

Extremity War Injury Symposium 2024

Sports Medicine and Medical Readiness Section Summary

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Collaboration between military and civilian investigators is necessary to develop strategies for optimizing treatments to diminish the sequelae of non-battle-related musculoskeletal injuries, which are highly prevalent among servicemembers. The 2024 Extremity War Injuries Symposium provided a forum whereby a diverse group of clinicians and researchers could develop strategies for optimizing treatments and diminishing the sequelae of conditions that are highly prevalent among active individuals. Key points were as follows:

1. The value of collaborations between military and civilian investigators cannot be overemphasized. These synergies can leverage the capabilities of established infrastructures in order to answer important questions pertaining to short-term outcomes—for example, warrior readiness of anterior cruciate ligament reconstructions among servicemembers and long-term posttraumatic osteoarthritis (PTOA) outcomes among civilian cohorts.
2. Current and future prospective trials will inform future treatment decisions related to multiligamentous knee injuries and glenohumeral instability.
3. Novel approaches to addressing PTOA in the acute postinjury period will need longitudinal surveillance to measure their impact on improving clinical outcomes and diminishing residual functional deficits.

Keywords: posttraumatic osteoarthritis; shoulder instability; orthobiologics; patient-reported outcomes

Since 2005, the Extremity War Injuries (EWI) Symposium has convened annually to bring clinicians, researchers, policy makers, and stakeholders together to identify the most conspicuous knowledge gaps related to musculoskeletal disease. Currently, musculoskeletal disease and nonbattle injuries (DNBIs) remain a preeminent threat to medical readiness among US servicemembers and a source of substantial health care-related costs.²⁰ Given this fact, recent EWI symposia, which have been cosponsored by the Society of Military Orthopaedic Surgeons (SOMOS), the American Orthopaedic Society for Sports Medicine (AOSSM), the Orthopaedic Trauma Association, and the American Society for Surgery of the Hand have focused on a number of injuries germane to sports medicine. EWI XVII convened in Washington, DC, on January 15-17, 2024, and the purpose of this summary is to report on the program's yield, highlight promising ongoing initiatives, and describe a way forward that leverages existing partnerships and stimulates new, multidisciplinary collaborations capable of enhancing the medical readiness and warfighter lethality of servicemembers.

THE PROMISE OF MILITARY-CIVILIAN COLLABORATIONS

Launched in 2016, the Military Orthopaedics Tracking Injuries and Outcomes Network (MOTION) has expanded to 15 military treatment facilities and represents a first-of-its-kind enterprise that exists as a repository for prospectively collected clinical data (patient-reported outcome measures, intraoperative surveys completed by surgeons) on over 15,000 patients.¹⁵ As this database continues to mature, so too do its capabilities to better describe the burden of a myriad of injuries, answer meaningful clinical questions, and forecast the likelihood of servicemembers returning to full, unrestricted duty.

Equally promising are the emerging opportunities for collaborations between the MOTION enterprise and civilian research teams, and the recent collaboration between MOTION and the Multicenter Orthopaedic Outcomes Network (MOON) promises to make significant strides toward optimizing the treatment of servicemembers with anterior cruciate ligament (ACL) injuries. Supported by a Medical Technology Enterprise Consortium Award, MOTION and the MOON Knee Group are leveraging previously published predictive return-to-high-activity calculators to

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forecast the likelihood of servicemembers returning to full, unrestricted duty. This award is also facilitating efforts to obtain 20-year clinical follow-up on the MOON Knee cohort, which will inform current and future perspectives on long-term clinical outcomes of ACL reconstruction and identify the most significant risk factors for the development of posttraumatic osteoarthritis (PTOA). A similar collaboration between MOTION and the MOON Shoulder Group is now underway as well and promises to sharpen current understandings of return-to-play/return-to-duty forecasts for patients undergoing glenohumeral stabilization procedures as well as the risk factors for developing glenohumeral joint PTOA. The evolution of these military-civilian collaborations has brought a diverse group of clinicians together to leverage the capabilities of existing data sets and apply validated analytical methods across more robust cohorts.

