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ABSTRACT

Objective. To provide an overview and methodology for the evaluation of impairment and functional residual capacity in complex regional pain syndrome I (CRPS I, RSD). This paper is intended to provide assistance to physicians asked to evaluate impairment- and disability-related issues and is not primarily geared to guide treatment of the CRPS I patient.

Method. Conference and literature review by neurology, anesthesiology, pain medicine, psychiatry, and disability evaluating physicians followed by description of issues, options, and recommendations based upon the committee's deliberations and the widely used AMA Guides to the Evaluation of Permanent Impairment, fourth and fifth editions.

The authors present functional criteria for assessing the severity of CRPS. These criteria were developed by committee consensus opinion based on multidisciplinary clinical experience considering daily functional issues. They can be used in conjunction with CRPS-ADL Classes of Impairment in order to categorize an individual into a specific class for purposes of permanent impairment rating. Future reliability and validity studies of this rating scale are pending future use, acceptance and, hopefully, additional studies.

Results. Evaluators should perform a comprehensive assessment of patients with CRPS I to make an accurate diagnosis and exclude other conditions that could explain the symptoms and signs of the condition. While radiological, laboratory, and other diagnostic studies may be of assistance in making the diagnosis, in the final analysis, this is a clinical diagnosis. Impairment is based on objectively validated limitation in activities of daily living (ADL).

Key Words: RSD; CRPS; Impairment; Disability

The passage of time has seen the syndrome of pain associated with autonomic dysfunction assume a number of colorful names (e.g., algodystrophy mineure, mimo-causalgia, sympathalgia, post-traumatic spreading neuralgia, etc.). The names reflex dystrophy, coined by DeTakats in 1937, and reflex sympathetic dystrophy, attributed to Evans in 1946, were changed to complex regional pain syndrome (CRPS) at the Orlando consensus-based workshop of 1995 (Table 1) [1-4]. Their taxonomy, complex regional pain syndrome, was meant to be descriptive, general, and not to imply any etiopathology. It is recommended that this taxonomy be consistently used and that older terms, such as reflex sympathetic dystrophy (RSD) (most consistent with the new name CRPS I), causalgia (new name CRPS II), and sympathetically maintained pain (SMP), not be used. SMP was used briefly as a diagnostic entity, but now is only useful as a designation for people who could benefit from a sympathetic block to allow progress in a functional restoration algorithm.

The first attempts at outlining diagnostic criteria were actually good clinical syntheses of cases, such as those by Bonica [5], based on vast experience. Attempts to identify formal criteria appeared later from Kozin [6] and Wilson [7,8]. Recently, the ef-
CRPS Impairment and Disability Issues

Table 1. IASP diagnostic criteria for complex regional pain syndrome* (adapted from Mersky & Bogduk [2])

1) The presence of an initiating noxious event or a cause of immobilization
2) Continuing pain, allodynia, or hyperalgesia in which the pain is disproportionate to any known inciting event
3) Evidence at some time of edema, changes in skin blood flow, or abnormal sudomotor activity in the region of pain (can be a sign or symptom)
4) This diagnosis is excluded by the existence of other conditions that would otherwise account for the degree of pain and dysfunction.

*If seen without "major nerve damage," diagnose CRPS I. If seen in the presence of "major nerve damage," diagnose CRPS II.
*Not required for diagnosis; <5-10% of patients will not have this.

... efforts to formally define the syndrome have turned on consensus symposia. The first of these was held at Schloss Rettershof in 1988 [9], and a later, more definitive conference was held in Orlando in 1994 [3,4]. The diagnostic criteria set forth were meant to be inclusive, sensitive, and broad. The taxonomy and criteria, which were adopted by the Committee for Classification of Chronic Pain of the International Association for the Study of Pain (IASP), have contributed greatly to progress in understanding the syndrome (Table 1) [2]. These substantial efforts finally provided standardized diagnostic criteria, improved clinical communication and homogeneity of research, and provided the promise of results that could be compared across studies [4].

Widespread use of the standardized IASP diagnostic criteria for CRPS (IASP/CRPS) has the potential to lead to improved understanding and treatment of the disorder. However, realization of this potential is somewhat limited by the fact that the current criteria were derived solely based upon the consensus opinion of a group of expert clinicians and basic scientists. While this was an appropriate first step, experience gained in developing diagnostic criteria for headache and psychiatric disorders highlights the necessity of validating and, if necessary, modifying these initial consensus-based criteria based upon results of systematic validation research [10]. Consensus-derived criteria that are not subsequently validated empirically may lead to over- or underdiagnosis of the syndrome, and thus, may reduce the ability to provide timely and optimal treatment.

External Validation

External validity of the diagnostic criteria refers to the utility in distinguishing between CRPS patients and patients with other types of neuropathic pain.

Ideally, the accuracy of diagnostic criteria for identifying patients with and without the disorder would be demonstrated based upon some clear external reference point or "gold standard" [11]. In the absence of a definitively known pathophysiology for CRPS, and thus, the absence of a definitive objective test to serve as such a "gold standard," providing evidence for the external validity of the IASP/CRPS criteria is more difficult, but not impossible [12].

However one can use the IASP/CRPS criteria themselves as a reference point for testing external validity [12, 13] and compare them with those of a non-CRPS neuropathic pain group. Discriminant function analysis (DFA) can then be used to test the external validity of the IASP/CRPS criteria. In such a pilot study, 18 patients meeting IASP/CRPS criteria and 30 patients with diabetic peripheral neuropathy were examined [13]. Results of this initial study indicated that the use of the IASP/CRPS criteria and decision rules (e.g., criterion 3 is satisfied by presence of edema or skin blood flow changes or sweating changes) to make diagnostic decisions could lead to substantial overdiagnosis. If glucose tolerance status was not known and diagnoses were made solely based on the pattern of signs and symptoms, up to 37% of diabetic neuropathy patients could be misdiagnosed as having CRPS [13].

