

NTRAP Orthopedic Trauma Literature Review

ORIGINAL ARTICLES

01. Surgical Management of Musculoskeletal Trauma. Stinner DJ, Edwards D. Surg Clin North Am. 2017 Oct;97(5):1119-1131. doi: 10.1016/j.suc.2017.06.005.

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URL: <https://www.ncbi.nlm.nih.gov/pubmed/28958361>

Musculoskeletal injuries cause a significant burden to society and can have a considerable impact on patient morbidity and mortality. It was initially thought that these patients were too sick to undergo surgery and later believed that they were too sick not to undergo surgery. The pendulum has subsequently swung back and forth between damage control orthopedics and early total care for polytrauma patients with extremity injuries and has settled on providing early appropriate care (EAC). The decision-making process in providing EAC is reviewed in an effort to optimize patient outcomes following severe extremity trauma.

02. The Importance of Optimizing Acute Pain in the Orthopedic Trauma Patient. Jones J Jr, et al. Orthop Clin North Am. 2017 Oct;48(4):445-465. doi: 10.1016/j.ocl.2017.06.003.

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Postoperative pain control is a highly studied topic because of its significant effect on costs, hospital course, and, most importantly, patient satisfaction. Opioid use has been the "status quo" of postoperative pain management but prolongs hospital stays and increases complications. Optimizing acute pain management in patients with orthopedic trauma is important and can translate into significant positive physiologic and financial outcomes. Although multiple viable examples of optimizing acute pain management in the literature demonstrate outcome improvements, implementation has not been widespread. Significant outcome success will depend more on systemwide implementation than a specific regimen for postoperative pain control.

03. Role of Bone Marrow Aspirate in Orthopedic Trauma. Schottel PC, Warner SJ. Orthop Clin North Am. 2017 Jul;48(3):311-321. doi: 10.1016/j.ocl.2017.03.005.

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Bone marrow aspirate grafting entails mesenchymal stem cell-containing bone marrow harvesting and injection into a fracture site to promote bone formation. Although the use of bone marrow aspirate in orthopedic trauma is not widespread, an increasing number of studies are reporting clinical success. Advantages of using bone marrow aspirate are that it is readily obtainable, has low harvest morbidity, and can be easily and quickly injected. However, no universally accepted role for its use exists. Future studies directly comparing bone marrow aspirate with conventional techniques are needed to define its role in the treatment of orthopedic trauma patients.

04. The Impact of Negative Pressure Wound Therapy on Orthopaedic Infection. Webb LX. Orthop Clin North Am. 2017 Apr;48(2):167-179. doi: 10.1016/j.ocl.2016.12.004.

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By hastening the resolution of edema and improving local microcirculation, topical negative pressure wound therapy (TNP) aids the establishment of early wound coverage. Its use in the setting of type III open fractures is reviewed. The author's initial use of TNP for closed surgical incisions and how it

morphed its way into being applied to closed surgical wounds with heightened likelihood for infection is presented. Several case studies are presented to illustrate the role and the technique for management of acute or subacute infections involving bone and implant.

05. Role of Systemic and Local Antibiotics in the Treatment of Open Fractures. Carver DC, et al. *Orthop Clin North Am.* 2017 Apr;48(2):137-153. doi: 10.1016/j.ocl.2016.12.005. Epub 2017 Jan 30.

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The orthopedic community has learned much about the treatment of open fractures from the tremendous work of Ramon Gustilo, Michael Patzakis, and others; however, open fractures continue to be very difficult challenges. Type III open fractures continue to be associated with high infection rates. Some combination of systemic and local antibiotics may be most appropriate in these high-grade open fractures. Further research is still necessary in determining optimal systemic antibiotic regimens as well as the role of local antibiotics. Any new discoveries related to novel systemic antibiotics or local antibiotic carriers will need to be evaluated related to cost.

06. Applications of Local Antibiotics in Orthopedic Trauma. Cancienne JM, et al. *Orthop Clin North Am.* 2015 Oct;46(4):495-510. doi: 10.1016/j.ocl.2015.06.010. Epub 2015 Aug 6.

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Local antibiotics have a role in orthopedic trauma for both infection prophylaxis and treatment. They provide the advantage of high local antibiotic concentration without excessive systemic levels. Nonabsorbable polymethylmethacrylate (PMMA) is a popular antibiotic carrier, but absorbable options including bone graft, bone graft substitutes, and polymers have gained acceptance. Simple aqueous antibiotic solutions continue to be investigated and appear to be clinically effective. For established infections, such as osteomyelitis, a combination of surgical debridement with local and systemic antibiotics seems to represent the most effective treatment at this time. Further investigation of more effective local antibiotic utilization is ongoing.