NECESSITY OF PROSPECTIVE CLINICAL TRIALS: CURRENT AND FUTURE

The value of military-civilian collaborations is seen in several other ongoing prospective clinical trials focused on multiple injury patterns commonly observed among servicemembers. Supported by a Peer Reviewed Orthopaedic Research Program (PRORP) award, the Surgical Timing and Rehabilitation Trial for Multiple Knee Ligament Injuries seeks to investigate the effects of the timing of surgery (early vs delayed) and timing of rehabilitation (early vs delayed) in patients undergoing multiligamentous knee injury (MLKI) reconstruction via 2 parallel randomized controlled trials.¹⁸ Three military treatment facilities have participated in patient enrollment as part of a broader, 28-site effort, which represents the largest prospective interventional trial of its kind seeking to optimize the treatment of non-combat related and combat-related MLKI alike, the latter of which has been observed to be a substantial source of long-term disability among servicemembers.²

Similarly, the Open Versus Arthroscopic Stabilization of Shoulder Instability with Subcritical Bone Loss (OASIS) Trial seeks to answer important clinical questions related to the surgical management of patients with anteroinferior glenohumeral instability. Also supported by a PRORP award, the OASIS Trial will prospectively enroll 450

participants with 10% to 20% anterior glenoid bone loss across 15 sites (10 civilian, 5 military) indicated for arthroscopic Bankart repair plus remplissage, open Bankart repair, or the Latarjet procedure to observe treatment outcomes. Given the high prevalence of recurrent glenohumeral instability among servicemembers,²⁴ this military-civilian collaboration promises to elucidate the limits of arthroscopic stabilization procedures performed in highly active and/or contact athletes, a patient population that has historically been difficult to treat. Additionally, given the expanding nuances of the bipolar bone-loss paradigm,^{1,14,23} the establishment of a multicenter prospective cohort study is necessary to improve current understandings of the most precise indications for remplissage augmentation of Bankart repairs and likelihood of servicemembers' return to duty without recurrent instability after glenohumeral stabilization procedures.

POSTTRAUMATIC OSTEOARTHRITIS: PERSISTENT CHALLENGES AND NEW APPROACHES

Whether it be in the setting of high-energy periarticular fractures or ACL injuries, the research priorities of multiple subspecialty and multidisciplinary areas converge on PTOA as an area in immediate need of continued innovation. As was the case during the EWI XV Symposium in 2020,²⁰ the PTOA breakout session provided a forum for clinicians and scientists to confer and generate a knowledge product that clarified the most pressing and conspicuous knowledge gaps and avenues for future study.

Consensus among the participants coalesced around the description of PTOA as a combination of radiographic features (radiographic and/or advanced imaging-based features characteristic of joint degeneration) with joint pain and/or dysfunction. However, the working group acknowledged the lack of an agreed-upon definition of what constitutes "significant clinical symptoms" as well as how exactly these symptoms should be quantified. The MOON Knee Group has gravitated toward a pain score threshold as measured by the Knee injury and Osteoarthritis Outcome Score of <80, but this threshold has been uniquely applied to those patients with a history of ACL reconstruction.⁸ The working group further outlined a list of research goals and priorities: (1) short-term assessments of the comparative effectiveness of acute phase interventions, (2)

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therapies tailored toward specific phenotypes, and (3) clinical trials focused on preventing and/or forestalling disease progression. It was further acknowledged that there is little evidence to support the efficacy of clinical interventions aimed at ameliorating the disease process once tissue damage is fully established, so there remains a pressing need for more work to better understand early detection and risk factor identification, with a special emphasis on those risk factors that may be modifiable and, therefore, are targets for novel interventions.¹³

Efforts to assess risk factors for disease onset and progression should focus on the several underlying principal factors: the nature of the precipitating trauma, the resulting alterations of the intra-articular synovial/biologic environment, and the pathomechanical sequelae of residual joint instability. Particularly in the setting of ACL injury, the biological milieu of the acutely injured knee has been implicated in joint inflammation and cartilage breakdown. These alterations continue to be a subject of special interest for researchers.^{9,22} With the relative safety of acute interventions such as intra-articular corticosteroid injections performed ≤ 10 days of ACL injury having been recently demonstrated,³ the working group recognizes the necessity for ongoing research into novel approaches that blunt the inflammatory cascade without diminishing the capacity for healing surgical repairs and ligamentous reconstructions. As previously described, the efficacy of these approaches will require more ambitious and longitudinal clinical trials to determine whether acute interventions are associated with disease progression and/or severity.

PUTTING IT ALL TOGETHER: THE BIOLOGIC ASSOCIATION REPOSITORY AND BIOREGISTRY

Orthopaedic-based biologic treatments (ie, orthobiologics) are regulated by the US Food & Drug Administration under the category of human cell and tissue products and offer alternative approaches to manage musculoskeletal disorders. This includes both nonoperative and operative applications, primarily targeting pain relief for symptomatic osteoarthritis (OA)/PTOA, along with the promotion of soft tissue regeneration and repair.²¹ However, persistent challenges (such as the lack of standardized procedures for delivery, processing, and characterization), combined with historical deficiencies in reporting requirements, have fueled a longstanding debate over the efficacy of orthobiologic therapies compared with conventional treatment modalities.^{6,12,17}