A larger external validation study led to similar findings [12]. DFA was again used to discriminate between 117 patients meeting IASP/CRPS criteria and 43 neuropathic pain patients with established non-CRPS etiology. The IASP/CRPS criteria and decision rules (e.g., "evidence at some time" of edema or color changes or sweating changes satisfies criterion 3) discriminated significantly between the CRPS and non-CRPS groups. However, closer examination of the results indicated that, while diagnostic sensitivity was quite high (0.98), specificity was poor (0.36), and a positive diagnosis of CRPS was likely to be correct in as few as 40% of cases.

For clinical purposes, sensitivity (i.e., being able to detect the disorder when it is present) is extremely important. On the other hand, the issue of specificity (i.e., minimizing false positive diagnoses) is quite important for selection of research samples, as well as minimizing unnecessary, potentially invasive, treatments. The clinical implication of high sensitivity at the expense of specificity is that CRPS may be overdiagnosed and, ultimately, overtreated. Such overdiagnosis must be balanced with the equally undesirable consequences of failing to identify clinically relevant syndromes and treat patients adequately. Use of the external validation model described above suffers from the inherent weakness...
of tending to inflate diagnostic sensitivity when the IASP/CRPS criteria are tested. However, such a model can be useful for testing the effects of modifications to criteria on specificity and overall diagnostic accuracy.

Internal Validation

Internal validation addresses several questions related to the internal structure of the IASP/CRPS criteria. For example, is it justified to combine edema, vasomotor, and sudomotor signs and symptoms in the same criterion (criterion 3 of IASP/CRPS criteria described in Table 1), or does this contribute to poor diagnostic specificity? Are the IASP/CRPS criteria sufficiently comprehensive, or are important criteria with potential treatment implications omitted [14,15]? Questions such as these must be addressed if diagnosis and treatment of the syndrome is to be improved.

Statistical pattern recognition methods, such as factor analysis and cluster analysis, have been used for internal validation of headache diagnostic criteria [16-18], as well as criteria for psychiatric diagnoses [19]. These statistical methods have a clear application to the issue of CRPS diagnostic validity as well.

Factor analysis identifies coherent, and presumably conceptually linked, subsets of variables within a dataset. Using factor analysis, subgroups of CRPS signs and symptoms (factors) can be identified that tend to covary, and thus, group together statistically (i.e., if one sign/symptom in a given factor is present, it is more likely that another sign/symptom in that factor will also be present). Such statistically derived subgroups provide an objective determination of distinct subsets of related signs/symptoms of CRPS as they present in the clinical setting. A reasonable assumption is that signs and symptoms that group together into the same factor are likely to share some underlying pathophysiology (e.g., color and temperature changes are both mediated by vasoconstriction).

If internally valid, the grouping of signs and symptoms within each of the IASP/CRPS criteria (e.g., criterion 3 combines edema, vasomotor, or sudomotor changes) should correspond highly with objective, statistically derived groupings of signs and symptoms. If the IASP/CRPS criteria do not correspond well with statistically derived groupings, this indicates that the diagnostic criteria do not adequately reflect natural groupings between various signs and symptoms as they cluster together in the clinical setting. This latter finding would indicate a lack of internal validity, as the internal structure of the criteria would not accurately reflect signs and symptoms subgroups that are objectively detectable in the clinical setting.

Internal validation research using factor analysis in a series of 123 patients meeting the IASP/CRPS criteria indicated that signs and symptoms of CRPS cluster into four statistically distinct subgroups [20]. The first is a unique set of signs and symptoms indicating abnormalities in pain processing. Skin color and temperature changes form a second distinct subset of signs and symptoms indicative of vasomotor dysfunction, with a third subset of signs and symptoms identified that reflects edema and sudomotor dysfunction (e.g., sweating changes). With regard to the internal validity of the IASP/CRPS criteria, the fact that statistically distinct vasomotor and sudomotor/edema subsets of signs and symptoms are combined into a single criterion (criterion 3) in the IASP taxonomy is particularly problematic. The clinical impact of grouping two distinct clusters of signs and symptoms into a single diagnostic criterion is a lowering of the diagnostic threshold, leading to poor specificity and probable overdiagnosis of the disorder [12,20]. A number of clinical characteristics not currently reflected in the IASP/CRPS diagnostic criteria were included in this factor analysis. These signs and symptoms have been described frequently in the older literature as being cardinal features of RSD [11,13,19]. For example, numerous studies previously have described various signs of motor dysfunction (e.g., dystonia, tremor) as important characteristics of this disorder [7,21,22]. In addition, trophic features have also been described in the older RSD literature [23,6] as being important clinical features of the syndrome (e.g., changes in hair or nail growth, development of thin "shiny" skin). Factor analysis indicates that these motor/trophic characteristics form a distinct subset of CRPS signs and symptoms that groups together, but does not overlap with the three other subgroups described above [20]. In light of the historical clinical conceptualization of the syndrome, these results suggest that a group of signs and symptoms relevant to accurate diagnosis of the disorder may have been omitted from the current IASP/CRPS criteria.

Recommendations for a More Specific Criteria for CRPS

A set of research criteria based upon results of the aforementioned factor analysis was developed [12,20]. These modified research criteria (Table 2) assessed
CRPS Impairment and Disability Issues

Table 2 Proposed modified research diagnostic criteria for CRPS (adapted from Harden et al. [20] and Bruehl et al. [12]).