07. Timing of Operative Debridement in Open Fractures. Rozell JC, et al. *Orthop Clin North Am.* 2017 Jan;48(1):25-34. doi: 10.1016/j.ocl.2016.08.006.

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The optimal treatment of open fractures continues to be an area of debate in the orthopedic literature. Recent research has challenged the dictum that open fractures should be debrided within 6 hours of injury. However, the expedient administration of intravenous antibiotics remains of paramount importance in infection prevention. Multiple factors, including fracture severity, thoroughness of debridement, time to initial treatment, and antibiotic administration, among other variables, contribute to the incidence of infection and complicate identifying an optimal time to debridement.

08. Thromboembolic Disease After Orthopedic Trauma. Whiting PS, Jahangir AA. *Orthop Clin North Am.* 2016 Apr;47(2):335-44. doi: 10.1016/j.ocl.2015.09.002.

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Orthopedic trauma results in systemic physiologic changes that predispose patients to venous thromboembolism (VTE). In the absence of prophylaxis, VTE incidence may be as high as 60%. Mechanical and pharmacologic thromboprophylaxis are effective in decreasing rates of VTE. Combined mechanical and pharmacologic thromboprophylaxis is more efficacious for decreasing VTE incidence

than either regimen independently. If pharmacologic thromboprophylaxis is contraindicated, mechanical prophylaxis should be used. Patients with isolated lower extremity fractures who are ambulatory, or those with isolated upper extremity trauma, do not require pharmacologic prophylaxis in the absence of other VTE risk factors.

09. Spinal Cord Injury-What Are the Controversies? Ahuja CS, et al. J Orthop Trauma. 2017 Sep;31 Suppl 4:S7-S13. doi: 10.1097/BOT.0000000000000943.

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Traumatic spinal cord injuries have a tremendous impact on individuals, families, and society as a whole. Substantial heterogeneity in the patient population, their presentation and underlying pathophysiology has sparked debates along the care spectrum from initial assessment to definitive treatment. This article reviews spinal cord injury (SCI) management followed by a discussion of the salient controversies in the field. Current care practices modeled on the American Association of Neurological Surgeons/Congress of Neurological Surgeons joint section guidelines are highlighted including key recommendations regarding immobilization, avoidance of hypotension, early International Standards for Neurological Classification of SCI examination and intensive care unit treatment. From a diagnostic perspective, the evolving roles of CT, MRI, and leading-edge microstructural MRI techniques are discussed with descriptions of the relevant clinical literature for each. Controversies in management relevant to clinicians including the timing of surgical decompression, methylprednisolone administration, blood pressure augmentation, intraoperative electrophysiological monitoring, and the role of surgery in central cord syndrome and pediatric SCI are also covered in detail. Finally, the article concludes with a reflection on clinical trial design tailored to the heterogeneous population of individuals with SCI.

10. Controversies in Spinal Trauma and Evolution of Care. Harrop JS, et al. Neurosurgery. 2017 Mar 1;80(3S):S23-S32. doi: 10.1093/neuros/nyw076.

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Management of spinal trauma is a complex and rapidly evolving field. To optimize patient treatment algorithms, an understanding of and appreciation for current controversies and advancing technologies in the field of spinal trauma is necessary. Therefore, members of the AOSpine Knowledge Forum Trauma initiative used a modified Delphi method to compile a list of controversial issues and emerging technologies in the field of spinal trauma, and a list of the 14 most relevant topics was generated. A total of 45 440 manuscripts covering the breadth of spine and spinal trauma were initially identified. This broad search was then refined using the 14 categories felt to be most relevant to the current field of spinal trauma. The results were further pared down using inclusion criteria to select for the most relevant topics. The 8 remaining topics were classification schemes, treatment of vertebral compression fractures, treatment of burst fractures, timing of surgery in spinal trauma, hypothermia, the importance of global sagittal balance, lumbar subarachnoid drainage, and diffusion magnetic resonance imaging. These 8 topics were felt to be the most relevant, controversial, rapidly evolving, and most deserving of inclusion in this summary. In summary, despite recent advances, the field of spinal trauma has many ongoing points of controversy. We must continue to refine our ability to care for this patient population through education, research, and development. It is anticipated that the new AOSpine fracture classification system will assist with prospective research efforts.

