

# Objective assessment of clinical features and level of impairment in patients suffering from Complex Regional Syndrome: a review

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## ABSTRACT

The diagnosis of complex regional pain syndrome (CRPS) is made on clinical grounds, based on the presence of several symptoms and signs that are relatively easy to find when recording the patient's history and in the clinical examination. It is not as easy, however, to quantify these features. Maintaining objectivity is desired in clinical practice, and is particularly important in research studies. Complex regional pain syndrome causes a functional impairment of the affected extremities and limits daily living activity in the patients. An objective measurement of these

limitations is also desired. In this paper we present methods used in contemporary research on CRPS, attempting to objectivize features that are primarily subjective, such as pain and level of impairment. The methods of assessment of these variables are useful in studies on the impact of the disease on patient functioning in daily living. They are also important in a complex assessment of the results of treatment of the condition.

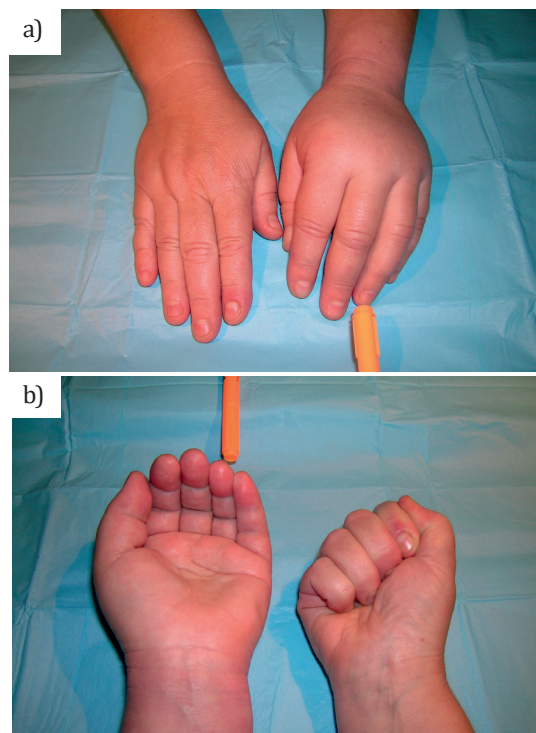
**Keywords:** CRPS – diagnosis; disability; outcome measurement; questionnaires.

## INTRODUCTION

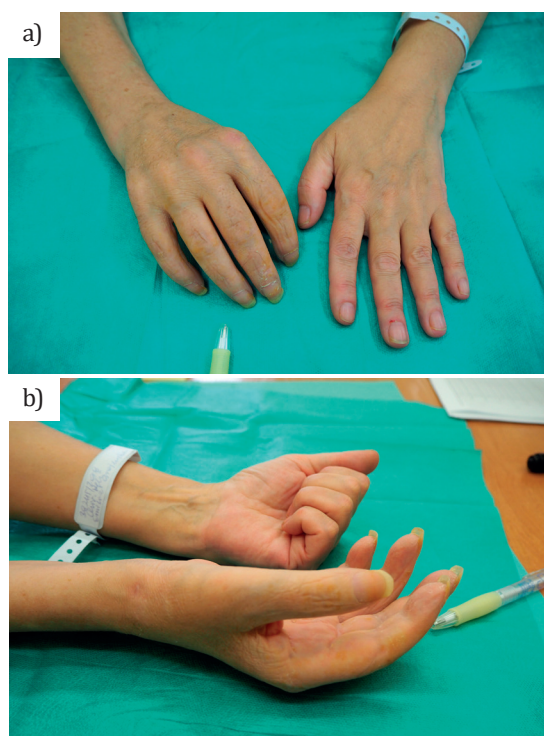
Complex regional pain syndrome (CRPS, formerly – reflex sympathetic dystrophy, algodystrophy, and Sudeck syndrome) is a descriptive term for a complex of symptoms and signs, such as pain at rest or at the slightest movement, swelling, vasomotor instability (changes of colour, temperature and sweating) accompanied by functional impairment of the affected hand or whole extremity. Complex regional pain syndrome is usually caused by trauma or surgery and is characterized by the presence of these symptoms and signs at a level more severe than would normally be expected for the degree of trauma of the precipitating event (which can sometimes be quite minor) and which can extend beyond the area involved by the initial trauma. Complex regional pain syndrome is not confined to the hand and upper extremity. Involvement of the foot, knee and hip have been described, and generally (although very infrequently) can occur anywhere in the body. Complex regional pain syndrome in the upper extremity most commonly occurs after trauma or surgery, but has been known to occur after a stroke, heart disease, or spontaneously [1, 2, 3, 4, 5, 6].