1) Continuous pain, which is disproportionate to any inciting event
2) Must report at least one symptom in each of the four following categories:
   Sensory: Reports of hyperesthesia
   Vasomotor: Reports of temperature asymmetry and/or skin color changes and/or skin color asymmetry
   Sudomotor/edema: Reports of edema and/or sweating changes and/or sweating asymmetry
   Motor/trophic: Reports of decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair, nail, skin)
3) Must display at least one sign in two or more of the following categories:
   Sensory: Evidence of hyperalgesia (to pinprick) and/or allodynia (to light touch)
   Vasomotor: Evidence of temperature asymmetry and/or skin color changes and/or asymmetry
   Sudomotor/edema: Evidence of edema and/or sweating changes and/or sweating asymmetry
   Motor/trophic: Evidence of decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair, nail, skin)

CRPS characteristics within each of the four statistically derived factors described above (pain/sensation, vasomotor, sudomotor/edema, motor/trophic). Given evidence from the Galer et al. [13] and Hardy et al. [20] studies that objective signs on examination and patient-reported symptoms both provide useful, but nonidentical, information, the research criteria required the presence of signs and symptoms of CRPS for diagnosis.

A test of these proposed research criteria regarding the ability to discriminate between the CRPS and non-CRPS neuropathic pain groups indicated that modifying the IASP/CRPS diagnostic criteria could increase diagnostic accuracy [12]. Results indicated that applying a decision rule requiring two of four sign categories and four of four symptom categories to be positive resulted in a sensitivity of 0.70 and a specificity of 0.94. Of all those tested, this decision rule resulted in the greatest probability of accurate diagnosis for both CRPS and non-CRPS patients (approximately 80% and 90% accuracy, respectively) even when a relatively low prevalence rate for CRPS was assumed [12]. The importance of proper decision rules in the criteria is demonstrated by the fact that using the research criteria, requiring two of four sign categories and only two of four symptom categories to be positive, resulted in a sensitivity of 0.94, but a specificity of only 0.36 [12]. Which decision rules are considered optimal would depend on their purpose, such as identifying stringent research samples (minimizing false positives) versus identifying as many CRPS patients as possible (minimizing false negatives).

The IASP criteria, while being very sensitive, lack specificity [12,13,20]. The intent of the Orlando conference was that these criteria would evolve with time, experience, and empirical testing and would be subject to systematic validation and research [3,4,11]. This has, in part, been accomplished and will, through a process of internal and external validation, provide the opportunity to improve the specificity of bedside diagnostic criteria [12,13,20]. Although the current IASP criteria can be met by purely subjective and/or historical symptoms, their specificity can be materially improved by objective data. Statistical pattern recognition methods, such as factor analysis and cluster analysis, have been used for internal validation of headache diagnostic criteria [16-18], as well as criteria for psychiatric diagnoses [19]. These statistical methods have a clear application to the issue of CRPS diagnostic validity as well. Both internal and external validation research suggests problems with overdiagnosis using the IASP/CRPS criteria [12,13,20]. One source of this over-diagnosis is the combination of distinct elements of the syndrome (vasomotor changes and sudomotor changes/edema) into the same diagnostic criterion in the current IASP system. The data also indicate that failure to include motor/trophic signs and symptoms in the current criteria could lead to important information being ignored that may help discriminate CRPS from other syndromes. The results described above suggest possible directions for change in future revisions of the IASP criteria.

A test of modified research diagnostic criteria indicated that it is possible to reduce the rate of overdiagnosis dramatically, although such changes modestly diminish diagnostic sensitivity as well [12]. The relative merits of enhanced specificity at the expense of diagnostic sensitivity will need to be weighed carefully in any future modifications of the IASP criteria.

The recommendation to improve the specificity of the diagnostic criteria is that four statistically derived diagnostic categories be present: Sensory (hyperesthesia, alldynia, hyperpathia), vasomotor (temperature and/or skin color asymmetry), sudomotor/edema (reports of asymmetrical sweating or edema), and motor/trophic (motor dysfunction or trophic changes) [12,13,20]. These studies have shown that, if two signs (observed by the physician) in two or more of these categories, and at least one symptom from all four categories are included, a sensitivity of 0.70 can be achieved while specificity is increased to 0.95 (Table 2) [20]. Although this level of specificity may be important for research, the original
IASP criteria should be used if maximal clinical sensitivity is desired.

Internal validation addresses several questions related to the internal structure of the IASP/CRPS criteria. For example, is it justified to combine edema, vasomotor, and sudomotor signs and symptoms in the same criterion (as in criterion 3, Table 1), or does this contribute to poor diagnostic specificity? Are the CRPS criteria sufficiently comprehensive, or are important criteria with potential treatment implications omitted [14,15]? Questions such as these must be addressed if diagnosis and treatment of the syndrome are to be improved.

Signs and Tests

The examining physician should always seek objective evidence, whenever possible. Any signs of altered central processing, including mechanical and temperature allodynia (innocuous stimuli that are now painful) or hyperpathia (slightly painful stimuli that are now significantly painful and/or painful for a prolonged period), should be systematically sought [24]. These signs can be formally documented using quantitative sensory testing [25-27], although the impact of this test on diagnostic specificity is unknown. Thermography, or at least a spot temperature measurement, preferably using passive infrared thermometry, provides good evidence of vasomotor disturbance [28]. It is recommended that sudomotor activity of the affected side be clinically assessed in every patient. This can be documented by measuring sweat output (RSO) and using quantitative sudomotor axon testing (QSART) [29]. Unfortunately, this test is not universally available. A decrease in range of motion, weakness, dystonia, and tremor are frequently seen [21]; myogenic activity in both early and longstanding cases is occasionally observed [30]. The interesting phenomenon of apparent motor neglect is also sometimes observed [13]. Although three-phase bone scintigraphy has been regarded as the gold standard in support of a diagnosis of complex regional pain syndrome, recent reports have thrown doubts as to its veracity [31,32].