For more than a decade, consensus groups organized by the AOSSM, the American Academy of Orthopaedic Surgeons, and several athletic associations and committees have been instrumental in establishing consensus statements, reporting standards, and guidelines for orthobiologic treatments.^{4,5,12,19} In fact, these efforts have led to the adoption of Minimum Information Studies Evaluating for Biologics in Orthopaedics reporting guidelines as well as regulatory recommendations.^{7,10,16} These resources outline current requirements and considerations necessary for conducting clinical trials, registries, and biorepository-based

studies to improve the standardization of orthobiologic therapies for musculoskeletal disorders. Given the importance of standardization and evidence-based practices within the orthobiologic domain of orthopaedics, sports medicine, and pain management, collaborative initiatives that adhere to these guidelines and recommendations have never been more necessary.

The Biologic Association Registry and Biorepository (BARB) is a nationwide, multicenter initiative focused on standardizing and evaluating orthobiologics such as platelet-rich plasma (PRP) to improve consistency in procedures and outcome assessment. The BARB initiative, partnered with the Musculoskeletal Injury Rehabilitation Research for Operational Readiness program at the Uniformed Services University, was established to expand a cohort that encompasses both civilian and noncivilian patient populations (7 civilian sites, 1 military site). This prospective study, incorporating both registry and biorepository components, aims to enroll over 1000 patients with symptomatic tibiofemoral or patellofemoral OA/PTOA. Validated questionnaires are administered ≤ 12 months (with a 6-month endpoint) after a single or series of intra-articular PRP injection(s).¹¹ A minimum injection requirement of 3 mL of PRP has been standardized across organizations, and standardized operating procedures have been implemented at each site to ensure consistent collection of details regarding preparation and injection methods as well as product characteristics (such as complete blood count), which will be correlated with patient demographics and outcomes. Excess PRP samples are also stored for proteomic analysis, using previously published targets of interest.^{25,26}

The main objective of this collaborative effort was to integrate clinical data from a diverse patient population and biological factors of PRP that may influence patient responses in the setting of knee OA/PTOA. The insights derived from these findings will then be used to inform machine-learning algorithms designed to predict patient responses to PRP therapy for knee OA/PTOA. Prospective, multicenter efforts between civilian and military investigators will be used to track other joints and conditions and ultimately refine future treatment strategies.

CONCLUSION



The ongoing partnership between SOMOS and AOSSM in facilitating the Readiness & Sports Medicine section of EWJ continues to shape the direction of research focused on improving outcomes associated with the treatment of musculoskeletal DNBI. The most promising avenues for innovation will continue to flow from military civilian collaborations. Resources must be devoted to longitudinal efforts to better characterize the effects of previous treatments and new approaches.

