

Combat Casualty Hand Burns: Evaluating Impairment and Disability during Recovery

CPT Ted T. Chapman, OTR/L
Reg L. Richard, MS, PT
CPT Travis L. Hedman, DPT
LTC Evan M. Renz, MD
Steve E. Wolf, MD
COL John B. Holcomb, MD

*United States Army Institute of Surgical Research,
Fort Sam Houston, Texas*

ABSTRACT: This study evaluated the use of the American Medical Association (AMA) impairment guides and Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire in U.S. military casualties recovering from burn injury to the hand. Study sample included patients with burns to at least one hand and complete evaluations of impairment and disability upon discharge from the hospital and at a follow-up visit less than four months later. AMA and DASH scores were calculated for each visit and standardized response means (SRMs) were calculated to indicate responsiveness. Correlation between impairment and disability was assessed at discharge and follow-up and scores were examined for ability to discriminate between casualties returned to duty (RTD) and casualties not returned to duty (N-RTD). Both outcome instruments revealed a statistically significant change in scores between visits ($p < 0.001$) with corresponding SRM indexes greater than 0.8 (large effect). There was a moderate correlation ($r = 0.50$) between impairment and disability at discharge and a moderately high correlation ($r = 0.74$) at follow-up. Both AMA and DASH scores clearly discriminated between casualties RTD (AMA 10 ± 10 and DASH 12 ± 12) and casualties N-RTD (AMA 39 ± 19 and DASH 41 ± 17) with improved accuracy at follow-up visit. The AMA and DASH can provide a comprehensive assessment of impairment and disability and may be used to detect changes in patient health status over time while clearly discriminating between RTD and N-RTD in combat casualties recovering from burn injury to the hand(s).

J HAND THER. 2008;21:150-9.

Burn injury is common in military operations and currently comprises 5–20% of conventional warfare casualties.¹ All military casualties from Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) with significant burns are cared for at the United States Army Institute of Surgical Research (USAISR) Burn Center, ensuring complete entry and follow-up for Department of Defense burn casualties.

Disclaimer: The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense. The brand names of any commercial devices cited are for illustrative purposes and do not imply endorsement by the Department of the Army or the Department of Defense. The authors have no financial interest in any commercial device herein cited.

Correspondence and reprint requests to Reg L. Richard, MS, PT, Clinical Research Coordinator Burn Rehabilitation, United States Army Institute of Surgical Research, ATTN: MCMR – USC – PT, 3400 Rawley E. Chambers Avenue, Fort Sam Houston, TX 78234-6315; e-mail: <reginald.richard@amedd.army.mil>.

0894-1130/\$ – This is a US government work. There are no restrictions on its use.

Published by Hanley & Belfus, an imprint of Elsevier Inc.

doi:10.1197/j.jht.2007.12.003

We recently investigated the presence of burn injury to the hand on returned to duty (RTD) and learned that the mere presence of hand burn does not predict whether injured military personnel will be able to RTD.² However, many full thickness (FT) hand burns can be tremendously incapacitating, despite the hand's small size (5% of the total body surface area [TBSA]), as they are often difficult to manage and treat even after successful wound closure and discharge from the hospital.³

During the post-Vietnam era in 1976, Salisbury and Pruitt reported that the problems of rehabilitating patients with burns to the upper extremity and returning them to work can be overwhelming and special emphasis should be placed on maintenance of function throughout the entire hospital course and far into convalescence.⁴ As an increasing number of patients survive large burn injuries, attention has become increasingly focused on functional outcome with a crucial element of quality of life being the restoration of hand function.⁵ Multiple treatment options exist for managing burns to the hand, which vary according to injury characteristics and clinician

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 01 APR 2008		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Combat casualty hand burns: evaluating impairment and disability during recovery				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Chapman T. T., Richard R. L., Hedman T. L., Renz E. M., Wolf S. E., Holcomb J. B.,				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) United States Army Institute of Surgical Research, JBSA Fort Sam Houston, TX 78234				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 10	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

preferences. However, most clinicians would agree that optimal outcome of the burned hand requires high-quality acute care with an unrelenting focus on prompt wound closure, preservation of motion and function, rehabilitation, reconstruction, and long-term multidisciplinary follow-up services.⁵⁻⁷ Unfortunately, achieving "optimal outcome" and defining "high-quality care" remain elusive as we lack outcome measures in the hand burn population that demonstrate the ability to detect clinical change in hand function during recovery. Effective outcome measures can assist in determining what works and what does not⁸⁻¹¹ and lead us toward publishing much needed high-quality clinical evidence.