11. The Need of Validated Disease-Specific Outcome Instruments for Spine Trauma. Oner C, et al. J Orthop Trauma. 2017 Sep;31 Suppl 4:S33-S37. doi: 10.1097/BOT.0000000000000945.

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This article focuses on patient-reported and clinician-reported outcome measures in spine trauma care. The measurement of the quality of care and functional and health-related quality of life outcomes of spine trauma patients has become increasingly important. However, no outcome instrument is specifically designed, validated, or universally adapted for this specific patient population. Issues specific to spinal trauma patients may not be adequately addressed by the instruments that are currently used in the literature and the daily clinical practice. The AOSpine Knowledge Forum Trauma initiated a project to develop and validate such instruments for spine trauma patients. To reflect the different perspectives of patients and the treating surgeons, 2 separate tools are being developed: the Patient Reported Outcome Spine Trauma (AOSpine PROST) and Clinician Reported Outcome Spine Trauma (AOSpine CROST). These tools hold promise, as useful instruments to measure the outcomes of spine trauma patients with and without neurological deficit, making it more feasible for clinical use as well. Treating surgeons around the world are encouraged to use the AOSpine PROST and AOSpine CROST in daily clinical practice and for research purposes to create and contribute to evidence-based and patient-centered care. Using the same outcome measures that are specifically developed and validated for traumatic spine injuries will allow us to compare the outcomes of various treatments in a valid and reproducible fashion. This contributes to a reduction of the ongoing controversies and providing the best treatments for our patients.

12. Minimizing Posttraumatic Osteoarthritis After High-Energy Intra-Articular Fracture. Phen HM, Schenker ML. *Orthop Clin North Am.* 2019 Oct;50(4):433-443. doi: 10.1016/j.jocl.2019.05.002. Epub 2019 Jul 12.

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URL: <https://www.ncbi.nlm.nih.gov/pubmed/31466660>

This article serves to provide an overview of molecular and surgical interventions to minimize the progression of posttraumatic arthritis following high-energy intra-articular fractures. The roles of cartilage and the microcellular environment are discussed, as well as the response of the joint and cartilage to injury. Molecular therapies, such as glucocorticoids, mesenchymal stem cells, and bisphosphonates, are presented as potential treatments to prevent progression to posttraumatic arthritis. High-energy intra-articular fractures of the elbow, hip, knee, and ankle are discussed, with emphasis on restoring anatomic alignment, articular reduction, and stability of the joint.

13. Negative pressure wound therapy versus conventional wound dressings in treatment of open fractures: A systematic review and meta-analysis. Liu X, et al. *Int J Surg.* 2018 May;53:72-79. doi: 10.1016/j.ijsu.2018.02.064. Epub 2018 Mar 16.

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BACKGROUND:

Though several systematic reviews concerned have been published, controversy still exists. The current systematic review was designed to clarify the detailed advantages and disadvantages of the negative pressure wound therapy (NPWT) in treatment of open fractures in comparison with the conventional wound dressings.

METHODS:

A systematic search was performed in Pubmed, Cochrane Library, Embase, and Google Scholar for the published relevant clinical studies. Unpublished studies were searched in Clinicaltrials, ICTRP and ISRCTN. The outcome measures included presence of infection, wound healing process, length of the patient hospital stay, flap issues, frequency of amputation, and patient life quality.

RESULTS:

In the 8 randomized controlled trials (RCTs) (421 patients) and the 6 retrospective cohort studies (488 patients), NPWT resulted in a significantly lower infection rate, significantly shorter wound coverage time, wound healing time and hospital stay length, and the lower amputation rate. However, no statistically significant difference was found in the need for flap surgery, the proportion of free flaps, the flap failure rate or the fracture non-union rate. Only 1 RCT was reported to have a higher physical component score of short form 36 in the infected patients.

CONCLUSION:

NPWT can significantly reduce the risk of infection in treatment of open fractures and accelerate their wound healing process. Some but not much evidence suggests that NPWT may possibly help reduce the severity of the limb injury and therefore provide a chance for the limb to avoid amputation. Use of NPWT in the flap area is probably safe, but should be carried out with caution. The advantage of NPWT over the conventional wound dressings still requires to be confirmed in the other aspects.

14. New Imaging, Diagnostic, and Assessment Techniques in Orthopedic Trauma. Conlan TK, et al. Orthop Clin North Am. 2019 Jan;50(1):47-56. doi: 10.1016/j.ocl.2018.08.010.

