However, while decreased maximum walking capacity may be associated with stress, extreme temperatures, or MS-related fatigue, it may also be an indication of transition to the secondary progressive phase. The lack of a quantitative measurement of this aspect is a significant problem for the clinician and it is very important to objectively monitor walking performance of patients using short-and long-distance walking tests, since it is not possible to monitor patients with EDSS only. Short walking tests that assess the walking distance and speed include the Timed 25-Foot Walk (T25FW) (24), 10-Metre Walk Test (10 mWT) (25), and Time Up and Go (TUG) (26), while long walking tests include tests such as 2-Minute Walk Test (2MWT) (27) and 6-Minute Walk Test (6MWT) (28). In addition to the above mentioned, the walking capability may also be assessed subjectively with the patient-reported MS Walking Scale-12 (MSWS-12) (29).

EDSS and cognitive status

Cognitive dysfunction is seen about 45% of MS cases and it may occur even in early phases of the disease (30). The most commonly affected cognitive functions in MS include attention, conceptualization, problem-solving, information processing, working memory, and verbal fluency. Language functions are relatively preserved (31). In MS cases, the reason of application is often physical complaints and in addition to many other disadvantages, EDSS, which is used to assess the disability level, is known to be inadequate in terms of assessing cognitive functions and MS-related cognitive deterioration. In EDSS, cognitive status is assessed in the mental functions category. "0" indicates no issue; "1" indicates mental alteration only (does not affect DSS score); "2" indicates mild decrease in mentation; "3" indicates moderate decrease in mentation; "4" indicates marked decrease in mentation (chronic brain syndrome-moderate); and "5" indicates dementia or chronic brain syndrome-severe or incompetent, and it appears that there is no objective assessment. The assessment depends solely on the clinician's opinion and patient's report. However, cognitive problems in MS cases constitute a intensive area which cannot be assessed with ordinary scales and are often overlooked by physicians and sometimes by patients. For many years, PASAT has been used for the assessment of cognitive dysfunction in MS cases. PASAT assesses working memory and information processing rate, and the normative data of PASAT for Turkey was created by Özakbaş et al. in 2016 (32). Developed by Brown and Peterson in 1958 (33), the Auditory Consonant Trigram is a cognitive test which assesses short-term memory, attention, and information processing capacity. The validity and reliability study of the instrument was made for Turkey (34) and it takes a shorter amount of time compared to PASAT. Recommended to be used for assessing information processing rate and as a screening test in MS cases, SDMT (35) is a test which can be administered in every visitation. Other instruments include the Minimal Assessment of Cognitive Function in Multiple Sclerosis (MACFIMS) (36), Brief Repeatable Battery (BRB) (37), which were developed for comprehensive assessment of cognitive functions in MS. Validated for Turkey (38), the Brief International Cognitive Assessment for Multiple Sclerosis (BICAMS) (39) can be administered in a very short time like 15 minutes.

EDSS and upper extremity functions

EDSS is scored based on functional systems until 4 points and upper extremity functions are assessed based on pyramidal, cerebellar, and sensory functional systems. Between 4 and 6.5, upper extremity functions are almost not assessed at all. This EDSS range resembles an ambulation index. However, the significance of upper extremity functions in the assessment of how physical status on daily life activities and the assessment of disease progression cannot be ignored. The Multiple Sclerosis Functional Composite (MSFC) test, which assesses the walking capacity as well, was developed due to the insufficiency of EDSS in the assessment of upper extremity functions and the necessity of an objective assessment of cognitive functions (24). MSFC tests lower extremity, upper extremity, and cognitive functions. Lower extremity functions are tested with the Timed 25-Foot Walk (T25W) test, upper extremity functions are tested with the 9 Hole Peg test, and cognitive status is assessed using PASAT. It was known that MSFC was more sensitive compared to EDSS in displaying changes in functional status during the attack period and better correlated with life quality.

The situation is actually not much different over EDSS 6.5. Because the assessment of upper extremity functions is based on whether or not arms can be used for transfer to wheel chair or whether or not arms can be used effectively, which is quite subjective. In EDSS, upper extremity functions are defined in a range which cannot show small differences between patients, which is one of the handicaps of EDSS. For this reason, it is recommended to use EDSS and MSFC together when assessing physical and cognitive status of patients.