Complex regional pain syndrome presents in 2 clinical forms, depending on the duration of symptoms: early (acute) stage and chronic (late) stage. These forms differ each other significantly. Classical symptoms and signs of acute CRPS include pain at rest, swelling, redness, and increased temperature of the affected hand, as well as the reduction of finger flexion (Fig. 1, 2, 3). These symptoms resemble inflammation of the affected area, so the acute stage is sometimes called the “warm phase”. In the chronic stage, these signs and symptoms change considerably. Chronic CRPS presents with moderate pain in the hand, mild swelling, colder and

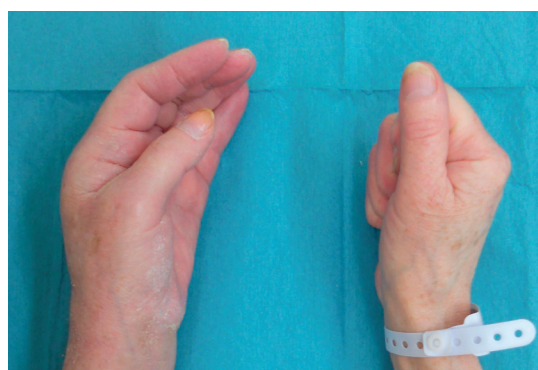
pale skin, frequently hyperhidrosis, with prevailing finger stiffness, giving the patients the greatest difficulties, impaired hand function, resulting in disability (Fig. 4). In some cases neurological signs may develop such as a tremor, muscle spasms, tenderness or allodynia. Many of the CRPS symptoms and signs typical for the acute stage may disappear in the chronic phase [1, 2, 3, 4, 5, 6].



**FIGURE 1.** Acute complex regional pain syndrome. Note: a) red and swollen hand; b) swelling and reduction of finger flexion (compared to a healthy hand)

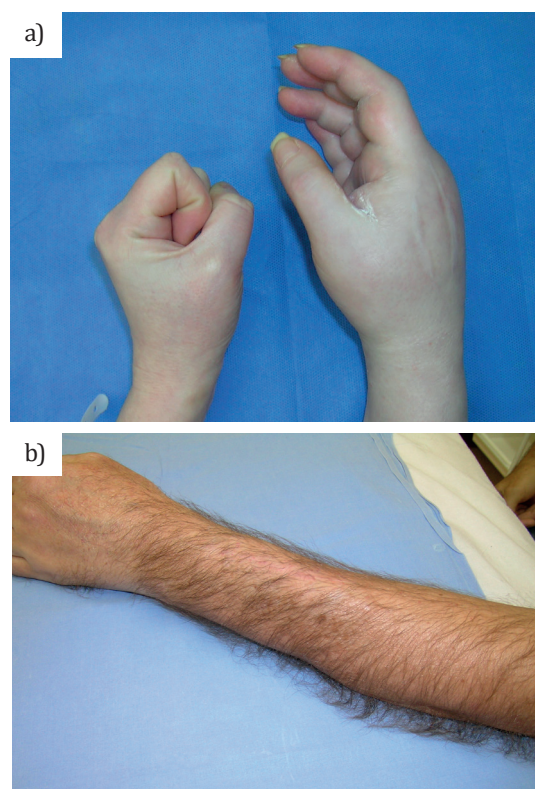


**FIGURE 2.** Acute complex regional pain syndrome: a) after distal radial fracture; b) note no finger movement and increased nail growth