LITERATURE REVIEW

The World Health Organization characterizes different levels of health status as impairment, disability (activity limitations), and handicap (participation restrictions).¹¹ Impairment is defined by the American Medical Association (AMA) as the "loss, loss of use, or derangement of any body part, organ system, or organ function."¹² Disability is the functional consequence of impairment and is defined as an alteration of an individual's capacity to meet personal, social, or occupational demands. An impaired individual may or may not have a disability.¹³ That is, if the individual can compensate or adaptations can be made to the environment, then the individual may not be disabled from performing specific activities.¹² Handicap is a disadvantage for a given individual, which limits or prevents that individual from fulfilling a role that is considered normal for that individual. Handicaps, or participation restrictions, are dependent on a variety of personal, psychosocial, societal, and cultural factors.¹¹ Not all impairments result in disabilities and a person can be disabled but not handicapped.

Examples of impairment that therapists typically evaluate include amputation, edema, range of motion, strength, sensation, and pain. Tests used to measure hand disability include the Jebson Test of Hand Function, Purdue Pegboard, and various other functional tests. Upper extremity disability measures may also be assessed by having a patient rate his or her own ability to perform specific tasks by completing questionnaires such as the Disabilities of the Arm, Shoulder, and Hand (DASH) or the Michigan Hand Outcomes Questionnaire.^{9,11} Level of handicap is often measured by an individual person using a variety of quality of life and participation surveys such as the Assessment of Life Habits or the London Handicap Scale.^{14,15}

Outcome measures are measurements of a patient's health status (impairment, disability, and

handicap) that can change as a result of time, treatment, or disease.¹¹

Outcome measures that specifically measure impairment and disability can be used to measure health status during various stages of recovery. Therapists determine which impairments are contributing to disability and design a treatment plan to mitigate impairment and disability. Therapists need to evaluate change in impairment and disability over time to know whether treatments are efficacious. Therapists also need to demonstrate to others that their treatment resulted in a clinically important improvement. When groups of patients are evaluated over time then efficacy of treatment can be assessed and rehabilitation programs can be evaluated and compared. Outcome scores may also be able to discriminate between groups of patients and potentially be used to predict long-term disposition of patients.¹¹

Amputation level, loss of range of motion, loss of strength, and loss of sensibility are the cornerstone of the AMA Guides to the Evaluation of Permanent Impairment, 5th edition.¹⁶ An impairment score can be derived using the AMA guides as it provides a well-documented and reproducible instrument for evaluating permanent impairment.¹⁶ Engrav et al. demonstrated the effective use of the AMA guides as an outcome instrument by assessing burn survivor impairment after the patient reached maximum medical improvement. They found that the average total body impairment in 325 burn patients was low (7.7%). However, the study further reported that higher impairment scores were noted when there was a loss of motion, amputation, and/or nerve damage.¹⁷

The use of computer-assisted evaluation systems to measure impairment in patients recovering from upper extremity burn injury has been shown to be a time saving and accurate method for measuring impairment.^{18,19} Harvey et al. reported that impairment measurements of the upper extremity performed with a computer-assisted evaluation system correlated well with conventional methods with correlation coefficient of 0.984 for grip strength and 0.996 for total active motion. They further reported that the computer system's printable evaluation report proved useful in supporting long-term disposition of military burn casualties¹⁹ and continues to be used at the USAISR Burn Center to support the medical disposition process for OIF/OEF burn casualties that are unable to return to active duty military service.

No known study has reported the impairment scores calculated by a computer-assisted system in patients recovering from burn injury to the hand, nor has any known study evaluated changes to impairment scores over time in the hand burn population. We selected the Greenleaf EVAL™ computer-assisted upper extremity evaluation system (Specialty

Therapy Equipment, Inc., Towson, MD) with AMA Impairment Guidelines, 5th edition, software to calculate physical impairment scores during recovery. An AMA impairment score can reflect deficits in range of motion, strength, sensation, and/or as a result of amputation, but is neither intended to reveal the way in which a patient copes with disability nor reflect an individual's ability to independently perform activities of daily living or work.^{16,20}

A comprehensive patient assessment of the upper extremity is considered incomplete if it does not include a subjective assessment of the patient's ability to perform daily living and recreational activities, symptoms (pain, tingling, numbness, stiffness), social (family care, occupational), and psychological (self-image) factors.^{16,21,22} Physical impairment can be measured by a therapist and disability can be measured by either the therapist observing the patient perform a task and/or the patients' self-reported performance of their ability to perform daily living tasks, work activities, and psychological factors.²¹ We selected the DASH questionnaire to score the effects of impairment on burn patients' function during recovery. The DASH is a validated, responsive, self-report questionnaire developed for patients with a variety of musculoskeletal diseases and conditions of the upper extremity.^{11,16,21,23,24} There has been no known study evaluating the use of the DASH in the hand burn population nor has any known study revealed outcome instruments that can detect important clinical changes in impairment and disability during recovery in the hand burn population.

An important consideration when selecting an outcome measure is to ask the question: Is the instrument able to measure change in function over time?^{8,10} Outcome instruments that are responsive (i.e., able to measure change over time) are essential to the evaluation of treatment effects resulting from therapy.¹¹ Responsiveness, or sensitivity, can be defined as the ability of an instrument to detect important changes in a patient's health status over time and may be considered one form of validity and is an important measurement property for evaluative tools and can be of value to the patient and therapist.^{23–26} The use of reliable and valid instruments to report disability by allowing patients to self-report their own disability is a well-accepted principle.²⁶ Despite this, there is no evidence revealing the responsiveness of outcome measures in the hand burn population.

