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**The Military Extremity Trauma Amputation/Limb Salvage (METALS) Study: Outcomes of Amputation Compared with Limb Salvage Following Major Upper-Extremity Trauma
Appendix 1 Outcomes Measurement Tools**

1. The Short Musculoskeletal Function Assessment²⁹ (SMFA) measures across four domains (mobility, arm/hand function, daily activities, and emotional) with higher score indicating worse function. There are 46 questions with 34 focusing on function and 12 address the degree to which the subject is bothered. Each question is scored 1-5.
2. The Paffenbarger Physical Activity Questionnaire³⁰ was used to determine participation in sports/leisure activities. It classifies activities in terms of metabolic equivalents as low, moderate or vigorous. Respondents identify up to five activities performed within the past three months. The 2000 version of the Compendium of Physical Activities was used to classify each activity according to the rate of energy expenditure expressed as metabolic equivalents (METS).³² Activities were classified as light (<3 METS), moderate (3 to 6 METS), or vigorous (>6 METS).
3. The Center for Epidemiologic Studies of Depression Scale Revised version³³ (CESDR) is a 20 item questionnaire asks about the emotional state in the last week scoring 0-4 with higher scores being worse. Scores are added with ≥ 16 has clinically relevant symptoms of depression and ≥ 21 having major depression.
4. The PTSD Checklist³⁵ (PCL) is a 17 item self administered questionnaire with each item score 1-5 giving a range of scores from 17-65. The military specific version of the PCL was utilized. Scores are assessed as probable PTSD if they had (1) experienced at least 1 re-experiencing/intrusive symptom, at least 3 avoidance experiences, and at least 1 symptom of hyperarousal, all at the moderate or extreme level (a score of ≥ 3), and (2) reported substantial distress as indicated by a total PCL score of ≥ 50 .
5. Chronic pain Grade³⁷ (CPG) evaluated pain based on interference with daily activities. This is a 7 item questionnaire that looks at pain intensity currently and in last 6 months and disability over the last 6 months on a 10 point scale. Composite scores are then calculated and divided into 5 grades with Grade 0 being pain free and no disability and Grade IV high disability and severely limiting.

References

1. Belmont PJ, McCriskin BJ, Hsiao MS, Burks R, Nelson KJ, Schoenfeld AJ. The nature and incidence of musculoskeletal combat wounds in Iraq and Afghanistan (2005-2009). *J Orthop Trauma*. 2013;27(5):107. Accessed Feb 16, 2018. doi: 10.1097/BOT.0b013e3182703188.
2. Schoenfeld AJ, Dunn JC, Bader JO, Belmont PJ. The nature and extent of war injuries sustained by combat specialty personnel killed and wounded in Afghanistan and Iraq, 2003-2011. *J Trauma Acute Care Surg*. 2013;75(2):287-291. Accessed Jan 23, 2018. doi: 10.1097/TA.0b013e31829a0970.
3. Hoencamp R, Vermetten E, Tan, Edward C T H, Putter H, Leenen LPH, Hamming JF. Systematic review of the prevalence and characteristics of battle casualties from NATO coalition forces in Iraq and Afghanistan. *Injury*. 2014;45(7):1028-1034. <https://www.ncbi.nlm.nih.gov/pubmed/24878294>. Accessed Aug 9, 2017.
4. Defense Casualty Analysis System: Department of Defense. <https://dcas.dmdc.osd.mil/dcas/pages/casualties.xhtml>. Accessed June 12, 2018.
5. Owens BD, Kragh JF, Macaitis J, Svoboda SJ, Wenke JC. Characterization of extremity wounds in Operation Iraqi Freedom and Operation Enduring Freedom. *J Orthop Trauma*. 2007;21(4):254-257. Accessed Feb 16, 2018. doi: 10.1097/BOT.0b013e31802f78fb.
