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Measuring Functional and Patient-Reported Outcomes after Treatment of Mutilating Hand Injuries – A Global Health Approach

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SYNOPSIS

Understanding the global burden of trauma, particularly upper extremity trauma, is necessary in addressing the global need for surgical services. Critical to that mission is to understand, and accurately measure, disability and related Disability Adjusted Life Years (DALY) resulting from massive upper extremity trauma. This is particularly important in developing nations, where these injuries occur more frequently, and social services to support the disabled are not available. The impact of these injuries on patients and on society is magnified when considering that they frequently occur to young people in their prime working years. In this article, we discuss these social and medical system issues. We also review components of a comprehensive approach to measuring outcomes after these injuries. Patient reported outcomes are highlighted, as they provide unique insights into quality of life and mental health components central to understanding composite disability, and must be used in outcomes evaluations for the mutilating upper extremity injury patient. Methods of optimizing outcomes measurements and studies, disability assessments, and associated research are also discussed.

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Keywords

Patient reported outcomes; Impairment and disability; DALY; Global health; Mutilating upper extremity trauma

Introduction

Inadequate access to high-quality surgical services is a notable gap in the World Health Organization's (WHO) goal of improving health care delivery for all nations.^{1,2} This is especially true of surgical services related to trauma, as injuries account for the greatest annual welfare lost among low and middle-income countries.^{3,4} To address the deficit of surgical services, various organizations have aligned to understand and improve access to safe surgery and anesthesia to meet 80% of the world's needs by the year 2030.² The foundation of this objective lies in the coordination of multiple disciplines, including governmental organizations, non-governmental organizations, local physicians and surgeons, and international funding sources. To achieve this 80% goal, we must first understand the global burden of surgical conditions and the resultant impact on society.⁵

Trauma to the upper extremity accounts for the majority of musculoskeletal trauma, in wealthy as well as developing nations.^{4,6–10} Musculoskeletal trauma is projected to contribute 20% of the overall global burden of disease by the year 2020, owing largely to disability caused by these injuries.¹¹ Disease burden is magnified with upper extremity injuries when considering many patients who sustain these injuries are young and otherwise healthy, with much of their productivity and financial stability dependent on working with their hands.^{9,12–14} In developing nations, where machinery and motor vehicle injuries are more common, mutilating upper extremity trauma is a frequent cause of disability and resultant loss of productivity.^{11,15,16}

Disability reflects limitations in an individual's cognitive or physical capacity that prevents completion of activities of daily living.¹⁷ Vulnerable populations, including those living in lower-income nations, experience disability with greater prevalence than those in higher income nations.¹⁸ As a result of a growing population of people with chronic illnesses and age-related diseases, the WHO has recently launched new programs to invest in services for the disabled, and improve public awareness of these conditions.¹⁹

Another focus of the WHO has been on improving research strategies and quantification of data important to improving conditions among those with disabilities. The disability-adjusted quality of life year (DALY) is one of the most commonly used metrics to define the economic consequences and effects of morbidity and mortality on the burden of disease (Figure 1). Introduced in the World Development Report in 1993, DALYs sum the total years of life lost and years of life lived with disability.^{20–22} A step beyond the Quality Adjusted Life Year (QALY) that some researchers are more familiar with, the DALY uses age-weighting that helps highlight the value of interventions that improve conditions affecting younger patients with longer time spent disabled.²³ This makes the DALY an important tool for evaluating upper extremity injuries.

By comparing the calculation of DALYs lost with and without an intervention, or between two interventions, it is possible to demonstrate potential economic and societal growth attributable to changes in care delivery.²⁰ Because the DALY quantifies the amount of time “lost” rather than “gained” owing to a particular treatment, this metric can be used to demonstrate potential improvements foreseeable as a result of changing systems and practices currently in place. However, a major challenge in implementing these types of analyses, especially for upper extremity trauma, is how to define surgical outcomes as they relate to function and associated disability. Disability weights are notably lacking for most upper extremity conditions, especially those related to trauma.²⁴ Considering that upper extremity use is intricately linked to economic growth and productivity, accurately and thoughtfully measuring outcomes of upper extremity trauma treatment is critical. This is especially true for complex injuries in mutilating upper extremity trauma.