Because disability is a functional consequence of impairment, it would seem plausible that the severity of impairment as measured by AMA impairment guidelines would correlate with disability as measured by the DASH. However, a study by Mink van der Molen et al. found only a weak correlation ($r = 0.38$) between AMA and DASH scores at six months after hand trauma.¹⁶ In another study, van

Oosterom et al. reported no statistically significant correlation between AMA impairment and DASH scores ($r = 0.30$) with a minimum follow-up of 2.3 years and a mean follow-up of 7.5 years. It was suggested that this lack of a strong correlation emphasized the difference between impairment and disability as separate entities.²⁷ Both studies suggested that when the patient follow-up time is much longer, their problems with functional activities slowly dissolve as patients learn to adapt to their injury through everyday use and compensatory techniques.^{16,27} In this study, we investigated the relationship between AMA and DASH scores during the early stages of recovery while simultaneous attempts are being made to mitigate impairment and disability as the patient is discharged from inpatient care to actively learn how to adapt and perform functional activities.

The purpose of our study was to evaluate the use of the AMA impairment and DASH disability instruments in combat casualties recovering from hand burns. The research questions are as follows:

1. Can computer-calculated AMA impairment scores of the upper extremity be used to detect clinical change in patients recovering from burns to the hand(s)?
2. Can the DASH questionnaire be used to detect clinical change in patients recovering from burns to the hand(s)?
3. Is there a relationship between AMA impairment and DASH disability scores during the early stages of recovering from burns to the hand(s)?
4. Can upper extremity AMA and DASH scores discriminate between combat casualties RTD and not returned to duty (N-RTD) when recovering from burns to the hand(s)?

MATERIALS AND METHODS

Sample and Design

A retrospective longitudinal study design was used to evaluate the use of the AMA impairment and DASH disability instruments on a cohort of combat casualties that were recovering from burns. We included U.S. military burn casualties from OIF/OEF with burns to at least one hand and admitted to the U.S. Army Burn Center from March 2003 through June 2005. Impairment and disability data were collected at two time points: upon discharge from inpatient care (visit 1) and during a subsequent follow-up outpatient visit less than four months later (visit 2). Only those patients with complete upper extremity impairment and disability evaluations at visit 1 and visit 2 were included in this study.

All burn casualties were evaluated by a burn therapist within 24 hours of admission and received daily

inpatient rehabilitation. On discharge from the hospital patients received outpatient rehabilitation accordingly. Data collection was approved by the Brooke Army Medical Center, Institutional Review Board.

Instrumentation

AMA Physical Impairment Testing

Impairment evaluations were preformed and recorded within the patient's medical record by therapists actively involved in treatment. Impairment measurements of sensation (two-point discrimination), active range of motion (shoulder, elbow, forearm, wrist, thumb, fingers), and strength (grip, pinch) were assessed using the following standardized equipment: static two-point Disk-Criminator, standard goniometers, Jamar dynamometer, and pinch meter gauge. Impairment measurements were documented in the patient's medical chart and later reviewed for complete inclusion data. If all measurements were recorded at both visit 1 and visit 2, then the data were mined from the patient's medical record and entered into the Greenleaf EVAL™ for Windows computer-assisted upper extremity evaluation system (Version 2.7.0.7i, Specialty Therapy Equipment, Inc., Towson, MD). The Greenleaf EVAL™ computer system used the AMA Impairment Guidelines, 5th edition, to attribute a percentage of impairment to amputation level, loss of sensation, loss of motion at each joint, and loss of strength to ultimately yield a percentage of upper extremity's contribution to total body impairment. The AMA upper extremity impairment scale is 0–84, where 0 equals no impairment and 84 equals severe total body impairment, that is, bilateral shoulder amputation.

DASH Outcome Measure

The DASH is a validated, responsive, and standardized 30-item patient-completed questionnaire developed for patients with a variety of musculoskeletal diseases and conditions of the upper extremity that focuses on function, symptoms (pain, tingling, weakness, stiffness), social activities, and self-image.²⁸ Therapists requested that their patient complete the DASH questionnaire to better learn their patients' perception of their upper extremity health status. The 30-item measure was completed by patients in approximately 10–15 minutes. The raw data were transformed into a 0–100 scale. A score of 0 indicates no problem (good function) and 100 reflected severe upper extremity disability.²⁸

Responsiveness, Relationship, and Known-group Validity

We assessed for the ability of the AMA and DASH outcome instruments to detect clinical change over

time, also known as responsiveness. The purpose for measuring responsiveness in this study was to validate the application of the AMA and DASH instruments in the hand burn population, rather than the instruments themselves. The responsiveness of the instruments was assessed using standardized response mean (SRM) indexes.²⁹ The SRM is thought to be a superior index for assessing responsiveness because it is not influenced by sample size.²⁵ The higher the index value, the greater the "effect," and the more responsive the measure and therefore the more likely it is to reflect an actual change in patient impairment and disability. Cohen's rule of thumb indexes were used to interpret the SRM: large effect >0.8, acceptable effect 0.8, moderate effect 0.5, and small effect 0.2.²⁹ The significance of change in scores between visits was further assessed via t-test.