The response to sympathetic block certainly defines "sympathetically maintained pain," which, if present, represents a substantial and bona fide clinical target [34]. Sympatholytic techniques can, in those cases, provide a therapeutic window of opportunity (decreased pain) in the context of an interdisciplinary pain management program.

We have come a long way toward finding diagnostic criteria with adequate sensitivity that enfranchise the majority of patients with pain and autonomic dysfunction syndromes, either therapeutically or in research. There is still much work to do in designing diagnostic schemes that are adequately specific to ensure homogeneity in research and general utility for evidence-based clinical paradigms.

Treatment Guidelines

It is beyond the scope of this paper to have a detailed discussion about treatment. However, Appendix I gives an overview of the disciplines involved in evaluation and treatment of CRPS. It is readily apparent that treatment is interdisciplinary, and that there is a strong emphasis on reactivation and functional rehabilitation, coupled with psychological and behavioral interventions, pharmacotherapy [35] and interventional procedures [36-39]. There is an emphasis on self-management techniques, motivation, and as is true with treatment approaches for chronic pain generally, on replacing maladaptive coping with more adaptive coping skills.

Maximum Medical Improvement (MMI)

Maximum medical improvement (MMI) is defined by the AMA Guides to the Evaluation of Permanent Impairment as a "condition or state that is well stabilized and unlikely to change substantially in the next year, with or without medical treatment. Over time, there may be some change; however, further recovery or deterioration is not anticipated." This concept has been problematic for many physicians performing impairment evaluations with individuals having neuropathic pain, but especially those with CRPS. It is this committee's belief that if the individual being evaluated for possible CRPS has failed to progress in return of function after an adequate functional restoration and rehabilitation effort, including adequate medical evaluation, pharmacotherapy, and when medically indicated, psychiatric/psychological treatment, and where appropriate, use of regional anesthetic and/or neuromodulatory procedures, that individual is likely to be at MMI. If the individual in question is refractory to all other conventional approaches and has been compliant with recommended treatment, it is recommended, prior to a neuromodulatory procedure, that a second opinion be requested from a physician from a specialty different from that of the treating physi-
CRPS Impairment and Disability Issues

cian with training and experience in the evaluation and treatment of CRPS. If there is a reason to suspect that emotional issues are involved in the onset or maintenance of the CRPS, a psychiatric or psychological consultation should be requested from a practitioner (MD/PhD) experienced in the assessment of CRPS sufferers. Many would consider that all patients should have a presurgical psychiatric screening prior to a neuromodulatory procedure.

Functional Limitations

When assessing functional capacities to perform work activities or activities of daily living for patients with CRPS, it is important to assess difficulties associated with measurement of pain and functional limitations associated with pain. The patient's self-report about changes in pain level upon performance of discrete physical activities, results of physician's examinations, and functional capacity assessment data provide a physician with tools for determining functional abilities and limitations. The areas needing to be addressed when assessing functional capacities of CRPS patients must be determined and appropriate data collected. The impact of CRPS on whole person function (i.e., cognitive/emotional, social, leisure/recreational, and vocational as well as physical capacities) must be determined in order to establish the extent of disability. Only when the relationships among self-report of pain, functional capacity assessment results, objective findings from a physician's examination, and overt, verifiable indicators of life function (such as ability to work, interaction with others socially, involvement in recreational and leisure activities, etc.) are clearly established will the extent of disability be known.

Simonsick et al. point out that functional limitation is the interim state between impairment and disability (40). Functional limitation results from a lack of ability to perform an action or activity due to impairment. Disability occurs when functional limitations result in a limitation or inability to perform socially defined normative activities and roles. In turn, it is the inability to perform normative activities that ultimately provides behavioral data upon which to base conclusions concerning disability. Therefore, objective assessment of functional capacity plays a key role in linking self-report and examination findings to inability to work or meet other life role expectations. Although there appears to be inherent face validity associated with collecting data about functional capacity, there are serious dilemmas in the use of functional capacity data in disability determination including:

1. Performance-based functional capacity evaluation protocols have not been standardized in terms of methodology or criterion levels of performance and overemphasize isolated physical functions; and

2. Self-report measures of inability to perform, need for assistance in performing, and amount of difficulty or tiredness associated with performing life tasks have not been developed and validated. This is particularly true when attempting to isolate the functions associated with upper and lower extremity function, common areas of concern when assessing the functional implications of CRPS.

The authors point to the need for further research on the relationship between objective, functional data and self-report of functional limitations. They also suggest that standardized functional capacity evaluation methodologies tend to emphasize strength factors when defining function in terms of solely the lifting/carrying requirements of specific categories of work (sedentary, light, medium, etc.). They offer a model for assessing functional capacities for CRPS patients with upper or lower extremity problems. This model uses self-report and functional capacity assessment data across the domains and tasks shown in Table 3.