**FIGURE 3.** Acute complex regional pain syndrome Note swelling and no finger movement

The diagnosis of CRPS is based on clinical grounds and the presence of a specified constellation of symptoms and signs, of which pain and dysfunction are fundamental. Nowadays, CRPS is diagnosed according to the Budapest criteria (Tab. 1). These criteria stipulate that CRPS is a diagnosis of exclusion, and alternative diagnoses are provided. No specific biochemical test or imaging is known to have greater diagnostic value than clinical examination [2]. However, the results of standard clinical examination are subjective to some extent, and, therefore, objectification of this assessment is desirable both in research and clinical practice. Finding a single symptom or sign is relatively easy during the examination of a patient. However, determination (measurement) of the range, degree or severity of the individual symptom is much more difficult, particularly for pain and functional impairment. The methods of assessing the clinical severity of clinical features of CRPS and the level of impairment from the disease are useful in studies on the impact of the disease on patient functioning in daily life and in a complex assessment of the results of treatment of the disease.



**FIGURE 4.** Chronic complex regional pain syndrome: Note: a) paleness, swelling and finger stiffness (compared to a healthy hand); b) increased hair growth on the forearm (hypertrichosis)

**TABLE 1.** The Budapest criteria of diagnosis for complex regional pain syndrome

**1. Presence of continuing pain, disproportionate to any inciting event**

**2. Must report at least 1 symptom in each of the 4 categories\***

Sensory	hyperalgesia and/or allodynia
Vasomotor	temperature asymmetry and/or skin colour changes and/or skin colour asymmetry
Sudomotor/ oedema	oedema and/or sweating changes and/or sweating asymmetry
Motor/ trophic	decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (skin, hair, nails)

**3. Must display at least 1 sign at the time of evaluation in 2 or more of the following categories**

Sensory	hyperalgesia (to pinprick) and/or allodynia (to light touch, temperature sensation, deep somatic pressure and/or joint movement)
Vasomotor	temperature asymmetry (>1°C) and/or skin colour changes and/or skin colour asymmetry
Sweating/ oedema	oedema and/or sweating changes and/or sweating asymmetry
Motor/ trophic	decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (skin, hair, nails)

**4. There is no other diagnosis that better explains the symptoms and signs**

\* In each of the 4 categories is a condition for research purposes. For clinical purposes, the report of at least 1 symptom in 3 of the 4 categories is enough to meet this criterion.

The objective of this review paper was a presentation of the methods used in contemporary research on CRPS, and an attempt to objectivize features that are primarily subjective, such as pain and the level of impairment, with particular attention to the disease localized in the upper extremity.

## **METHODS OF ASSESSMENT OF CLINICAL SYMPTOMS AND SIGNS IN PATIENTS SUFFERING FROM COMPLEX REGIONAL PAIN SYNDROME AND THEIR CHANGES IN THE COURSE OF THE TREATMENT**

### **Methods of assessment of intensity and attributes of pain**

Pain is the leading symptom of CRPS. The presence of pain is fundamental in making a confident diagnosis, from the definition and diagnostic consensus for CRPS. There are several attributes of pain in CRPS reported by patients, such as:

- spontaneous (a rest pain) which is typical for the early stage of the condition, or “motion pain” which is provoked by movements or loading the affected extremity (experienced in both stages),
- “diffuse”, as it has a non-anatomic distribution and is experienced usually in the entire distal part of the affected extremity,
- “out of proportion” to the nature of the precipitating injury,
- persisting beyond the expected healing period of the trauma and having no tendency to resolve.

Pain may also be verbally characterized by patients as burning, throbbing, nagging, itching, etc. In some forms of the disease the pain is extremely severe and called by the patients “intractable”. In research studies on CRPS, several aspects of pain intensity are estimated, such as:

- momentary pain,
- the worst and least pain in the preceding week,
- pain caused by loading the extremity.

Results of measurements of pain intensity in these situations may differ [6, 7]. There are also several features of pain which should be recorded in research studies on CRPS. Some are explained below.

### *Localization*

In the upper extremity, pain is usually experienced in a distal part (in the hand, wrist, distal forearm) which is most frequently the affected part. Less frequently pain is localized in the shoulder. As it has been mentioned earlier, CRPS pain has a non-anatomical distribution and is experienced in an area much wider than the site of the precipitating trauma. Therefore it is called “diffuse”.