The outcomes research movement has grown as a result of an increased focus on patient-reported outcomes (PROs). As techniques for measuring and analyzing outcomes have substantially improved, the value of PROs in guiding high-quality, high-value care has been frequently demonstrated.^{25,26} Although radiographs, range of motion, wound healing, or bone healing were the primary outcomes of early research, patient-reported outcomes, composite functional tests, and complex movement analysis are now used to provide more objective, direct measures of hand surgery outcomes. Although the value of some of these complex approaches is not yet clear, understanding outcomes of care in terms of cost and quality has come to the forefront of research, clinical care, and health care policy around issues of resource utilization and distribution.

Improved understanding of outcomes has progressively changed hand and upper extremity care delivery, but these research approaches are made more difficult by the complex nature of mutilating upper extremity injuries. When considering the various mechanisms, anatomic injuries, extent of contamination, reconstruction options, and other anatomic and injury-related variations, gathering organized and valuable data about these patients is difficult.²⁷ These challenges are more pronounced when evaluating mutilating upper extremity injuries across the international spectrum. Not only are there wide gaps in available resources and care infrastructure, but also different cultural and regional views on expectations and delivery of surgical care.^{28–30} Despite these challenges, evaluating outcomes after surgical treatment of the mangled upper extremity is of critical importance. Unlike the lower extremity, the prosthetic options for the upper extremity remain limited and inadequate as compared to preserving a functional limb, even if not at full capacity.^{31,32} Salvage treatment for patients with mutilating upper extremity injuries remains a top priority so that outcomes can be optimized and patients can return to function and gainful employment as often as possible. Measuring and understanding outcomes after mutilating upper extremity injuries is critical for improving care and quality of life for these injured patients.

In this article, we review techniques used for measuring outcomes after upper extremity surgery, the challenges associated with using these techniques for the mutilating hand injury patient, and the potential value of these instruments for patients of varying demographics and regions across the globe.

Measuring Outcomes

With the increased focus on understanding outcomes has come a wave of new measurement approaches and tools. Certainly, understanding how a patient is able to move and function after an upper extremity injury is important. However, as we engage in understanding the multi-dimensional facets of functional recovery on a patient's psychosocial well-being and their interaction with the external environment -- such as their family, their work place, and society -- a holistic concept of health-related quality of life (HRQL) has developed.^{23,33} Quality of life is an interactive tenet with contributing influence from psychological, physical, functional, and social factors. Additionally, related economic and spiritual/religious elements can have an effect. HRQL describes how these components of a patient's life are affected by their health condition and health status.^{17,34–36}

The movement to understand HRQL and related elements of post-traumatic recovery has drawn attention to understanding patient-reported outcomes. By allowing patients to report on their condition and ability to function, we have gained insights into overall disability beyond simple anatomic evaluations or basic functional tests. These approaches have shown the importance of understanding returning to function and work, mental health and coping, and other critical components of post-injury support that contribute to long-term treatment success.

One of the critical elements to understanding outcomes after upper extremity trauma is the distinction between impairment and disability. Impairment is defined as “an alteration of an individual's health status – a deviation from normal in a body part or organ system and its functioning,” whereas disability is defined as “an alteration of an individual's capacity to meet personal, social, or occupational demands because of an impairment.”^{37,38} For some patients they are related, but in many cases, a patient's anatomic impairment does not correlate to their degree of disability.^{39,40} Some with less severe injuries are functionally limited, yet others with mutilating injuries find ways to return to useful function even with severe impairment.⁴¹ This gap is often accentuated when evaluating patients with external pressures to optimize function.

Measurement Approaches and Techniques

Although PROs are immensely valuable in measuring post-traumatic outcomes, applying standardized norms and comparing scores across PROs defined in high-income countries may result in inaccurate comparisons in measured impairment and disability among patients in developing nations. Many of these patients are potentially more likely to overcome obstacles in order to return to adequate function so they can provide for themselves and their families. Although these external pressures may result in an optimization of outcomes, they also make understanding treatment outcomes as well as the gap between impairment and disability an even greater challenge. For some patients, utilizing the traditional strength, range of motion, and composite functional tests – especially as they relate to PROs – may be of great value in helping understand which treatments are better than others. The complex and variable nature of the injuries necessitates a comprehensive multi-modal approach to measuring outcomes after mutilating upper extremity trauma.