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This article examines new imaging, diagnostic, and assessment techniques that may affect the care of patients with orthopedic trauma and/or infection. Three-dimensional imaging has assisted in fracture assessment preoperatively, whereas improvement in C-arm technology has allowed real-time evaluation of implant placement and periarticular reduction before leaving the operating room. Advances in imaging techniques have allowed earlier and more accurate diagnosis of nonunion and infection. Innovations in bacteriologic testing have improved the sensitivity and specificity of perioperative and peri-implant infections. It is critical that surgeons remain up to date on the options available for optimal patient care.

15. The Role of Value-Based Implants in Orthopedic Trauma. Lybrand KE, Althausen PL. Orthop Clin North Am. 2018 Oct;49(4):437-443. doi: 10.1016/j.ocl.2018.05.005. Epub 2018 Jun 27.

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Health care costs in the United States continue to rise, and economic pressures influencing the care of the orthopedic trauma patient have never been greater. Value-based health care is vital to the survival of the current health care system, and the use of value-based implants is central to success. Value-based implants have similar clinical outcomes to conventional implants; however, multiple barriers exist. Despite biomechanical equivalence and significant cost savings, surgeons have difficulty changing implant use without financial incentive. The rise of physician-owned surgery centers, bundled payments, and gain sharing and co-management agreements will likely drive this change.

16. The Role of Implant Removal in Orthopedic Trauma. Barcak EA, et al. Orthop Clin North Am. 2018 Jan;49(1):45-53. doi: 10.1016/j.ocl.2017.08.014.

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Although implant removal is common after orthopedic trauma, indications for removal remain controversial. There are few data in the literature to allow evidence-based decision-making. The risk of complications from implant removal must be weighed against the possible benefits and the likelihood of improving the patient's symptoms.

17. Critical-Sized Bone Defects: Sequence and Planning. Toogood P, Miclau T. *J Orthop Trauma*. 2017 Oct;31 Suppl 5:S23-S26. doi: 10.1097/BOT.0000000000000980.

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Bone defects associated with open fractures require a careful approach and planning. At initial presentation, an emergent irrigation and debridement is required. Immediate definitive fixation is frequently safe, with the exception of those injuries that normally require staged management or very severe type IIIB and IIIC injuries. Traumatic wounds that can be approximated primarily should be closed at the time of initial presentation. Wounds that cannot be closed should have a negative pressure wound therapy dressing applied. The need for subsequent debridements remains a clinical judgment, but all nonviable tissue should be removed before definitive coverage. Cefazolin remains the standard of care for all open fractures, and type III injuries also require gram-negative coverage. Both induced membrane technique with staged bone grafting and distraction osteogenesis are excellent options for bony reconstruction. Soft tissue coverage within 1 week of injury seems critical.

18. Vascular Injury in Orthopedic Trauma. Mavrogenis AF, et al. *Orthopedics*. 2016 Jul 1;39(4):249-59. doi: 10.3928/01477447-20160610-06. Epub 2016 Jun 20.

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Vascular injury in orthopedic trauma is challenging. The risk to life and limb can be high, and clinical signs initially can be subtle. Recognition and management should be a critical skill for every orthopedic surgeon. There are 5 types of vascular injury: intimal injury (flaps, disruptions, or subintimal/intramural hematomas), complete wall defects with pseudoaneurysms or hemorrhage, complete transections with hemorrhage or occlusion, arteriovenous fistulas, and spasm. Intimal defects and subintimal hematomas with possible secondary occlusion are most commonly associated with blunt trauma, whereas wall defects, complete transections, and arteriovenous fistulas usually occur with penetrating trauma. Spasm can occur after either blunt or penetrating trauma to an extremity and is more common in young patients. Clinical presentation of vascular injury may not be straightforward. Physical examination can be misleading or initially unimpressive; a normal pulse examination may be present in 5% to 15% of patients with vascular injury. Detection and treatment of vascular injuries should take place within the context of the overall resuscitation of the patient according to the established principles of the Advanced Trauma Life Support (ATLS) protocols. Advances in the field, made mostly during times of war, have made limb salvage the rule rather than the exception. Teamwork, familiarity with the often subtle signs of vascular injuries, a high index of suspicion, effective communication, appropriate use of imaging modalities, sound knowledge of relevant technique, and sequence of surgical repairs are among the essential factors that will lead to a successful outcome. This article provides a comprehensive literature review on a subject that generates significant controversy and confusion among clinicians involved in the care of trauma patients. [*Orthopedics*. 2016; 39(4):249-259.].

19. Pediatric Orthopedic Trauma. Grossman J, et al. *Pediatr Clin North Am*. 2020 Feb;67(1):101-118. doi: 10.1016/j.pcl.2019.09.010.