6. Schoenfeld AJ, Dunn JC, Belmont PJ. Pelvic, spinal and extremity wounds among combat-specific personnel serving in Iraq and Afghanistan (2003-2011): A new paradigm in military musculoskeletal medicine. *Injury*. 2013;44(12):1866-1870. Accessed Jan 23, 2018. doi: 10.1016/j.injury.2013.08.001.
7. Armed Forces Health Surveillance Center, (AFHSC). Amputations of upper and lower extremities, active and reserve components, U.S. Armed Forces, 2000-2011. *MSMR*. 2012;19(6):2-6. Accessed Feb 16, 2018.
8. Tennent DJ, Wenke JC, Rivera JC, Krueger CA. Characterisation and outcomes of upper extremity amputations. *Injury*. 2014;45(6):965-969. Accessed Jan 23, 2018. doi: 10.1016/j.injury.2014.02.009.
9. Krueger CA, Wenke JC, Ficke JR. Ten years at war: comprehensive analysis of amputation trends. *J Trauma Acute Care Surg*. 2012;73(6 Suppl 5):438. <https://www.ncbi.nlm.nih.gov/pubmed/23192067>. Accessed Aug 8, 2017.
10. Belisle JG, Wenke JC, Krueger CA. Return-to-duty rates among US military combat-related amputees in the global war on terror: job description matters. *J Trauma Acute Care Surg*. 2013;75(2):279-286. Accessed Feb 16, 2018. doi: 10.1097/TA.0b013e31829bb777.
11. Stinner DJ, Burns TC, Kirk KL, Ficke JR. Return to duty rate of amputee soldiers in the current conflicts in Afghanistan and Iraq. *J Trauma*. 2010;68(6):1476-1479. Accessed Feb 16, 2018. doi: 10.1097/TA.0b013e3181bb9a6c.
12. Stansbury LG, Lalliss SJ, Branstetter JG, Bagg MR, Holcomb JB. Amputations in U.S. military personnel in the current conflicts in Afghanistan and Iraq. *J Orthop Trauma*. 2008;22(1):43-46. Accessed Feb 16, 2018. doi: 10.1097/BOT.0b013e31815b35aa.
13. Tintle SM, Baechler MF, Nanos GP, Forsberg JA, Potter BK. Reoperations following combat-related upper-extremity amputations. *J Bone Joint Surg Am*. 2012;94(16):1191. Accessed Jan 23, 2018. doi: 10.2106/JBJS.K.00197.

14. Tintle SM, Baechler MF, Nanos GP, Forsberg JA, Potter BK. Traumatic and trauma-related amputations: Part II: Upper extremity and future directions. *J Bone Joint Surg Am*. 2010;92(18):2934-2945. <https://www.ncbi.nlm.nih.gov/pubmed/21159994>. Accessed Aug 8, 2017.
15. Pet MA, Morrison SD, Mack JS, et al. Comparison of patient-reported outcomes after traumatic upper extremity amputation: Replantation versus prosthetic rehabilitation. *Injury*. 2016;47(12):2783-2788. Accessed Feb 17, 2018. doi: 10.1016/j.injury.2016.10.004.
16. Larson JV, Kung TA, Cederna PS, Sears ED, Urbanchek MG, Langhals NB. Clinical factors associated with replantation after traumatic major upper extremity amputation. *Plast Reconstr Surg*. 2013;132(4):911-919. Accessed Feb 17, 2018. doi: 10.1097/PRS.0b013e31829f4a49.
17. Graham B, Adkins P, Tsai TM, Firrell J, Breidenbach WC. Major replantation versus revision amputation and prosthetic fitting in the upper extremity: a late functional outcomes study. *J Hand Surg Am*. 1998;23(5):783-791. Accessed Feb 28, 2018.
18. Woodruff SI, Galarneau MR, Sack DI, McCabe CT, Dye JL. Combat amputees' health-related quality of life and psychological outcomes: A brief report from the wounded warrior recovery project. *J Trauma Acute Care Surg*. 2017;82(3):592-595. <https://www.ncbi.nlm.nih.gov/pubmed/28030485>. Accessed Aug 8, 2017.