The correlation between AMA and DASH scores were examined in this study during the early stages of recovery to assess whether DASH scores were consistent with AMA impairment scores. We postulated that DASH scores should correlate at least moderately (correlations ≥ 0.5) with AMA scores at visit 1 and visit 2.

Known-group validity examines the extent to which a measure is capable of distinguishing between groups of patients who are known to have different levels of an attribute of interest. Previous upper extremity outcome studies have shown that the DASH can discriminate between individuals able to perform all their activities of daily living and those who cannot; individuals able to work and individuals not able to work; and individuals working without restrictions and those working with restrictions.^{26,28} We examined known-group validity to determine how well the AMA and DASH instruments can discriminate between casualties RTD and casualties N-RTD. A finding of such a difference would help support the discriminative validity of the AMA and DASH in the hand burn population.

Statistical Analysis

Descriptive statistics and parametric data were analyzed using Microsoft Excel© 2002 Data Analysis Tools (Microsoft Corp., Redmond, WA) and presented as means $\pm$ SD. Nonparametric data analyzed using Fisher's exact test. SRM was calculated to assess responsiveness between visits 1 and 2. SRM is calculated as the average change score (discharge visit 1 to follow-up visit 2) divided by the standard deviation of the change scores. Change scores were further analyzed for significance using paired two-sample t-tests. The relationship between AMA and DASH scores was quantified by applying the Pearson correlation tests. Known-group validity was evaluated using unpaired two-sample t-tests. Demographic data comparing RTD and N-RTD

groups assessed for significance using unpaired t-test for parametric data and the Fisher's exact test for nonparametric data. An alpha level of <0.05 was established as significant.

RESULTS

From March 2003 through June 2005, 299 OIF/OEF combat casualty burn patients were admitted to the U.S. Army Burn Center and 285 survived injury. Of the 285 burn survivors, 190 (67%) were able to recover and RTD. Two hundred and twenty-one (78%) of the 285 casualties sustained burn injury to at least one hand, of which 143 (65%) recovered and RTD. Of the 221 OIF/OEF casualties admitted to our burn center with a hand burn, 61 (28%) had complete AMA impairment and DASH disability evaluation data recorded in their medical chart at discharge from hospital (visit 1) and a subsequent follow-up visit less than four months after discharge (visit 2). Study group demographics are shown in Table 1. The study group included 58 males and 3 females with an average age of 27 ± 7 years and an average burn size of $14.5 \pm 13.2\%$. The average inpatient length of stay was 25 ± 27 days when discharge visit 1 evaluations were recorded. Follow-up visit 2 evaluations were performed at an outpatient rehabilitation visit 52 ± 31 days after inpatient discharge.

TABLE 1. Demographics of Study Group ($n = 61$)

Age	27 ± 7 (range 19–49)
Gender	M: 58 F: 3
Hand dominance	R: 57 L: 4
Type of hand burn	60 Thermal (98%) 1 Electrical (2%)
TBSA Burn	$14.5 \pm 13.2\%$ (range 0.2–53%)
TBSA FT Burn	$6.4 \pm 10.2\%$ (range 0–40%)
Hands burned	112 (92%) R: 57 (51%) L: 55 (49%)
Mean TBSA Hand Burn	$1.4 \pm 0.85\%$ FT $0.6 \pm 0.9\%$
Mean TBSA arm and forearm burn	R: $0.7 \pm 1.2\%$ L: $0.7 \pm 1.3\%$
Hands skin grafted	61 (50%) R: 31 (51%) L: 30 (49%)
Patients with UE Amputation	3 (5%) Below elbow: 1 Thumb MCP: 2 MCP: 9 PIP/DIP: 4
Inpatient days	25 ± 27 (range 1–154)
Days between visit 1 and visit 2	52 ± 31 (range 14–120)

TBSA = Total body surface area; FT = full thickness.

Responsiveness

Mean AMA and DASH scores are shown in Table 2 for visit 1 and visit 2. AMA impairment scores decreased 9 ± 9 points ($p < 0.0001$) and DASH scores decreased 18 ± 15 points ($p < 0.0001$) between visit 1 to visit 2. Change in AMA and DASH scores revealed an SRM of 0.96 and 1.17 respectively, with both instruments indicating a large effect (>0.8) in detecting clinical change between visits (Table 2). On discharge from the hospital (visit 1), 4 patients had an AMA impairment score of zero and no patients had a DASH disability score of zero.