### *Intensity (severity)*

The intensity of pain is a subjective trait and relatively difficult to measure as it is dependent on several factors, such as the individual's susceptibility (tolerance) to pain. The most frequently used instrument to quantify the intensity of pain is the visual analogue scale (VAS) or the numeric rank scale

(NRS). Using VAS, the patient is asked to indicate the actual intensity of the pain by marking a point along a 10 cm horizontal line, ranging from “no pain” to “maximal pain ever experienced in life”. After indicating this level of pain, the examiner measures (in millimetres) the distance from the beginning of the scale to the marked point. The results of VAS are given in absolute values from 0–100. Numeric rank scale is a similar measure, but the horizontal line is graduated in millimetres (range 0–100) or centimetres (range 0–10). Likewise, in the VAS the patient indicates by marking a point at the intensity of the actual pain. The results of NRS are given in absolute values from 0–100 or 0–10. To appropriately use the pain scales, the patients should be informed how to translate pain intensity into the scale adequately. The author frequently found overestimation of the pain by the patients, i.e. given the patient had not used any analgesic drugs, yet rated the pain intensity at 9–10 points. This result is obviously biased. Despite some drawbacks, VAS and NRS are the most useful instruments for the assessment of pain severity in scientific studies.

### *Character (attributes) of pain*

Pain phenomenon is not uniform and has characteristic attributes (traits), irrespective of its severity.

This concerns particularly the chronic form of pain. These attributes are usually described by the patients with adjectives such as: sharp, dull, bursting, shooting, piercing, burning, throbbing, nagging, etc. The character of the pain is, to some extent, related to its localization in a specific part of the body; for instance abdominal pain is experienced differently by patients than a headache or back pain. Complex regional pain syndrome presents pain also has its specific features due to its localization in the extremity and character of the disease. The McGill Pain Questionnaire (MPQ) is an instrument developed for assessment of several attributes of pain [8]. It consists of 22 words describing various features of pain feeling (some of them are listed above). The intensity of each particular feature is then rated in a numeric scale 0–10. The patient indicates only the particular features of the pain that is experienced. An analysis of the results of measurements of pain with this instrument showed that the number of words (adjectives) used by patients for describing the pain is closely related to the pain intensity: the more words, the more severe the pain is being experienced [7, 8]. This also translates into higher measures in NRS or VAS. The use of MPQ in practice may be difficult due to possible misunderstandings of the numerous adjectives assigned to the pain traits. Therefore this questionnaire is rarely used in studies on CRPS, but more frequently in psychiatry in examination patients with psychogenic pain. Daviddoff et al. found that an assessment of pain severity in CRPS is more reliable and valid with NRS or VAS than with MPQ [9].

### *Character of other pain phenomena (hyperpathia and allodynia)*

Some patients suffering from CRPS experience specific pain phenomena called hyperpathia, tenderness and allodynia. Hyperpathia and tenderness are defined as hypersensitivity

to touch stimuli. Patients suffering from hyperpathia complain of unpleasant feelings in the affected part of the extremity to light touching or when wearing clothes or gloves. Allodynia is the phenomenon of central misinterpretation of innocuous (non-painful) stimuli as severe pain, i.e. light touch, temperature changes (warm into cold) or air movement (draught, wind) are experienced by the patients as a pain. In most patients pain and allodynia are exacerbated by negative emotions (fear, sorrow, grief) or traumatic social life events. Both pain phenomena are typically seen in chronic stages of the condition, particularly in the chronic refractory CRPS. They also accompany the CRPS form caused by nerve injuries which was formerly called causalgia. Both hyperpathia and allodynia are very strenuous for the patients and cause many negative psychological consequences, such as guarding reaction, catastrophisation and depression. It is not clearly known what the pathophysiological backgrounds of these phenomena are, but one theory suggests misinterpretation of the afferent (input) stimuli coming from skin receptors (touch-, thermal- and mechanoreceptors). Signals from all these receptors would be falsely re-directed in the spinal cord into pain afferent pathways and finally recorded and interpreted in brain as pain [7, 10]. For quantification of the intensity of these phenomena, VAS and NRS are employed. There is also a special device called a "dolorimeter" or "pressure algometer" which may be used for the assessment of tenderness in the affected area of the extremity. Measurements with these devices consist of steadily applying increasing pressure locally until the pain threshold is reached. It is however unknown to what extent the data obtained with pressure algometry truly represent tenderness in CRPS [7].