Patients were asked to rate their level of difficulty in performance of specified tasks on a four-point Likert scale ranging from "little difficulty" to "unable to do". Functional measurement then addressed the ability to lift to eye level and overhead, rotate the shoulders internally and externally, pick up and place pegs on a board, button, turn a key in a lock, pinch, walk distances, balance, and stand up

### Table 3 - Model for functional assessment of CRPS

<table>
<thead>
<tr>
<th>Domain</th>
<th>Tasks</th>
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</thead>
<tbody>
<tr>
<td>Mobility/exercise tolerance</td>
<td>walking, climbing/descending steps, getting in and out of bed, chairs, doing heavy housework, stooping, crouching, kneeling</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>raising arms overhead, using fingers to grasp or handle, lifting/carrying, turning a key in a lock, preparing meals using the telephone, doing light household work, preparing meals, shopping dressing, bathing or showering, using the toilet, eating</td>
</tr>
<tr>
<td>Higher functioning (Instrumental activities of daily living)</td>
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<tr>
<td>Self-care activities (Activities of daily living)</td>
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from a seated position, as well as perform knee extension and hip flexion. When functional capacities and self-report data were compared, a significant correlation was found between self-reported function and performance-based testing for the lower extremities, but was not found for the upper extremities. It was felt that upper extremity function may be too detailed for patients to make an accurate self-assessment (asking patients to make very subtle discriminations between functions negating the precision gained by having the Likert-type rating system). These findings suggest that functional assessment and self-report both provide information useful for assessing disability across the identified domains of function. Standardization of how self-reported function is coupled with functional assessment will provide physicians with the opportunity to assess the reliability and validity of both data sources while providing an accurate clinical picture of the impact of CRPS on life function.

Objective findings on examination, self-reported anatomical and functional changes, and self-reported and observable changes in daily function should focus on areas of inquiry that are seen as most closely related to CRPS as opposed to other disease entities. Development of a methodology for assessing the impact of CRPS on function and function on disability must be based on an understanding of what symptoms are associated with CRPS. Gelber et al. noted that the initial symptoms of CRPS included severe pain (100%), abnormal swelling (90.5%), abnormal coldness (74.2%) of heat (54.8%), color changes (74.2%), weakness (71%), inability to move an extremity (71%), muscle spasm (58.1%), abnormal sweating (48.4%), tremors (38.7%), skin dryness (22.6%), and feelings as though the limb was disconnected (54.8%) [41]. Ongoing symptoms included pain (100%), weakness (96.7%), and swelling (96.7%). Although the majority of patients indicated that the symptoms remained the same or worsened over time despite treatment, improvements in skin color (58.1%) and swelling (51.6%) were noted. Weakness improved in 48.4% (remaining the same in 25.8%), and pain improved in 29% (remaining the same in 29%). Pain increased under stressful situations in 77.4% and with fatigue in 80.6% of the sample. Pain was described as "deep," "unpleasant," "sensitive," and "hot," not unlike other samples of CRPS patients. In terms of function, a majority of patients felt that symptoms caused "substantial interference" with general activities (74.2%), mood (74.2%), mobility (67.7%), normal work (74.2%), relations (64.5%), sleep (67.7%), enjoyment (71%), recreational activities (77.4%), and social activities (74.2%). Interference in self-care was identified by 45.2% of the patients. The common themes of pain, anatomical changes, and interference with function found in this study support the value of clinical examination, functional assessment, and self-report.

Once examinations, self-report, and functional assessment have been conducted, the impact of CRPS on life function needs to be addressed if an accurate assessment of disability is a goal. A survey of CRPS patients conducted by the RSD Foundation found that 23% of the respondents had to stop daily activities occasionally and 74% had to stop them frequently due to pain [42]. More than 30% noted that pain interfered with their marriages and family life all of the time, and 28.9% felt pain interfered with this area of life function most of the time. More than 35% of the respondents reported that pain interfered with social activities and friendships all of the time, and 30.5% reported that pain interfered with these activities most of the time. About 50% of the respondents reported that pain interfered with household chores all of the time and 32.2% reported that pain interfered with these activities most of the time. About 47% of the respondents felt that pain interfered with recreation and hobbies all of the time and 33% felt it did so most of the time. These findings suggest that chronic pain associated with CRPS affects function across the social, recreation/leisure, physical, and emotional domains of quality of life. About 87% of the respondents suffered from constant or nearly constant pain, supporting the contention that these results reflect the functional limitations of CRPS patients who experience constant rather than episodic pain.

CRPS has a significant negative effect on function, and therefore, has a potentially profound effect on quality of life. More specifically, a change in mobility and general activity level were found to result in a dramatic reduction in quality of life in several empirical studies [43,44]. The negative impact of functional limitations on ability to work is equally significant in that restrictions on work capacity impact emotional well-being, intellectual function, family and social relationships, and performance of household chores. CRPS can have a very constricting effect on functional capacity and result in a narrowing of one's options for enjoying life.

Work and Disability

The impact of chronic pain and functional limitations associated with CRPS on ability to perform
CRPS Impairment and Disability Issues

the physical and mental demands of work has not received extensive attention in the rehabilitation literature. However, some attention has been given to the relationship between chronic pain, emotional distress, diminished physical capacities, and work as they relate to overall well-being, such as quality of life.

Kirkpatrick noted that difficulty initiating movement of joints and decreased mobility of extremities were commonly associated with CRPS [45]. Involuntary jerking movements or tremors and sudden onset of debilitating muscle cramps were also mentioned. In some patients, symptoms lasted indefinitely, and in others, there were periods of exacerbation and remission lasting from weeks to years. Psychological stress was seen to exacerbate these symptoms [46]. Such issues as the family support structure, pain coping skills, and behavioral consequences of physical and/or psychological limitations on work and social interactions play important roles in determining the long-term impact of CRPS on life function. Persons with CRPS who desire to remain engaged in work activity must develop strategies for working with pain and dealing with exacerbations. Work can contribute to stress and fatigue, which are factors known to exacerbate CRPS symptoms. Yet, work can also have a very positive effect on one's perception of quality of life by providing intellectual stimulation, purposeful activity, social contacts, enhanced self-esteem, and financial rewards. Work also helps one avoid the isolation and boredom commonly associated with unemployment. Finding a lifestyle that allows a person with CRPS to be productive while managing pain is one of the desired outcomes of treatment. Planning for engaging in meaningful work and related life activities during one's lifespan is a critical part of the treatment process.