Relationship

The Pearson method for correlation revealed a moderate correlation ($r = 0.50$) between AMA and DASH scores ($n = 61$) at visit 1 and a moderately high correlation ($r = 0.74$) at visit 2. This moderate correlation reveals evidence of a relationship between DASH and AMA scores during the early stages of hand burn recovery.

Known-group Validity

We assessed AMA and DASH scores for known-group validity on ability to discriminate between casualties RTD and N-RTD (Table 3). Of the 61 patients in this study, 41 (67%) patients RTD, whereas the remaining 20 (33%) patients were N-RTD and subsequently discharged from military service due to medical reasons. Patients N-RTD had higher AMA scores at visit 1 (44 vs. 21, $p < 0.0001$) and visit 2 (39 vs. 10, $p < 0.0001$) and higher DASH scores at visit 1 (54 vs. 33, $p < 0.0002$) and visit 2 (41 vs. 12, $p < 0.0001$) (Table 3).

Table 4 shows a comparison of demographic data between patients able to RTD and those patients N-RTD. The 20 patients N-RTD had 14% greater TBSA burn ($p < 0.001$) and 10% greater FT TBSA burn ($p = 0.002$). Skin grafting of the hands was required 39% more in the N-RTD group ($p = 0.002$). At discharge from the hospital (visit 1), 95% of those patients N-RTD had a range of motion deficit compared to only 51% of those patients RTD (data not included in table). Three patients suffered a total of 15 finger and thumb amputations of which none RTD ($p = 0.032$). There was no significant difference in the number of days between visit 1 and visit 2 evaluations in regard to RTD and N-RTD ($p = 0.442$) (Table 4).

Change in AMA and DASH scores on RTD and N-RTD was also assessed for responsiveness. Table 3 shows the mean AMA and DASH scores at visit 1 and visit 2 along with change scores between visits and calculated SRM indexes. For casualties RTD, an AMA change score of 11 revealed an SRM of 1.22 (large effect). For casualties N-RTD, the AMA mean

TABLE 2. Responsiveness of AMA and DASH to Clinical Change in Hand Burn Patients

<i>n</i> = 61	Visit 1 Score	Visit 2 Score	Change Score	SRM	<i>t</i> -Value	<i>p</i> -Value
AMA	29 ($\pm$ 17)	20 ($\pm$ 19)	9 ($\pm$ 9)	0.96	7.25	<0.0001
DASH	40 ($\pm$ 21)	22 ($\pm$ 19)	18 ($\pm$ 15)	1.17	9.19	<0.0001

AMA = American Medical Association; DASH = disability of the arm, shoulder, and hand; SRMs = standardized response means.

change score was only 4 points with an SRM 0.40 (<moderate effect). The DASH mean change score on RTD was 21 points between visits demonstrating a large effect (SRM 1.40) and for casualties N-RTD, the average DASH change score was 13 points with an acceptable effect (SRM 0.81) (Table 3).

DISCUSSION

This study demonstrated that upper extremity computer-calculated AMA impairment scores can be used to detect change in impairment and the DASH questionnaire can be used to detect change in disability in patients recovering from burn injury to the hand. OIF/OEF hand burn casualties were assessed during the early stages of convalescence and both instruments were able to detect clinical change on discharge from hospital during the initial months of outpatient recovery. The responsiveness of the AMA impairment system compared favorably with that of another study of physical impairment measurements²⁵ and the responsiveness of the DASH instrument compared well with indexes obtained by other upper extremity conditions.^{21,23–25} The measurement of change in impairment and disability revealed a large effect (>0.8) when using the SRM method and *t*-tests revealed a significant difference between initial and follow-up scores, indicating that a change in patients' impairment and disability occurred over time. A change in DASH score exceeding 15 points is the most accurate change score for discriminating between improved and unimproved patients and is considered to be a clinically important difference for the DASH indicating a real change in patient health status, rather than measurement error alone.^{24,26,28} The mean change score for the DASH in this study was 18 ± 15 (Table 2).

Two previously conducted hand studies evaluated the relationship between AMA impairment and DASH disability scores and found only a weak correlation at a greater than six-month follow-up period.^{16,27} However, we found a moderate correlation ($r = 0.50$) between AMA and DASH scores during the early stages of hand burn recovery at discharge from the hospital and a moderately high correlation ($r = 0.74$) less than four months later. Just as the authors observed in the two previous studies, we expect that the relationship between the AMA and DASH to lessen significantly over time. We further suspect that AMA impairment scores will begin

to plateau while corresponding DASH scores progressively decline as patients learn to cope, adapt, and compensate.