Functional Testing

Traditionally, outcomes studies are centered on strength, range of motion, and sensory tests. For strength testing, grip, three-finger pinch, key pinch, and many others have been routinely used, with technique descriptions and standardized instruments available.⁴² However, even if these tools are not available to investigators with limited resources, these strength metrics can be tested other ways as long as the methods are reproducible and standardized across patients and measurement episodes.⁴³

For sensory testing, Semmes-Weinstein monofilaments and 2-point discrimination are frequently used, although many others exist.^{44,45} These techniques can evaluate static and dynamic sensory function, vibratory and pressure sensation, and sensory acuity. Although the technique used across testers is somewhat more susceptible to variation and inconsistency than the strength tests, these sensory metrics all have standard techniques for use that can be taught.⁴⁶

The appeal of these tests is that they are easy to perform, reproducible, understood by patients and providers, and can be compared amongst studies. As a result, many of them have become commonplace in the discussion of treatment outcomes after upper extremity surgery. However, they do not provide a complete understanding of function. As a result, composite functional testing is also frequently used.

Composite functional tests aim to evaluate the patient's use of the entire limb, and often test fine and gross motor tasks. Some also include tests that evaluate composite activities of daily living (ADLs) as a way to evaluate a patient's ability to function independently with their condition. Each method differs in approach to testing function and ADLs, with varying clinimetric properties and overall utility in understanding the condition of the upper limb.^{47,48} One shortcoming of these tests is that they often use time as a gauge for success and adequate performance, which introduces additional biases and inaccuracies in measurement unrelated to isolated limb recovery and function (eg. visual acuity, baseline tremors, traumatic head injuries, and others). Age-based normative values have been reported for some tests, helping to reduce that measurement inaccuracy over groups of patients.^{49–52}

More recently, biomechanics and kinesiology specialists have worked to devise technology-based approaches to testing strength, range of motion, and function of the upper limb.^{53–55} Across these composite and biomechanical tests, none has been repeatedly shown to be better than the others; however, most of them provide some useful information. Additionally, similar to the static tests described above, these approaches provide a standardized and reproducible way to evaluate function.

Many consider these functional tests, especially the digitized strength and range-of-motion measurement tools, to be more “objective” measures; however, the amount of effort and force a patient puts in to the test, as well as reporting accurately for sensory testing, can all be altered by the patient if they choose to do so.^{56,57} Therefore, the terms objective and subjective should be eliminated in any hand functional measures because the patient, based on their effort and intangible motivation, can influence them all. Where these tests are

notably lacking is in the ability to measure and report on psychosocial aspects of recovery that are not directly related to function. As a result, researchers and providers use PROs to fill those knowledge gaps.

Patient-Reported Outcomes Measurements

The patient-centered outcomes movement has increasingly put value on reporting, understanding, and optimizing health-related quality of life (HRQL). Understanding how to consistently improve HRQL after treating a condition, while minimizing excess spending and waste, is important to providers, economists, health systems, patients, and society as a whole.^{26,58} In efforts towards reaching this goal, the value and importance of patient-reported outcomes has grown immensely. It has been repeatedly demonstrated that allowing patients to report on their conditions provides unique and reliable insight into their recovery and overall condition.

PROs are obtained through questionnaires. The questionnaires focus on general, system-specific, or condition specific HRQL.²⁶ Many evaluate how patients believe they are able to perform critical activities of daily living (ADLs). To be used for research and outcomes measurements, these questionnaires are thoroughly evaluated for numerous metrics, including reliability, validity, and reproducibility (TABLE 1). Questionnaire results can then be compared across studies and among conditions. Critics regard these PROs as subjective and potentially manipulated by patients with ulterior motives; however, they are no more easily manipulated than the functional tests, and in many cases provide unique insights that the functional tests can not evaluate.

Challenges in the Mangled Extremity Patient

PROs after upper extremity trauma, when followed over time, often show improvement in HRQL.⁵⁹ Some of this is attributable to recovery but some is also related to patients adjusting to their conditions.³⁰ The ability to adjust to a condition varies. Patients from different financial, cultural, and regional backgrounds may approach their treatment, rehabilitation, and outcomes differently.⁶⁰ Considering that a substantial volume of these injuries occur among patients in developing nations, we must think about the different experiences these patients have in dealing with upper extremity trauma compared to those in higher income nations. The absence of adequate social services, rehabilitation, and financial support for families creates a different series of motivations for these patients to push through their recovery.⁶¹ Additionally, these differences will change how patients report their outcomes, increasing the difficulty with which these treatments and results can be studied in a systematic fashion. Most of what we know about PROs has come from patients and studies in wealthy nations. Interpreting and translating PRO results from patients in the developing world is likely different from patients in wealthy nations, and may limit how well these metrics reflect long-term functional outcomes and disability.