In a national survey of 1,348 CRPS patients conducted by the Reflex Sympathetic Dystrophy Foundation, 38% reported being unemployed due to CRPS, 17.4% reported being employed full time, 8% were employed part time, and 21% reported being employed at one time but not currently working because of CRPS [42]. This clearly indicates that short-term or chronic unemployment is a prevalent problem faced by persons with CRPS. When asked if they changed employment, 75.6% of the respondents stated they did not. Work was seen to increase pain (79%). Only movement (79.2%) and exercise (85.2%) were more prevalent sources of increased pain. Specific physical activities that increased pain were standing (70.7%) and sitting (44.9%). Of the survey respondents, the primary areas affected by CRPS were the upper extremities (39.3%), the lower extremities (47%), and the spine (9.7%).

From a vocational perspective, it is clear that upper extremity impairments, associated functional limitations, and chronic pain have a significantly negative impact on the probability of working. The ability to use the upper extremities for grasping and manipulating is critical to the performance of highly skilled managerial and professional employment in the age of computer keyboards as it is for the unskilled worker doing hand assembly. Likewise, CRPS affecting the lower extremities can lead to difficulty standing. Standing is a critical physical demand for performing essential job tasks associated with skilled crafts, clerical tasks, machine operation/feeding/off-bearing, and laboring, as well as a number of service occupations on a sustained basis. Roughly 63% of those surveyed said that pain interfered with work "all the time," and another 18.2% said it interfered "some of the time." Sustaining work activity over time following the onset of CRPS may be difficult. As the severity and functional limitation increase as one progresses through the various stages of CRPS, the likelihood of work on a full-time, part-time, or intermittent basis decreases.

Job loss resulting from absences, reduced productivity, or functional inability to perform job demands is particularly challenging for the CRPS patient. As severity of symptoms increases, job loss increases the likelihood of long-term unemployment, a precursor to disability. Jackson et al. point out that unemployment and its resultant loss of wages and increased financial strain can result in emotional turmoil [47]. Also, loss of purposeful use of time, fewer opportunities for social contact, and loss of social status or identity as a result of unemployment have been found to erode well-being. Findings from their survey of employed versus unemployed volunteers supported the contention that higher levels of pain resulted in increased emotional distress, increased financial strain, and less structured and purposeful time. Unemployment was directly linked to financial strain, and financial strain was directly linked to emotional distress. The CRPS patient who is not working must endure greater emotional distress and pain at a time when diminishing pain is their primary goal. Unemployment can easily be seen as a major contributor to pain, and ultimately, disability.

It is important to look at a number of factors when assessing the likelihood that CRPS will result in disability. Looking at disability as a functional
inability to engage in essential activities of living from a quality of life perspective can contribute significantly to understanding the global factors that promote or impede disability. Table 4 provides some general questions about life activities, as well as specific questions relative to work that can be used in assessing the potential for CRPS to result in disability. These questions are specific to issues relative to CRPS and should complement general questions regarding function.

These questions mirror the issues that are most challenging for CRPS patients. These are not issues that are unique to this population, but deserve detailed discussion when assessing disability from a global, "whole-person" perspective. Through development of a standardized approach to seeking self-report, data can be collected about the impact of CRPS on disability and quality of life. Although these questions do not solve the reliability and validity problems inherent in dealing with self-report, the authors have provided some initial thoughts in the hope that research protocols focused on looking at self-report and function will be forthcoming.

Careful analyses of the interaction between function across the quality of life domains and changes in pain-related symptomatology must be conducted in order to look for potential factors that would promote health and well-being or lead to disability [48-50].

Analysis of self-report data collected by asking these or related questions over time needs to occur so that the impact of different treatment regimens on function can be assessed over time. Such questions could be used to judge the efficacy of treatment as well as to determine long-term disability. Returning persons with CRPS to work or other life functions requires a careful understanding of how pain interacts with their functional capacity across all areas of life over time. It is important for a physician who is assessing the impact of CRPS on ability to perform work functions to address issues including the use of an assistive device, such as a cane, walker, crutch, wheelchair, or orthosis. These devices may be beneficial from a physical/medical perspective for enhancing function, but may impose limitations from an employment/work per-