### Methods of assessment of movement disorders

Reduction of movements in joints of the involved extremity is one of the fundamental signs of CRPS. It is frequently called "stiffness" or "contracture". Quantification of movement disorders is relatively easy in the upper extremity. Both active and passive ranges of motion (AROM/PROM, respectively) of the fingers and wrist are assessed with an instrument called a goniometer, either mechanical or electronic, connected with a computer. Both AROM and PROM are given in grades and are easy to interpret and compare. Some difficulties may be associated with objective assessment of the passive range of motion in CRPS patients due to the pain experienced by the finger or wrist movements, so PROM in these patients is always underestimated; the actual range of passive motion may be measured under anaesthesia of the extremity, i.e. under brachial plexus block anaesthesia. Range of motion in the lower limb is not as important in research studies as in the upper extremity. The ability to walk without any support or using crutches is usually enough for the assessment of potential disability. The walking activity questionnaire (WAQ) is an instrument designed for quantification of gait disorders [7].

### Methods of assessment of swelling

Swelling is one of the most frequently signs seen in CRPS patients. In the upper extremity it typically involves the hand

and wrist and contributes to a reduction in finger movement. In the lower limb it is also localized in the distal part (the foot and calf), unless the disease selectively involves the knee joint. In clinical practice, swelling is rarely quantified and commonly described with adjectives such as "mild", "moderate" or "diffuse". In research studies, the circumference of the affected part of the extremity may be measured (in centimetres) and compared with the corresponding part of a healthy extremity and given in an absolute value or as a percentage. More precise measurements of swelling are performed with the use of a special vessel called a volumeter. It is a calibrated jar filled with water, in which the affected part of the extremity is dipped. The overflow of water from the jar is measured and reflects the volume of the examined part of the extremity. The same measurement can be repeated with a non-involved extremity and compared. Resolution of swelling as a result of therapy is a positive sign showing its effectiveness and is associated with clinical improvement. However, swelling also decreases spontaneously in the evolution of CRPS from acute into the chronic stage [6, 7].

### Methods of assessment of vasomotor disturbances

Vasomotor disturbances are frequently seen in CRPS. This term is used for abnormal skin colour, temperature change and abnormal sudomotor activity. The skin of the extremity may be warmer or colder, pink or pale and more wet or dry, comparing to the skin of the unaffected contralateral limb. These disturbances are depended on the status of the vascular bed in the extremity. In the acute stage of CRPS, the vascular bed is dilated, blood flow in the skin is increased and results in a red and warm. In the course of healing (as a result of treatment or spontaneously) these phenomena tend to normalize, but if the syndrome turns into a chronic form, the vascular bed becomes narrower, blood flow in the skin decreases and the skin become pale and cold. In some patients, the skin of the affected extremity become dark (cyanotic) when kept in dependency; it is frequently observed in the lower limbs.

In clinical practice, vasomotor disturbances are described in verbal form, i.e. that the extremity is cold or warm, red or pale, usually in comparison to the other. In research studies requiring more precise assessments of temperature differences between the hands, skin temperature is measured with an infrared thermometer, a surface thermometer or thermovisual cameras [7]. It is important to do these measurements in standard conditions, in closed rooms with a constant temperature and humidity. However, in clinical practice, precise measurements of temperature of the involved extremity is of secondary importance because it is not closely related to more important (leading) symptoms, such as pain and functional impairment.