Improvements in data collection and databases provide new ways to analyze group data to evaluate systems of care and utilization.⁶² Whether using patient databases for clinical trial and outcomes studies, or larger state or national databases for “big data” studies, improvements in data collection and organization have opened doors to answering many new

and challenging questions. Additionally, by pooling data, researchers are able to evaluate components of care that otherwise could not be properly analyzed owing to smaller patient numbers or too little variation in small outcomes studies. However, larger database approaches are a challenge for evaluating the treatment of mutilating upper extremity injuries because of variability inherent in these traumas. This is made more difficult by the variations in treatment approaches and options for these patients. This heterogeneity results in limited utility of the currently available large databases for studying these types of injuries, and makes it difficult to organize a clinical study evaluating mutilating hand injury treatments and outcomes with most of the resources available today. Additionally, much of the available data in trauma registries has inconsistent quality, especially for data from developing nations.²⁷

Another challenge in using PROs to evaluate massive upper extremity trauma is that these questionnaires are mostly all written in English and geared towards Western society with certain values and norms.⁶³ As a result, using these PROs globally requires accurate translation (FIGURE 2) and cross-cultural validation.⁶⁴ This is especially important when attempting to gain insights into elements such as satisfaction that can largely be dependent on expectations and goals.^{63,65} Patients in developing nations may have different approaches to their care, and that may be reflected in how they consider and respond to items in questionnaires. This may also limit the comparability of PRO results from different patient populations in ways unique to international research. As researchers look to use these translated instruments in the international arena, it will be important to validate them across the different cultures and populations of interest – including comparisons to some of the functional metrics – similar to what has been done in English-speaking countries.

Validation of PROs

A key step is to validate PROs for use in this population. As described above, there are metrics used to evaluate the questionnaires, and confirming that these questionnaires correlate to the traditional measures of recovery – strength, sensation, composite function, etc. – is an essential step in that process. This has already been done for some questionnaires, and although the sample populations for the validation studies are somewhat limited, these questionnaires should be used in future studies. Most notably, the Michigan Hand Questionnaire (MHQ)^{66,67} and the Disability of the Arm, Shoulder, and Hand (DASH) questionnaire⁶⁸ have been frequently used and evaluated with the upper extremity trauma patient.^{69,70} With the addition of an aesthetic element and greater focus on satisfaction and HRQL, the MHQ often correlates more strongly to mental health outcomes than other upper extremity questionnaires.³⁹ Although the impact of this finding is not yet clear, especially as it relates to measuring quality of overall care and long-term disability, it illustrates how across validated PROs there can still be variations in the findings. Understanding the different benefits and downsides of the questionnaires helps in choosing the appropriate metric to use for each research question.^{71,72} It is also important to consider the factors that can affect questionnaire responses (Table 2) and mitigate them as best as possible in designing and implementing a study.⁷³

One study that aimed at answering the question of how the functional measures relate to the PROs, and how both of these outcomes contribute to overall functional disability, highlights the complex interplay between these elements. In this study, finger amputation patients performed functional tests and completed PRO questionnaires.³⁹ They also had anatomic injury (“impairment”) measured based on a standardized weighting system by digit and length lost. The patients then performed complex functional tasks as a measure of their ability to perform ADLs and as a way to reflect overall disability. In this study, the upper extremity PROs not only correlated with the functional tests, but they also correlated with mental health and HRQL questionnaires, and overall composite function and disability. The impairment score, reflecting anatomic injury, did not correlate with performance and overall disability. This study confirms the importance of measuring outcomes after upper extremity injuries, and of using instruments that will reflect total composite function and not just see the anatomic injury as the only element in recovery.

Where this becomes even more important is in translating PROs and the results of these studies to the developing world. In these patients, the degree of anatomic injury is potentially less likely to predict outcomes and return to function. The external motivation to optimize recovery is different in those cultures and economic systems. As a result, aspects of rehabilitation care systems, returning to work, and patient participation also must be evaluated to fully understand the recovery process. Considering the impact that a return to function can have for these patients, it is even more important that we find ways to measure outcomes and improve care in the resource-limited setting.

Applications in Research

The available literature on outcomes after mutilating upper extremity trauma is sparse. Although a few larger case series as well as large database studies exist, the vast majority are published using small case series and single surgeon or single center experiences that focus on distal amputations and replantation. Within high-income nations, documenting the consequences of severe mangling and proximal injuries is limited to small series as a result of the low incidence of these injuries. In developing nations where these injuries are more common, the lack of access to proper surgical services and research support limits the opportunity to gain perspective on these injuries regardless of the high incidence.