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REFERENCES

- Barrow AE, Charles SJ, Issa M, et al. Distance to dislocation and recurrent shoulder dislocation after arthroscopic Bankart repair: rethinking the glenoid track concept. *Am J Sports Med.* 2022; 50(14):3875-3880.
- Barrow AE, Sheehan AJ, Burns TC. Return to duty following combat-related multi-ligamentous knee injury. *Injury.* 2017;48(4):861-865.
- Cantrell WA, Cox CL, Johnson C, et al. The effect of aspiration and corticosteroid injection after ACL injury on postoperative infection rate. *Am J Sports Med.* 2023;51(14):3665-3669.
- Chu CR, Rodeo S, Bhutani N, et al. Optimizing clinical use of biologics in orthopaedic surgery: consensus recommendations from the 2018 AAOS/NIH U-13 conference. *J Am Acad Orthop Surg.* 2019;27(2):e50-e63.
- Cole BJ, Gilat R, DiFiori J, Rodeo SA, Bedi A. The 2020 NBA Orthobiologics Consensus Statement. *Orthop J Sports Med.* 2021;9(5):23259671211002296.
- DeClercq MG, Fiorentino AM, Lengel HA, et al. Systematic review of platelet-rich plasma for rotator cuff repair: are we adhering to the minimum information for studies evaluating biologics in orthopaedics? *Orthop J Sports Med.* 2021;9(12):23259671211041971.
- Engelbrechtsen L, Steffen K, Alsousou J, et al. IOC consensus paper on the use of platelet-rich plasma in sports medicine. *Br J Sports Med.* 2010;44(15):1072-1081.
- Felson D, Lotz MK, Jin Y, Jones M, Kim JS, Spindler K. New approach to testing treatments for osteoarthritis: FastOA. *Ann Rheum Dis.* 2024;83(3):274-276.
- Hunt ER, Villasanta-Tezanos AG, Butterfield TA, Lattermann C, Jacobs CA. Upregulation of systemic inflammatory pathways following anterior cruciate ligament injury relates to both cartilage and muscular changes: a pilot study. *J Orthop Res.* 2020;38(2):387-392.
- Jang K, Berrigan WA, Mautner K. Regulatory considerations of orthobiologic procedures. *Phys Med Rehabil Clin N Am.* 2023;34(1):275-283.
- Jawanda H, Khan ZA, Warriar AA, et al. Platelet-rich plasma, bone marrow aspirate concentrate, and hyaluronic acid injections outperform corticosteroids in pain and function scores at a minimum of 6 months as intra-articular injections for knee osteoarthritis: a systematic review and network meta-analysis. *Arthroscopy.* 2024;40(5):1623-1636.
- LaPrade RF, Dragoo JL, Koh JL, Murray IR, Geeslin AG, Chu CR. AAOS research symposium updates and consensus: biologic treatment of orthopaedic injuries. *J Am Acad Orthop Surg.* 2016;24(7):e62-e78.
- Lattermann C, Jacobs CA, Bunnell MP, et al. Logistical challenges and design considerations for studies using acute anterior cruciate ligament injury as a potential model for early posttraumatic osteoarthritis. *J Orthop Res.* 2017;35(3):641-650.
- Li RT, Kane G, Drummond M, et al. On-track lesions with a small distance to dislocation are associated with failure after arthroscopic anterior shoulder stabilization. *J Bone Joint Surg Am.* 2021;103(11):961-967.
- Mauntel TC, Tenan MS, Freedman BA, et al. The Military Orthopedics Tracking Injuries and Outcomes Network: a solution for improving musculoskeletal care in the military health system. *Mil Med.* 2022;187(3-4):e282-e289.
- Murray IR, Geeslin AG, Goudie EB, Petrigliano FA, LaPrade RF. Minimum Information for Studies Evaluating Biologics in Orthopaedics (MIBO): platelet-rich plasma and mesenchymal stem cells. *J Bone Joint Surg Am.* 2017;99(10):809-819.
- Murray IR, LaPrade RF, Musahl V, et al. Biologic Treatments for Sports Injuries II Think Tank—current concepts, future research, and barriers to advancement, part 2. *Orthop J Sports Med.* 2016;4(3):2325967116636586.
- Poploski KM, Lynch AD, Burns TC, et al; STaR Trial for Multiple Ligament Knee Injuries Network. Presentation and surgical management of multiple ligament knee injuries: a multicenter study from the Surgical Timing and Rehabilitation (STaR) Trial for MLKIs Network. *J Bone Joint Surg Am.* 2023;105(8):607-613.
- Rodeo SA, Bedi A. 2019-2020 NFL and NFL Physician Society orthobiologics consensus statement. *Sports Health.* 2020;12(1):58-60.
- Sheehan AJ, Dickens JF, Provencher MT. Extremity War Injury Symposium XV: sports and readiness symposium summary. *J Am Acad Orthop Surg.* 2022;30(5):189-194.
- Su CA, Jildeh TR, Vopat ML, et al. Current state of platelet-rich plasma and cell-based therapies for the treatment of osteoarthritis and tendon and ligament injuries. *J Bone Joint Surg Am.* 2022;104(15):1406-1414.
- Sullivan B, Stone AV, Conley CEW, Hunt ER, Lattermann C, Jacobs CA. Human synovial fluid interleukin-6, but not type II collagen breakdown, positively correlated with pain after anterior cruciate ligament injury and reconstruction. *J Orthop Res.* 2023;41(2):300-306.
- Verweij LPE, van Iersel TP, van Deurzen DFP, van den Bekerom MPJ, Floor S. "Nearly off-track lesions" or a short distance from the medial edge of the Hill-Sachs lesion to the medial edge of the glenoid track does not seem to be accurate in predicting recurrence after an arthroscopic Bankart repair in a military population: a case-control study. *J Shoulder Elbow Surg.* 2023;32(4):e145-e152.
- Wolfe JA, Christensen DL, Mauntel TC, Owens BD, LeClere LE, Dickens JF. A history of shoulder instability in the military: where we have been and what we have learned. *Mil Med.* 2018;183(5-6):e158-e165.
- Zahir H, Dehghani B, Yuan X, et al. In vitro responses to platelet-rich plasma are associated with variable clinical outcomes in patients with knee osteoarthritis. *Sci Rep.* 2021;11(1):11493.
- Ziegler CG, Van Sloun R, Gonzalez S, et al. Characterization of growth factors, cytokines, and chemokines in bone marrow concentrate and platelet-rich plasma: a prospective analysis. *Am J Sports Med.* 2019;47(9):2174-2187.