Another vasomotor disturbance that is relatively frequently seen in chronic CRPS is cold sensitivity (cold intolerance), consisting of exacerbation of pain, reduction of finger movement and cyanosis skin of the affected extremity when exposed to cold. It is particularly troublesome for patients in cold seasons of the year (autumn, winter). Cold sensitivity is not specific for CRPS; it is frequently observed both in replanted fingers or

hands and in the stumps of amputated fingers, when replantation was not attempted.

This phenomenon is difficult to control and may contribute significantly to deterioration of function of the hand and overall quality of life of the patients. The degree of cold sensitivity can be assessed with VAS or NRS, however a specific instrument has been developed called the cold intolerance severity scale [11].

Colour changes of the skin are closely related to the temperature of the affected extremity. In acute stage of CRPS the skin of the hand is red, becoming normal in the course of recovery or becoming pale when the condition becomes chronic. An assessment of colour changes of the skin is of secondary importance both in clinical practice and in research studies, and, therefore is usually scored anamnestically, in comparison to the unaffected limb.

Sudomotor disturbances are less frequently seen than temperature and colour changes. They are present in about 20–30% of CRPS patients, mostly in the chronic stage. Increased sweating (hyperhidrosis) is typically observed in the palm of the hand. This phenomenon is related to local dysfunction of the sympathetic nervous system, but has minor diagnostic value and does not need any treatment. There are several methods of investigation of sympathetic activity, including the sympathetic skin response test, vasomotor response measured by Doppler technique and assessment of the capillary bed under microscopic magnification (capillaroscopy). These methods however are very rarely used in research studies on CRPS [1, 2, 3, 4, 5, 6].

### Trophic changes

Trophic changes in the condition of the soft tissue of the affected hand, the skin, nails and hair, such as faster growth and increased fragility of the nail plates, are typically observed in the acute stage of CRPS (Fig. 2), while increased hair growth (hypertrichosis) is seen rather in the chronic stage (Fig. 4b). Hairs typically grow faster on the dorsal side of the hand and the forearm. Changes in the skin condition and texture are also seen in chronic CRPS: it becomes thin, pale and atrophic. In some patients, a hyperpigmentation or depigmentation may develop. Trophic changes in juxta-articular soft tissue and atrophy of intrinsic hand muscles may contribute to the development of stiffness and contractures. Trophic changes are of minor importance for making a diagnosis of CRPS and in monitoring of the treatment. They are not measured, but rather recorded in a descriptive form as “present” or “absent” [1, 2, 3, 4, 5, 6, 7].

## METHODS OF ASSESSMENT OF THE DEGREE OF FUNCTIONAL IMPAIRMENT

Complex regional pain syndrome always cause functional impairment of the involved extremity. It is associated with a reduction in movement, weakness, and limitations in daily activity. In clinical practice the degree of impairment is simply

scored as mild, moderate or severe, but in research studies quantification of this variable is desirable. As the level of impairment cannot be measured with 1 parameter, questionnaires have been employed to assess it as objectively as possible. There are 2 categories of questionnaire used in research studies: generic and disease-specific measures [12, 13]. The generic questionnaires are designed for assessment of the level of impairment of the affected extremity in various diseases or injuries. One drawback of these instruments is their limited sensitivity and validity in the case of comparison of results between patients suffering from different diseases or injuries. They are also relatively sensitive to bias. The disease-specific forms assume that each disorder disturbs (impairs) the functioning of the patient or the extremity in a specific way and form. These instruments are more precise in the assessment of impairment level, have greater validity (the ability of an instrument to measure what is intended to be measured) and reliability (the ability to measure something in a reproducible manner). They are also more sensitive in the detection of small changes in subsequent measurements, i.e. when monitoring the course of the therapy. Obviously, the results of these measurements can be compared between studies without bias.

Several questionnaires have been developed or adapted for measuring functions of the upper extremity, such as disability of arm, shoulder and hand, patient evaluation measure and Michigan hand questionnaire. All are generic instruments. The Levine (Boston, Carpal Tunnel) questionnaire is a disease specific form developed for the assessment of clinical status and the results of treatment of carpal tunnel syndrome. The short form 36 is a generic questionnaire used frequently in the assessment of the health-related quality of life. The European quality of life scale is similar, but less complicated and shorter for the same aim. Two other questionnaires are used in research on CRPS: WAQ and the acceptance and action questionnaire (AAQ), along with the CRPS specific Raadboud skill questionnaire (RASQ) [7, 14]. In assessments of the level of impairment caused by CRPS, all these instruments were used with limited success. In further parts of this paragraph, some of these will be presented.