19. Krueger CA, Wenke JC, Cho MS, Hsu JR. Common factors and outcome in late upper extremity amputations after military injury. *J Orthop Trauma*. 2014;28(4):227-231. Accessed Feb 16, 2018. doi: 10.1097/BOT.0b013e3182a665f5.
20. Rivera JC, Glebus GP, Cho MS. Disability following combat-sustained nerve injury of the upper limb. *Bone Joint J*. 2014;96-B(2):254-258. Accessed Jan 23, 2018. doi: 10.1302/0301-620X.96B2.31798.
21. Paryavi E, Pensy RA, Higgins TF, Chia B, Eglseder WA. Salvage of upper extremities with humeral fracture and associated brachial artery injury. *Injury*. 2014;45(12):1870-1875. Accessed Feb 17, 2018. doi: 10.1016/j.injury.2014.08.038.
22. Mattiassich G, Rittenschober F, Dorninger L, et al. Long-term outcome following upper extremity replantation after major traumatic amputation. *BMC Musculoskelet Disord*. 2017;18(1):77. Accessed Feb 23, 2018. doi: 10.1186/s12891-017-1442-3.
23. Otto IA, Kon M, Schuurman AH, van Minnen LP. Replantation versus Prosthetic Fitting in Traumatic Arm Amputations: A Systematic Review. *PLoS ONE*. 2015;10(9):e0137729. Accessed Feb 17, 2018. doi: 10.1371/journal.pone.0137729.
24. Märdian S, Krapohl BD, Roffeis J, Disch AC, Schaser K, Schwabe P. Complete major amputation of the upper extremity: Early results and initial treatment algorithm. *J Trauma Acute Care Surg*. 2015;78(3):586-593. Accessed Feb 17, 2018. doi: 10.1097/TA.0000000000000548.
25. Doukas WC, Hayda RA, Frisch HM, et al. The Military Extremity Trauma Amputation/Limb Salvage (METALS) study: outcomes of amputation versus limb salvage following major lower-extremity trauma. *J Bone Joint Surg Am*. 2013;95(2):138-145. <https://www.ncbi.nlm.nih.gov/pubmed/23324961>. Accessed Aug 8, 2017.

26. Zimet GD, Powell SS, Farley GK, Werkman S, Berkoff KA. Psychometric characteristics of the Multidimensional Scale of Perceived Social Support. *J Pers Assess*. 1990;55(3-4):610-617. Accessed Jan 12, 2018. doi: 10.1080/00223891.1990.9674095.
27. Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *N Engl J Med*. 2004;351(1):13-22. Accessed Jan 12, 2018. doi: 10.1056/NEJMoa040603.
28. Ewing JA. Detecting alcoholism. The CAGE questionnaire. *JAMA*. 1984;252(14):1905-1907. Accessed Jan 12, 2018.
29. Swiontkowski MF, Engelberg R, Martin DP, Agel J. Short musculoskeletal function assessment questionnaire: validity, reliability, and responsiveness. *J Bone Joint Surg Am*. 1999;81(9):1245-1260. Accessed Jan 12, 2018.
30. Paffenbarger RS, Wing AL, Hyde RT. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol*. 1978;108(3):161-175. Accessed Feb 18, 2018.
31. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA*. 1995;273(5):402-407. Accessed Feb 18, 2018.
32. Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc*. 2000;32(9 Suppl):498. Accessed Feb 18, 2018.
33. Eaton WW, Smith C, Ybarra M, Muntaner C, Tien A. Center for Epidemiologic Studies Depression Scale: Review and Revision (CESD and CESD-R). In: Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers; 2004:363-377.
34. Schulberg HC, Saul M, McClelland M, Ganguli M, Christy W, Frank R. Assessing depression in primary medical and psychiatric practices. *Arch Gen Psychiatry*. 1985;42(12):1164-1170. Accessed Feb 18, 2018.