However, we have developed great knowledge from what is presented in the upper extremity trauma outcomes literature. By measuring outcomes after surgical treatment of the traumatized upper extremity, we have improved understanding of external fixation versus internal fixation techniques, methods to optimize bone healing, timing of reconstruction, replantation techniques, and much more. Notably, the value of replantation and complex salvage of the mangled upper extremity has been evaluated.^{74–76} The early outcomes research for these injuries has paved the way for the complex care and complex research methodology.

As we look to improve how we measure outcomes in these patients, the focus has shifted to improving utilization of PROs to understand the complexities of recovery, functionality, and associated disability from these injuries. Through this information not only can we guide

appropriate care to improve outcomes, but also establish the value of upper extremity salvage, the need for services in resource-limited settings, and approaches to optimize care of the upper extremity trauma patient. Additionally, as treatment guidelines and care criteria are established, data collection can be done in a more organized and systematic way to build databases and facilitate larger studies.

One of the next steps is to develop a core outcomes set to be used for all upper extremity trauma studies.⁷⁷ This set should be based on a conceptual framework of health, and vetted thoroughly to determine the best set of outcome measures to encompass all critical elements of recovery after upper extremity trauma. This will help minimize confusion across studies, facilitate better cross-study comparisons, and reduce inconsistencies in data collection and reporting to begin addressing the gaps in available data and measured outcomes after upper extremity reconstruction and salvage.

Impact and Related Research

Beyond measuring outcomes, there are related areas of research that help clarify the impact of understanding how these patients recover after injury. To evaluate the true economic implications of mutilating hand injuries in developing nations, we must first identify the percentage of musculoskeletal trauma that is related to upper extremity injury, and to define the incidence and prevalence of this particular trauma. Although studies have been performed to evaluate the global burden of surgically treatable conditions as a whole, additional studies are required to understand the epidemiology, mechanisms of injury, and environmental exposures that contribute to the globally high incidence of trauma in a condition-specific manner.^{18,24,78} Given the basic principle that the economic and societal burden of surgical disease is based on the incidence and prevalence of any condition, global estimates of upper extremity trauma are critical – not only to understand the need for care delivery, but also to add value to improvements we can make in treatment outcomes and optimization.⁵

We must create an accurate metric of disability among patients with hand injuries to improve the generalizability of findings as we move forward with additional studies. This approach ties in closely to the concept of creating a core set of outcomes measures to use in all upper extremity trauma studies. The inextricable link between hand injuries, functional outcomes, and occupational consequences is likely underestimated and underreported in the absence of such a system. Although the DALY is a useful measure that can be compared across conditions and populations, some have suggested that categorizing surgical needs into met, unmet, and unmeetable needs is a more practical method. Calculating “effective coverage,” as a metric of met need compared to overall need, would promote countries to more effectively plan and improve access to care for conditions that place the greatest burden on society.⁷⁹ Different nations have different needs, and the benefits of adding and expanding surgical services vary based on the unmet needs in different regions. Understanding these variations across the international spectrum will guide prioritizing care delivery.

Another novel approach to evaluating the disability burden due to a condition is the Model Disability Survey (MDS), piloted by the WHO and the World Bank.⁸⁰ The MDS avoids

using surveyors who often under-report patients with mild to moderate disability, and instead compares affected to non-affected patients to determine disability criteria. Such improved evaluation and capture of disabled persons is a substantial step towards understanding injury burden, and could benefit the study of upper extremity disability after trauma. This, alongside improvements in understanding what treatments and approaches optimize outcomes, will facilitate improvement in the care of these patients worldwide.

One of the most important elements is to establish that high-quality outcomes can be obtained in the resource-limited setting. This has been done by the Ganga hospital group, along with select others.^{16,74} Complex reconstruction can be performed in these settings. Until recently, the need in these regions has largely been ignored aside from intermittent mission work. Mission trips focused on hand surgery are thought to be cost effective in that the cost per DALY averted is less than twice the per capita gross national income.⁸¹ Although mission trips are important to minimize the continued disability associated with remote injuries, it is only by having well-trained local providers that a sustainable system is achieved.⁸² This includes availability of complex reconstruction and microsurgery. Current data reflect an overall limited number of orthopedic and plastic surgeons practicing in the developing world, where need for these services is high.⁸³ For example, in the United States and Canada there is one plastic surgeon per 57,000 people. In India and China, there are 1.5 plastic surgeons for every one million people. In sub-saharan Africa, there are even fewer providers -- Ghana has 6 plastic surgeons for 22 million people, and Uganda has 3 plastic surgeons for 27 million people.^{83,84} As we improve our understanding of treatment outcomes, disseminating this information to front-line providers will aid in optimizing quality and triage of the limited care that can be delivered by the available surgeons.