<table>
<thead>
<tr>
<th>Domain of Quality of Life</th>
<th>Activity</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>physical</td>
<td>sitting</td>
<td>1) Does sitting relieve or increase pain?</td>
</tr>
<tr>
<td></td>
<td>standing</td>
<td>2) Does standing increase pain?</td>
</tr>
<tr>
<td></td>
<td>movement</td>
<td>3) Does movement increase pain?</td>
</tr>
<tr>
<td></td>
<td>exercise</td>
<td>4) Are you still on first engaging in movements?</td>
</tr>
<tr>
<td></td>
<td>mobility</td>
<td>5) Does exercise increase pain?</td>
</tr>
<tr>
<td></td>
<td>boredom</td>
<td>6) Are you able to drive or use public transportation?</td>
</tr>
<tr>
<td>mental/emotional</td>
<td>autonomy/spontaneity</td>
<td>1) Do you get bored because you cannot engage in purposeful activity?</td>
</tr>
<tr>
<td></td>
<td>sexual interest</td>
<td>2) Do you miss being required to function within a definite time structure?</td>
</tr>
<tr>
<td></td>
<td>energy</td>
<td>3) Has boredom increased your feelings of anxiety or depression?</td>
</tr>
<tr>
<td></td>
<td>social contacts</td>
<td>4) Are you able to make spontaneous decisions and act out on them?</td>
</tr>
<tr>
<td>social/familial</td>
<td>family</td>
<td>5) Are you interested in sexual activity?</td>
</tr>
<tr>
<td>chores/activities</td>
<td>household chores</td>
<td>6) Do you have the emotional and mental energy to control your pain?</td>
</tr>
<tr>
<td></td>
<td>recreation/hobbies</td>
<td>1) Have the number of times and/or length of time you see friends or</td>
</tr>
<tr>
<td></td>
<td>self-care</td>
<td>2) Has the number of times and/or amount of time you spend with your</td>
</tr>
<tr>
<td>work</td>
<td>hours</td>
<td>family decreased?</td>
</tr>
<tr>
<td></td>
<td>attendance</td>
<td>1) Has your ability to engage in household chores diminished?</td>
</tr>
<tr>
<td></td>
<td>job changes</td>
<td>2) Have the types of recreational activities/hobbies and/or the time spent</td>
</tr>
<tr>
<td></td>
<td>performance</td>
<td>3) Has your ability to care for yourself diminished?</td>
</tr>
<tr>
<td></td>
<td>tenure</td>
<td>4) Do you feel more dependent on others to do household chores or</td>
</tr>
<tr>
<td></td>
<td>job finding</td>
<td>5) Do you feel that your privacy and personal autonomy have diminished?</td>
</tr>
<tr>
<td></td>
<td>finances</td>
<td>1) Are you able to work on a full-time (typically 40 hours per week) or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Has your ability to go to work in a timely manner decreased?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Have you been tardy or have you had to leave work early more often?</td>
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<tr>
<td></td>
<td></td>
<td>4) Due to exacerbations of your condition, is it hard for you to predict</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5) Have you had to change jobs because of your limitations?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6) Has your job performance deteriorated?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7) Are you in danger of losing your job?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8) Do you believe your condition will make looking for a job harder?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9) Are you under greater than usual financial stress?</td>
</tr>
<tr>
<td>Activity</td>
<td>Class I</td>
<td>Class II</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>ADLs (bathing, dressing, feeding, toileting)</td>
<td>Independent with all ADLs</td>
<td>Independent with all ADLs most of the time. May need intermittent help. Care would be provided on an &quot;as needed&quot; basis for 4-8 hours per day.</td>
</tr>
<tr>
<td>Ambulation</td>
<td>Independent without an assistive device (i.e., cane, AFO, etc.)</td>
<td>Ambulates independently with a mild limp or uses a cane or orthosis occasionally.</td>
</tr>
<tr>
<td>Transportation</td>
<td>Able to drive or use public transportation independently.</td>
<td>Not able to drive, but able to use public transportation.</td>
</tr>
<tr>
<td>Cognition</td>
<td>Able to think clearly and communicate effectively (verbal and written).</td>
<td>Unable to drive, but able to use public transportation.</td>
</tr>
<tr>
<td>Pain perception/effects of medication</td>
<td>May or may not take medication for CRPS and functions well with pain. Pain perception does not limit functional ability.</td>
<td>Pain perception is frequently present and interferes with functioning to some degree. Pain does not reduce personal autonomy to any meaningful extent. May or may not take medication with no or little side effects.</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>If affected, able to use it for all self-care tasks.</td>
<td>Able to use it for self-care, daily activities, and holding, but is limited in digital dexterity.</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>If affected, able to bear full body weight. May or may not limp.</td>
<td>Ambulates with a limp, but it able to walk with little or no limitation.</td>
</tr>
<tr>
<td>Work</td>
<td>Able to work part time or full time. Has no meaningful restrictions on work activities.</td>
<td>Able to work part time or full time with some accommodation and restrictions/limitations.</td>
</tr>
</tbody>
</table>
spective. The use of a straight cane to ambulate would limit a person to one-handed activities while the cane is in use. Assistive devices that require more upper/lower extremity activity, such as crutches, walkers, wheelchairs, etc., would limit functional use of those extremities for work activities. Likewise, implantable devices, such as a spinal cord stimulator, peripheral nerve stimulator, or infusion system, may restrict the performance of job demands that involve repetitive bending, stooping, twisting, or rotating. The effects of exposure to repetitive whole-body vibration may have a detrimental effect on electrode/catheter position and/or tissue injury. The cognitive effects of medications, including reduced attention/concentration, task persistence, and/or stamina, could also erode one's functional capacity to work. Use of public transportation limits job selection to the immediate area surrounding the available routes and does not offer the same job opportunities as driving independently. These examples illustrate that well-intended recommendations in one area of function can impose added limitations in another area. Unless all domains of life function are assessed on an ongoing basis, it will be difficult to judge the intended and unintended outcomes of care.

Throughout the different stages of CRPS, functional capacity can change over the significant domains of life function. Looking at functional issues across these domains allows the physician to make judgments about disability and future care needs. Table 5 gives a brief analysis of how function is affected at each stage of CRPS. The functional descriptors offered for each area of function articulated in Table 5 are designed to provide a general statement of consensus from the authors, resulting from their direct patient contact and research. It is recognized that a given individual may vary in specific functions from one class to another. Rating overall class of function (by assigning a numerical value for the class that best describes one's function across each of the variables and then dividing by the number of variables assessed to calculate an average score) may provide a single indicator of change of functional status. The authors cannot suggest that this is a reliable and valid tool for generating a class of severity index at this time, but intend the chart as the beginning effort to build a construct upon which such research could be done.