For those casualties who RTD, both the AMA and DASH instruments detected clinically significant changes in health status with corresponding SRM indexes indicating a large effect (>0.8) (Table 3). However, for those casualties N-RTD the instruments were less responsive as the mean AMA change score was only 4 points between visits, indicating only minimal improvement in range of motion, strength, and sensation for the N-RTD group. This lack of change in impairment was confirmed with an SRM of 0.40 (<moderate effect) and a significant difference found between RTD and N-RTD AMA change scores ($p = 0.01$) indicating that impairment improved significantly in the RTD group and only slightly in the N-RTD group (Table 3). The difficulty with improving impairment after discharge from the hospital may very well indicate the importance of inpatient burn rehabilitation in regard to preventing burn scar contracture well before hospital discharge. Also, the N-RTD group stayed in the hospital much longer indicating that they may already have plateau (Table 4). Even though impairment improvements were minimal in those casualties N-RTD, there was a modest improvement in their disability between visits as the DASH instrument detected a change of 13 points (SRM 0.81) in upper extremity function for the N-RTD group, which did not differ significantly from the RTD group ($p = 0.07$)

TABLE 3. Known-group Validity and Responsiveness of AMA and DASH to Clinical Change on RTD

	Visit 1 Score	Visit 2 Score	Change Score	SRM
AMA impairment				
RTD (<i>n</i> = 41)	21 ($\pm$ 12)	10 ($\pm$ 10)	11 ($\pm$ 9)	1.22
Not RTD (<i>n</i> = 20)	44 ($\pm$ 16)	39 ($\pm$ 19)	4 ($\pm$ 10)	0.40
<i>t</i> -Value	6.10	6.28	2.64	—
<i>p</i> -Value	<0.0001	<0.0001	0.0106	—
DASH disability				
RTD (<i>n</i> = 41)	33 ($\pm$ 19)	12 ($\pm$ 12)	21 ($\pm$ 15)	1.40
Not RTD (<i>n</i> = 20)	54 ($\pm$ 19)	41 ($\pm$ 17)	13 ($\pm$ 16)	0.81
<i>t</i> -Value	4.05	6.78	1.83	—
<i>p</i> -Value	<0.0002	<0.0001	0.0719	—

AMA = American Medical Association; DASH = disability of the arm, shoulder, and hand; RTD = return to duty; N-RTD = not returned to duty; SRMs = standardized response means.

TABLE 4. Demographic Comparison of Study Group on Return to Duty and Not Returned to Duty

<i>n</i> = 61	<i>Returned to Duty</i> (<i>n</i> = 41)	<i>Not Returned to Duty</i> (<i>n</i> = 20)	<i>p</i> -Value
Age	27 ± 6 (range 19–49)	28 ± 8 (range 21–48)	0.550
Gender	M: 40 F: 1	M: 18 F: 2	0.248
Hand dominance	R: 39 L: 2	R: 18 L: 2	0.591
Type of hand Burn	41 Thermal (100%)	19 Thermal (95%) 1 Electrical (5%)	0.328
TBSA Burn	9.8 ± 8.6% (range 0.2–32%)	24.2 ± 15.6% (range 2–53%)	<0.001
TBSA FT	3.0 ± 6.7% (range 0–27%)	13.4 ± 12.6% (range 0–40%)	0.002
Hands burned	74 (90%) R: 38 (51%) L: 36 (49%)	38 (95%) R: 19 (50%) L: 19 (50%)	1.000
TBSA hand burn	2.4 ± 1.3% FT 0.6 ± 1.1%	3.4 ± 1.5% FT 2.4 ± 2.1%	0.007 0.002
TBSA arm and forearm burn	R: 0.5 ± 1.1% L: 0.3 ± 0.9%	R: 1.3 ± 1.3% L: 1.6 ± 1.6%	0.003
Skin grafted hands	31 (38%) R: 16 L: 15	30 (77%) R: 15 L: 15	0.002
Upper extremity amputation	0 Patients (0%)	3 Patients (15%) Below Elbow: 1 Thumb MCP: 2 MCP: 9 PIP/DIP: 4	0.032
Inpatient days	14 ± 12 (range 1–50)	45 ± 36 (range 3–154)	0.001
Days between visit 1 and visit 2	50 ± 31 (range 24–120)	57 ± 32 (range 14–115)	0.442

TBSA = Total body surface area, FT = full thickness.

(Table 3). As noted earlier, impairments do not always lead to disability, as patients tend to learn how to become “able” despite their physical impairment deficits.

Both AMA and DASH scores clearly discriminated between casualties RTD vs. N-RTD with improved accuracy at follow-up visit 2 (Table 3). In general, casualties with lower impairment and disability scores were more likely to RTD if they obtained an AMA score ≤ 20 and/or DASH score ≤ 24 at follow-up visit 2. In contrast, those casualties with higher scores were at greater risk of N-RTD to duty if AMA score was ≥ 20 and/or DASH score ≥ 24 at visit 2. Future research involving specific impairment and disability cut-off scores could potentially provide a more accurate prediction in estimating the long-term disposition in recovering military hand burn casualties. Also, there are numerous patient characteristics and injury variables for the multidisciplinary team to consider throughout the recovery process as 8 of the 12 demographic variables in this study between RTD and N-RTD groups were found to be statistically different (Table 4). Various other outcome measures may further provide valuable information for the team to consider when discussing disposition of patients with hand burn injury. Much work is also required

to fully understand which variables and outcome measures may further assist with predicting long-term outcome of military patients recovering from hand burn injury.