Advantages of EDSS

EDSS is the most commonly used MS scale which has been in use for the longest period of time. It has been in use since 1983 without much change, which is one of its most significant advantages. It includes all functional systems (although with some shortcomings) that may be affected in MS and reflects the clinical status as a number, which is quite valuable. Although there may be differences between EDSS practitioners, it has been in use for more than 30 years and it can objectively display the difference between a patient's clinical picture 20 years ago and today, which can be said for only a small number of scales. Also, the comparison of EDSS scores in MS cohorts of 1991 and 2001 shows that the distribution of EDSS scores is very similar in both time periods (Figure 1) (Stephen S. Kamin). This shows the importance of using the same scale for diseases that require long-term monitoring such as MS. For this reason, it is a consensus that EDSS will not undergo major changes so that its greatest advantage can be preserved. Also, the consensus in the available literature is that EDSS will never lose its value.

Disadvantages of EDSS

Alongside its many advantages, EDSS has certain disadvantages as well. First of all, it does not provide ordinal data for clinicians and researchers due to its non-linear nature. What this means is that an increase of 1 point has a different significance for each level. Also, it shows bi-modal distribution; it has been demonstrated that there usually is a build-up between 3 and 6, while the number of patients between 3 and 4.5 is low. According to Amato and Ponziani, it is not suitable for parametric statistical analysis methods for these reasons (40, 41). Also, the time spent in different steps of EDSS is variable as well. For example, the time spent at EDSS 4 may to be 1.22 years, while the time spent in EDSS 6 may to be 3.75 years. This is another point to remember when analyzing studies that use EDSS.

It is today obvious that EDSS resembles an ambulation index at moderate scores and while ambulation is a quite important aspect in a patient's physical disability, over-assessment of ambulation may lead to undesired results. Because MS is a very complex disease that cannot be reduced to walking capacity and patients must be assessed in many different aspects in each examination. Also, intermediate ambulation values cause confusion for clinicians and lead to differences between assessors, sometimes even between two assessments of the same clinician.

Although the 10-step DSS was elaborated to the 20-step EDSS in 1983 to increase its sensitivity, higher steps of EDSS are still too wide to be sensitive enough to detect differences. Other areas where EDSS is not sensitive include the assessment of cognitive functions, which are very significant causes of disability in MS cases at all score levels, and the assessment of upper extremity functions between 4.0 and 6.5. At lower levels of EDSS, small differences are reflected, yet small changes may not be reflected at higher levels. The difference between EDSS 1 and 2 and the difference between EDS 6 and 7 have very different meanings and in both clinical practice and research, it is not sufficient to monitor MS patients, who require longitudinal monitoring, with EDSS only.

In terms of functional systems, the pyramidal and cerebellar functions have significant contributions to the EDSS score, the brain stem and sensory functional systems have moderate contributions, while the cerebellar functional system has very a limited contribution to the EDSS score, especially at higher score levels. EDSS is also limited in terms of showing the walking capacity of the patient; it cannot assess performance changes over 500 m. Additionally, not all EDSS scores may indicate the same neurological examination. For example, an EDSS score of 4.5 indicates that the patient can walk 300 m without aid, while it may also mean that a fully ambulatory patient with 4 points from two functional systems. In other words, the same EDSS score may not lead to the same thought in the clinician's head.

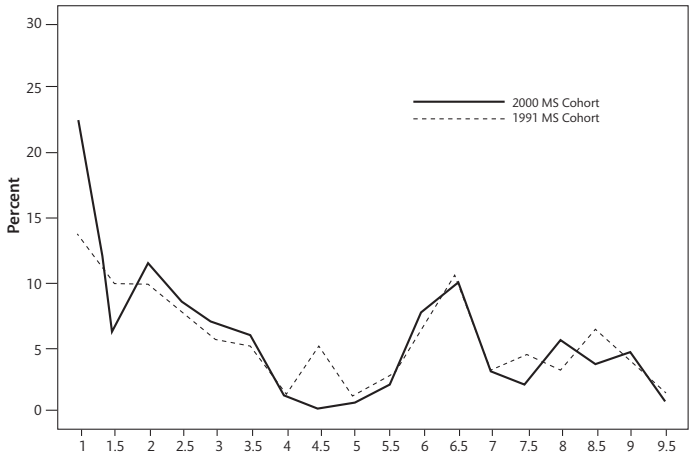

Figure 1. Comparison of EDSS scores in MS cohort in 1991 and 2000 (Stephen S. Kamin).

In conclusion, both as a clinician and a researcher, the idea that monitoring patients with EDSS only is not sufficient is now widely accepted. However, considering all advantages and disadvantages of EDSS, it is still the most commonly used physical disability scale in MS cases and maintains its significance.

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