Table 6 Chronic regional pain syndrome—activity of daily living (ADL) impairment rating method

| Impairment attributable to CRPS I relies upon demonstrable interference with ADL. For evaluation of impairment attributable to CRPS II in injuries adhering to a specific peripheral nerve territory/structure, the examiner should consider the anatomic approach using peripheral nerve injury rating methods in the current version of the AMA Guides unless the examiner feels the derived impairment would not reflect the limitations of ADL. Rating the examinee by both methods and awarding the higher of the two is recommended. The CRPS-ADL impairment rating method differs only slightly in the lower category, but in the higher categories, a fundamental difference is apparent. In the proposed CRPS-ADL impairment rating method, impairment may equal or exceed amputation value of the extremity. If the examiner feels substantial function of the individual would be improved through amputation of a body part affected by CRPS, the use of the CRPS-ADL impairment rating method is preferred. The role of treatment is considered only through the indirect effect it may have on ADL limitation, providing treatment itself has not resulted in an additional apportionable impairment. In other approaches, the examiner must meet criteria for ongoing CRPS and self-reported limitations of ADL cannot be the sole basis for the impairment. ADLs shown in Table I-H (p. 4 of the AMA Guides, 5th edition) include activities such as self-care, personal hygiene, communication, ambulation, travel, sexual function, and sleep. The examiner is to determine the extent to which the individual is capable of initiating and sustaining activities in both home and work-like settings if such tasks and expectations are relevant. In establishing classes of impairment (Table 7), several criteria are not considered a distinguishing criterion since the availability of a sheltered work environment, the generosity of an employer's accommodation, or local economic fortunes would alter the impairment rating without altering the medical condition. In all categories, the diagnosis of CRPS I or II does not justify an impairment, although CRPS must be documented and present at the time of the examination. The examiner should determine at the time of the examination that the condition is unlikely to change significantly.

Table 7 CRPS-ADL classes of impairment

| Class I (0%) no impairment noted in function. |
| Class II (1-5%) Mild impairment is compatible with most useful function. To obtain the upper limit of impairment within this range, external corroboration of the limitation of activity must be noted. |
| Class III (10-25%) Moderate impairment is compatible with some but not all useful function. The extent of useful function serves to distinguish Class II from III. Interactions with others are impaired but not precluded in this category. |
| Class IV (25-38%) Severe impairment may not preclude all useful function but most independent activities are impeded. It is the ability to retain independent activities that distinguishes Class IV from V. To obtain the upper limit of impairment within this range, all aspects of ADL must be ongoingly affected. |
| Class V (40-60%) Extreme impairment is not compatible with useful function and implies dependency on another for care. It is the degree of dependency that serves to determine impairment within the range. |

An impairment rating can be given as a single numerical rating of total body impairment, taking into account the cumulative effect of CRPS on whole person impairment. Impairment as a result of CRPS affecting multiple body parts shall not be combined for the purpose of establishing the impairment rating. CRPS impairment values may be combined with concurrent pathology as long as whole person impairment value does not exceed amputation equivalent value. Example: Carpal tunnel syndrome in Class II = 8% + CRPS Class II = 9%. Combined impairment rating = 16%.
CRPS Impairment and Disability Issues

(Table 6). Furthermore, it can be used as a clinical guideline for assessing change in functional status following interventions/treatments until such time as it is refined as a result of empirical study.

The authors present the following as an example of how Table 5 can be used in conjunction with Table 7 in order to determine the permanent impairment rating (PIR). For example:

A person is rated as a Class I in three categories, two in Class II, one in Class III, one in Class IV, and one in Class V.

- Class I × 3 = 3
- Class II × 2 = 4
- Class III × 1 = 3
- Class IV × 1 = 4
- Class V × 1 = 5
- 19 / 8 = 2 1/8

The evaluator places the person in the nearest category in Table 7, that is, Class II (1.9% whole person). However, it should be clearly understood that this is a guide. Should the evaluator feel that the person has a significant functional limitation not adequately reflected with the above calculation. The evaluation may adjust the PIR accordingly and state the reason for the adjusted PIR.

Summary
We have attempted to correlate the impaired functional ability as a result of CRPS as it relates to the impairment rating process. While our brief discussion of treatment is valuable, the focus of this paper is to emphasize those issues related to impairment and disability. We have shown that there are multiple parameters involved when dealing with functional ability to perform work and other significant life factors for those diagnosed with CRPS.

Acknowledgment
The AMA Guides to the Evaluation of Permanent Impairment is acknowledged as a reference that has been suggested to be a source to determine quantification of impairment. In many jurisdictions, these Guides have been determined by statutory or regulatory guidelines to quantify impairment related to CRPS.

References
30 van der Laan L, Veldman PH, Goris RJ. Severe complications of reflex sympathetic dystrophy: in-
CRPS Impairment and Disability Issues

CRPS Care Continuum

Pain Management with Oral and Topical Drugs
Psychological Treatment with Educational Focus

Rehabilitation Pathway

Psychological Treatment
- Assess for Axis I Disorders
- Pain Coping Skills
- Biofeedback/Relaxation Training
- Cognitive Behavioral Therapy for Treatment of Axis I Disorders

- Increase Frequency/Intensity of Psychotherapy

- Reactivation
- Desensitization
- Isometrics
- Flexibility
- Edema Control
- Peripheral E-stim
- Treat Secondary MFP
- ROM (gentle)
- Stress Loading
- Isotonic Strengthening
- Aerobic Conditioning
- Postural Normalization
- Ergonomics
- Movement Therapies
- Normalization of Use
- Vocational/Functional Rehab

Interventional Pain Management
- Minimally Invasive
  - Sympathetic Nerve Block(s)
  - IV Regional Block(s)
  - Somatic Nerve Block(s)
- More Invasive
  - Epidural and Plexus Catheter Blocks
  - Neurostimulation
  - Intrathecal Drug Therapy (e.g., Baclofen)
  - Surgical or Experimental Therapies
    - Sympathectomy
    - Motor Cortex Stimulation

EXCELLENT RESPONSE

FOLLOW UP

RELAPSE

REPEAT PATHWAY

Appendix 1