Limitations

Despite efforts to ensure measurements were recorded at discharge and follow-up, our ability to collect all required inclusion data was only 28% of the hand burn population. It proved difficult to collect all physical impairment measures at discharge from inpatient care and subsequent follow-up visits as our own efforts at record keeping were less than exemplary. Overall though, this low collection rate may not have biased our results as there was a 67% RTD rate in our sample compared to the 65% RTD rate for all military casualties with hand burn injury admitted between April 2003 and June 2005. Another limitation could very well be selection bias toward those patients with less severe impairments as recording measurements within normal limits requires much less time for therapists to record in the patients' chart during evaluation. Therefore, it is likely that there was more impairment than what was included in this study sample.

Skin impairment was not included in our AMA calculations because the EVAL™ system does not compute AMA skin impairment. The four patients with impairment scores of 0 at discharge may have had impairment of their integument system, which was not included in our AMA impairment score. Costa et al. describe a standardized method to assess burn scar impairment using the AMA five-class skin rating scale¹³ and future studies may want to contribute a percentage of AMA skin impairment of the upper extremity to total body impairment. Also, the DASH was intended to measure function of the upper limb and did not incorporate esthetics.²² One might also consider evaluating an outcome measure that includes appearance as a component of disability as this may be an important issue for burn patients. Another limitation is that we used two-point discrimination to measure sensation with a static two-point Disk-Criminator but current evidence suggests it is less valid and responsive than other quantitative sensory testing.³⁰ Future studies may want to consider using a more valid and responsive sensory testing instrument.

Since this was a retrospective review, therapists may have been biased toward improvements while recording or calculating impairment measurements and the DASH questionnaire was administered by therapists actively involved in the treatment of the patients. Future prospective studies may want to limit potential bias by blinding therapists while performing impairment measurements²⁶ and have the DASH questionnaire administered by an independent person to minimize the opportunity for bias.²⁸

CONCLUSION

This study demonstrated that both computer-generated AMA impairment scores and the DASH questionnaire can serve as responsive instruments in detecting clinical change in military casualties recovering from burns to the hand. A moderate relationship was found between impairment and disability scores during the early stages of hand burn recovery, which needs to be replicated and further studied. Furthermore, AMA and DASH scores revealed the ability to discriminate between those casualties RTD and N-RTD.

Together, the AMA and DASH instruments provide a comprehensive assessment of upper extremity impairment and disability in combat casualties recovering from burns to the hand(s). Self-report questionnaires do not and will not replace the need to perform physical impairment measurements,²¹ but they do add to our ability to understand what is happening to our patients.²³ Further research is needed to assess outcome measures in the hand burn

population that extend the entire hospital course and far into convalescence.