The cost-effectiveness of surgical interventions overall compares favorably to that of vaccines. Although the cost of vaccinations is \$5 for every DALY averted, the cost of surgery is slightly higher at \$11–77 per DALY averted.⁸⁵ In developing nations, the cost is on the lower end of that range because the DALY benefit for the same procedures is often higher.⁸⁶ Improving care and associated outcomes will only make reconstructive upper extremity surgery more valuable. Given the importance of hand function on all aspects of economic productivity, as plastic and orthopedic surgeons we must clearly delineate the contributions of hand injuries to this system. By defining the proper metrics, disease-specific factors, and modeling schematics unique to treating mutilating hand injuries, we can create an environment of sustainable progress within middle- and low-income nations.

Summary

Measuring outcomes after massive upper extremity trauma is a critical yet difficult task, made more complicated by the various cultures and regions affected by these types of traumatic events. As a result, a comprehensive approach to this international problem is warranted, one that combines the various modalities in a way that promotes thorough outcomes measurement, consistent and reliable reporting, and an ability to improve our understanding of treatment quality and value as they relate to long-term disability and patient satisfaction. As this information becomes available, it must be spread to the already overburdened providers in the developing world, so that they may optimize care systems and

care delivery for this high-need population. This has unique implications for the developing world, where economics of care place even greater value on capacity building, quality improvement, and high-yield approaches to complex surgical challenges.

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KEY POINTS

- Measuring outcomes after mutilating upper extremity trauma is a key component to understanding disability after these injuries, and holds major implications for addressing the global burden of extremity trauma.
- Patient reported outcomes are necessary for understanding disability and associated quality of life after these injuries.
- Due to the complexity and variability of massive upper extremity trauma, understanding outcomes requires a multi-modal approach, along with improvements in data collection.
- Using outcomes measures to determine disability after extremity trauma is critical to understanding the value of associated surgical care delivery and resource utilization, especially in developing nations.

Figure 1.
Components used to calculate Disability Adjusted Life Years (DALY)

Figure 2.

Flow diagram for the process of translating a PRO questionnaire. *Adapted from* Sperber AD. Translation and validation of study instruments for cross-cultural research. *Gastroenterology*. Jan 2004;126(1 Suppl 1):S126; with permission.

Table 1

Definitions for key measurement properties used in evaluating the quality of patient reported outcomes instruments

Measurement Property	Definition
Content Validity	Degree to which the content of an instrument is an adequate reflection of the construct being measured
Criterion Validity	Strength of relationship between questionnaire scores and a measurable criterion ("gold standard")
Construct Validity	Degree to which the scores of a questionnaire are consistent with the theoretical construct (hypothesis) being measured
Face Validity	Degree to which items in an instrument look as though they are an adequate reflection of the construct being measured
Internal Consistency	Extent to which the items are interrelated, and thus measure the same construct
Reliability	Extent to which patients can be distinguished from each other despite measurement errors
Test-Retest Reliability	Extent to which scores for patients who have not changed are the same in repeated measurements over time
Interrater Reliability	Extent to which scores for patients who have not changed are the same over repeated measurements by different examiners during the same visit
Responsiveness	Ability to detect clinically meaningful change over time in the construct being measured
Interpretability	Degree to which quantitative scores can be given qualitative meaning. Identifying clinically important differences in results.
Cross-Cultural Equivalence	The same measurement instrument used in different cultures measures the same construct without additional external cultural influences on results

Table 2

Factors affecting accurate completion of questionnaires

Patient Factors	Literacy
	Comprehension
	Mental and Emotional State
	Personality
	Fatigue
	Secondary Gain
Questionnaire Factors	Length
	Clarity
	Applicability and Relevance of Content
Other	Environment
	Compensation
	Ongoing Litigation
	Family or Caregiver Influence

Adapted from Bindra RR, Dias JJ, Heras-Palau C, Amadio PC, Chung KC, Burke FD. Assessing outcome after hand surgery: the current state. *Journal of hand surgery*. Aug 2003;28(4):291; with permission.