35. Forbes D, Creamer M, Biddle D. The validity of the PTSD checklist as a measure of symptomatic change in combat-related PTSD. *Behav Res Ther*. 2001;39(8):977-986. Accessed Feb 18, 2018.
36. Thomas JL, Wilk JE, Riviere LA, McGurk D, Castro CA, Hoge CW. Prevalence of mental health problems and functional impairment among active component and National Guard soldiers 3 and 12 months following combat in Iraq. *Arch Gen Psychiatry*. 2010;67(6):614-623. Accessed Feb 18, 2018. doi: 10.1001/archgenpsychiatry.2010.54.
37. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain*. 1992;50(2):133-149. Accessed Feb 18, 2018.
38. Engelberg R, Martin DP, Agel J, Swiontkowski MF. Musculoskeletal function assessment: reference values for patient and non-patient samples. *J Orthop Res*. 1999;17(1):101-109. Accessed Jan 12, 2018. doi: 10.1002/jor.1100170116.
39. Elliott AM, Smith BH, Hannaford PC, Smith WC, Chambers WA. The course of chronic pain in the community: results of a 4-year follow-up study. *Pain*. 2002;99(1-2):299-307. Accessed Feb 21, 2018.
40. Reiber GE, McFarland LV, Hubbard S, et al. Servicemembers and veterans with major traumatic limb loss from Vietnam war and OIF/OEF conflicts: survey methods, participants, and summary findings. *J Rehabil Res Dev*. 2010;47(4):275-297. Accessed Mar 13, 2018.

41. Gajewski D, Granville R. The United States Armed Forces Amputee Patient Care Program. *J Am Acad Orthop Surg*. 2006;14(10 Spec No.):183. Accessed Mar 13, 2018.
42. Hoge CW, McGurk D, Thomas JL, Cox AL, Engel CC, Castro CA. Mild traumatic brain injury in U.S. Soldiers returning from Iraq. *N Engl J Med*. 2008;358(5):453-463. Accessed Mar 13, 2018. doi: 10.1056/NEJMoa072972.
43. Grieger TA, Cozza SJ, Ursano RJ, et al. Posttraumatic stress disorder and depression in battle-injured soldiers. *Am J Psychiatry*. 2006;163(10):1783; quiz 1860. Accessed Mar 13, 2018. doi: 10.1176/ajp.2006.163.10.1777.
44. Blackwell DL, Lucas JW, Clarke TC. Summary health statistics for U.S. adults: National Health Interview Survey, 2012. *National Center for Health Statistics*. 2014; Vital Health Stat 10(260).
45. Wells TS, LeardMann CA, Fortuna SO, et al. A prospective study of depression following combat deployment in support of the wars in Iraq and Afghanistan. *Am J Public Health*. 2010;100(1):90-99. Accessed Mar 13, 2018. doi: 10.2105/AJPH.2008.155432.
46. Frey K, Mitchell S, Pugh MJ, et al. Selection Bias in Military Cohort Studies: An Analysis of Differences between Participants and Non-Participants in a Study of Service Members with Severe Limb Trauma. Poster presented at: 2018 Military Health System Research Symposium; August 20-23, 2018; Kissimmee, FL.
47. Eberlin KR, Ducic I. Surgical algorithm for neuroma management: a changing treatment paradigm. *Plast Reconstr Surg Glob Open*. 2018 Oct; 6(10): e1952. Published online Oct 2018. doi: 10.1097/GOX.0000000000001952
48. Kuiken T. Targeted reinnervation for improved prosthetic function. *Phys Med Clin North Am*. 2006;17(1):1-13.
49. Cancio JM, Ikeda JK, Barnicott SL, Childers WL, Alderete JL, Goff BJ. Upper extremity amputation and prosthetics care across the active duty military and veteran populations. *Phys Med Rehabil Clin N Am*. 2019 Feb;30(1):73-87. doi: 10.1016/j.pmr.2018.08.011