REFERENCES

1. Cancio LC, Horvath EE, Barillo DJ, et al. Burn support for operation Iraqi freedom and related operations. *J Burn Care Rehabil.* 2005;26:151–61.
2. Chapman TT, Richard RL, Hedman TL, et al. Military return to duty and civilian return to work factors following burns with focus on the hand and literature review. *J Burn Care Research.* 2008, in press.
3. Allen BD, Whitson TC, Henjyoji EY. Treatment of 1,963 burned patients at 106th general hospital, Yokohama, Japan. *J Trauma.* 1970;10:386–92.
4. Salisbury RE, Pruitt BA. *Burns of the Upper Extremity.* Philadelphia, PA: WB Saunders, 1976.
5. Sheridan RL, Hurley J, Smith MA, et al. The acutely burned hand: management and outcome based on a ten-year experience with 1047 acute hand burns. *J Trauma.* 1995;38:406–11.
6. Barillo DJ, Harvey KD, Hobbs CL, Mozingo DW, Cioffi WG, Pruitt BA. Prospective outcome analysis of a protocol for the surgical and rehabilitative management of burns to the hands. *J Amer Soc Plas Surg.* 1997;100:1442–51.
7. Cartotto R. The burned hand: optimizing long-term outcomes with a standardized approach to acute and subacute care. *Clin Plast Surg.* 2005;32:515–27.
8. Pereira C, Murphy K, Herndon D. Outcome measures in burn care: is mortality dead? *Burns.* 2004;30:761–71.
9. Umraw N, Chan Y, Gomez M, Cartotto RC, Fish JS. Effective hand function assessment after burn injuries. *J Burn Care Rehabil.* 2004;25:134–9.
10. Staley M, Richard RL, Warden GD, Miller SF, Shuster DB. Functional outcomes for the patient with burn injuries. *J Burn Care Rehabil.* 1996;17:362–8.
11. MacDermid JC. *Outcome Measurement in the Upper Extremity.* 5th ed. St. Louis, MO: Mosby, 2002.
12. Cocchiarella L, Andersson GBJ. *Guides to the Evaluation of Permanent Impairment.* 5th ed. Chicago: American Medical Association, 2001.
13. Costa BA, Engrav LH, Holavanahalli R, et al. Impairment after burns: a two-center, prospective report. *Burns.* 2003;29:671–5.
14. Desrosiers J, Malouin F, Bourbonnais D, Richards CL, Rochette A, Bravo G. Arm and leg impairments and disabilities after stroke rehabilitation: relation to handicap. *Clin Rehabil.* 2003; 17:666–73.
15. Jenkinson C, Mant J, Carter J, Wade D, Winner S. The London handicap scale: a re-evaluation of its validity using standard scoring and simple summation. *J Neurol Neurosurg Psychiatr.* 2000;68:365–7.
16. Mink van der Molen AB, Ettema AM, Hovius SER. Outcome of hand trauma: the hand injury severity scoring system (HISS) and subsequent impairment and disability. *J Hand Surg [Br].* 2003;28B:295–9.
17. Engrav LH, Covey MH, Dutcher KD, Heimbach DM, Walkinshaw MD, Marvin JM. Impairment, time out of school, and time off from work after burns. *Plast Reconstr Surg.* 1987;79: 927–34.
18. Moore ML, Engrav LH, Vedder NB, Gibran NS, Esselman P, Costa BA. Dexter®: a tool to facilitate impairment ratings. *J Burn Care Rehabil.* 2001;22:397–400.
19. Harvey KD, Barillo DJ, Hobbs CL, et al. Computer-assisted evaluation of hand and arm function after thermal injury. *J Burn Care Rehabil.* 1996;17:176–80.
20. Cocchiarella L, Turk MA, Andersson G. Improving the evaluation of permanent impairment. *JAMA.* 2000;283:532–3.
21. Wong J, Fung B, Chu M, Chan R. The use of disabilities of the arm, shoulder, and hand questionnaire in rehabilitation after acute traumatic hand injuries. *J Hand Ther.* 2007;20:49–56.
22. MacDermid JC, Tottenham V. Responsiveness of the disability of the arm, shoulder, and hand (DASH) and patient-rated

- wrist/hand evaluation (PRWHE) in evaluating change after hand therapy. *J Hand Ther.* 2004;17:18–23.
23. Amadio PC. Outcome assessment in hand surgery and hand therapy: an update. *J Hand Ther.* 2001;14:63–7.
24. Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the disabilities of the arm, shoulder and hand outcome measure in different regions of the upper extremity. *J Hand Ther.* 2001;14:128–42.
25. MacDermid JC, Richards RS, Donner A, Bellamy N, Roth JH. Responsiveness of the short form-36, disability of the arm, shoulder, and hand questionnaire, patient-rated wrist evaluation, and physical impairment measurements in evaluating recovery after a distal radius fracture. *J Hand Surg [Br].* 2000;25:330–4.
26. MacDermid JC, Stratford P. Applying evidence on outcome measures to hand therapy practice. *J Hand Ther.* 2004;17:165–73.
27. van Oosterom FJT, Ettema AM, Mulder PGH, Hovius SER. Impairment and disability after severe hand injuries with multiple phalangeal fractures. *J Hand Surg.* 2007;32A:91–5.
28. McConnell S, Beaton DE, Bombardier C. The DASH Outcome Measure: A User's Manual. Toronto: Ontario: Institute for Work & Health, 1999.
29. Michener LA, Leggin BG. A review of self-report scales for the assessment of functional limitation and disability of the shoulder. *J Hand Ther.* 2001;14:68–76.
30. MacDermid JC. Measurement of health outcomes following tendon and nerve repair. *J Hand Ther.* 2005;18:297–312.

JHT Read for Credit

Quiz: Article # 089

Record your answers on the Return Answer Form found on the tear-out coupon at the back of this issue. There is only one best answer for each question.

- #1. The outcome measures utilized in this study were the
 - a. SRM
 - b. RTD and N-RTD
 - c. Jebson and 9 hole peg board
 - d. DASII & AMA
- #2. The correlation between impairment and disability was
 - a. high
 - b. low
 - c. moderate
 - d. none
- #3. Comparing RTD and N-RTD, the results showed
 - a. clear discrimination using both the DASH and AMA
 - b. minimal discrimination using both the DASH and AMA

- c. clear discrimination using the DASH, but not the AMA
 - d. clear discrimination using the AMA, but not the DASH
- #4. Burn injuries to the hand account for up to of all injuries in conventional warfare
 - a. 10%
 - b. 20%
 - c. 30%
 - d. 40%
- #5. All subjects were evaluated initially by
 - a. a hand therapist
 - b. a burn therapist
 - c. an OT or PT
 - d. a hand or plastic surgeon

When submitting to the HTCC for re-certification, please batch your JHT RFC certificates in groups of 3 or more to get full credit.