### Short form 36

This questionnaire has been commonly employed in studies investigating the impact of injuries or diseases on health-related quality of life. The form consists of 36 items grouped in 8 scales (domains): physical functioning, role physical (role limitations because of physical health problems), bodily pain, general health, vitality, social functioning, role emotional (role limitations because of emotional problems) and mental health. The first 4 domains consist of physical components, and the latter 4 consist of mental components. Raw scores from each item are translated into a final score, ranging from 0 (poor health) to 100 (optimal health). The questionnaire also comprises 1 separate question not related to any scale. This concerns the patient's feeling of actual health status compared to 1 year earlier. This outcome is recorded using a 3-grade scale: better, the same or worse than a year earlier [6, 14].

### Raadboud skill questionnaire

This instrument has been developed to measure the level of disability and handicap caused by CRPS in the upper extremities. It was designed by a team from St. Raadboud University Hospital in Nijmegen (the Netherlands) which is involved in the research and treatment of CRPS. The items in this form were fitted to cover most of the daily activities performed with the hands. The questionnaire consists of 11 domains, with the first 4 belonging to personal care (18 questions), the next 3 to domestic activities (22 questions) and the latter 4 to other activities (18 questions). A numeric (1–5) score is connected to each question on the list. A score of 1 means that given activity can be performed “normally, as usual for the patient” whereas 5 means it “cannot be done any more, because of the patient’s affected hand”. In answering the questions the patient is asked to compare problems in the past 5 days to the condition before the onset of CRPS. Raadboud skill questionnaire scores range 44–220 and a smaller value indicates a lower level of impairment, whereas a larger value indicate a higher level of impairment [7].

### Walking activity questionnaire

This instrument was designed for the assessment of limitations in daily functioning caused by diseases and injuries involving the lower extremities. It is a generic form, but has been used in research on CRPS [7].

The WAQ consists of 36 items grouped in 2 domains: the 1st concerns limitations in walking at home, and the 2nd is focused on walking outside (outdoor). The particular items concern speed, confidence and dexterity of the gait, the ability to overcome obstacles, i.e. stairs, steps, and the necessity of crutches for walking. Each item is answered categorically: “yes” or “not” and scored 1–0. Walking activity questionnaire scores range 0–36, and smaller values indicate lower levels of limitation, while larger values indicate greater gait disturbances. The WAQ reflects only functional impairment, with no direct relation to pain problems [7].

### Acceptance and action questionnaire

Complex regional pain syndrome, particularly in the chronic stage, has a significant impact on the psychological functioning of the patient.

Both ongoing (debilitating) pain and disability may cause many negative psychological consequences, such as decreased self-confidence, mood disorders, catastrophisation, fear of the future, suicide thoughts and predisposition to depression. Depression is a facilitating factor in the initiating and mediating of many secondary psychosomatic disorders. Both physical and psychological impairments translate directly into a deterioration of health-related quality of life. Therefore it is desirable to assess the impact of CRPS on the psychological sphere of a patients’ life and the AAQ has been developed for this purpose. It consists of 10 statements, each scored 0–7, depending on how close it concerns the actual situation of the patient. The particular items are related to the patient’s sensitivity

to traumatic life events, and the ability to overcome them in a way to reach life’s aims [7, 15]. The AAQ is a disease-specific instrument, however its use in practice and research is limited.

### FINAL REMARKS

This article presents known methods of scientific investigation of the symptoms and signs of CRPS as well as the degree of impairment caused by the disease. These instruments are used in research studies investigating the possible effects of the condition on a patients’ functioning in daily life and in comprehensive assessment of treatment outcomes. The authors believe that this information may be interesting for doctors and therapists who are involved in diagnosing and treating this very interesting and still mysterious disease. Likewise, it should be interesting for scientists conducting research studies on CRPS.

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