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The management of pediatric orthopedic trauma continues to evolve rapidly. Whereas the strong healing potential of pediatric patients often allows for the nonoperative treatment of most conditions, many injuries require urgent operative treatment to ensure that patients may return to all activities

without disability. Some injuries may require additional follow-up and interventions, as complications such as growth arrests or deformity may occur. This article summarizes the most common fractures and orthopedic injuries of the pediatric patient. The keys to diagnosis, acute management, nonoperative and operative treatments, and complications are discussed. The detection and management of nonaccidental trauma are also examined.

20. Pediatric Orthopedic Trauma: An Evidence-Based Approach. Hubbard EW, Riccio AI. *Orthop Clin North Am.* 2018 Apr;49(2):195-210. doi: 10.1016/j.ocl.2017.11.008. Epub 2017 Dec 14.

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The management of pediatric fractures has evolved over the past several decades, and many injuries that were previously being managed nonoperatively are now being treated surgically. The American Academy of Orthopaedic Surgeons has developed clinical guidelines to help guide decision making and streamline patient care for certain injuries, but many topics remain controversial. This article analyzes the evidence regarding management of 5 of the most common and controversial injuries in pediatric orthopedics today.

21. Use of Tourniquets in Limb Trauma Surgery. Bogdan Y, Helfet DL. *Orthop Clin North Am.* 2018 Apr;49(2):157-165. doi: 10.1016/j.ocl.2017.11.004. Epub 2017 Dec 9.

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Although tourniquets are commonly used in patients with limb trauma patients, both in the acute and elective settings, no set protocols exist for their indications, contraindications, or proper use. This article addresses the current literature on optimal pressure, timing, cuff design, and complications of tourniquets in trauma patients. General issues are discussed, followed by those specific to upper and lower extremities. Lastly, serious complications, such as pulmonary embolism, are described.

22. Impact of Infection on Fracture Fixation. Willey M, Karam M. *Orthop Clin North Am.* 2016 Apr;47(2):357-64. doi: 10.1016/j.ocl.2015.09.004.

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Surgical site infection can be a devastating complication that results in significant morbidity in patients who undergo operative fixation of fractures. Reducing the rate of infection and wound complications in high-risk trauma patients by giving early effective antibiotics, improving soft tissue management, and using antiseptic techniques is a common topic of discussion. Despite heightened awareness, there has not been a significant reduction in surgical site infection over the past 40 years. Patients should be treated aggressively to eliminate or suppress the infection, heal the fracture if there is a nonunion, and maintain the function of the patient.

23. Arthrofibrosis After Periarticular Fracture Fixation. McAlister I, Sems SA. *Orthop Clin North Am.* 2016 Apr;47(2):345-55. doi: 10.1016/j.ocl.2015.09.003.

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Arthrofibrosis after periarticular fractures can create clinically significant impairments in both the upper and lower extremities. The shoulder, elbow, and knee are particularly susceptible to the condition. Many risk factors for the development of arthrofibrosis cannot be controlled by the patient or surgeon. Early postoperative motion should be promoted whenever possible. Manipulations under anesthesia are effective for a period of time in certain fracture patterns, and open or arthroscopic surgical

debridements should be reserved for the patient for whom nonoperative modalities fail and who has a clinically significant deficit.

24. Fracture Fixation Using Shape-Memory (Nitinol) Staples. Wu JC, et al. *Orthop Clin North Am.* 2019 Jul;50(3):367-374. doi: 10.1016/j.ocl.2019.02.002. Epub 2019 Apr 16.

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Shape-memory alloy (SMA) staples are a recent innovation in fracture fixation. These staples have inherent compressive properties that create a stable fracture environment that promotes primary bone healing. They have been used successfully for osteotomies, arthrodesis, and fracture fixation.

Understanding where SMA staple compression can be optimized and using proper indications are important for obtaining consistent success and minimizing failures. SMA staples are not a substitute for lag screw fixation or traditional plate and screw constructs.

25. Options and hazards of the early appropriate care protocol for trauma patients with major fractures: Towards safe definitive surgery. Pape HC, et al. *Injury.* 2016 Apr;47(4):787-91. doi:

10.1016/j.injury.2016.03.020.

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No abstract

26. Factors associated with surgeon referral for physical therapy in patients with traumatic lower-extremity injury: results of a national survey of orthopedic trauma surgeons. Archer KR, et al. *Phys Ther.* 2009 Sep;89(9):893-905. doi: 10.2522/ptj.20080321. Epub 2009 Jul 9.

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Abstract

BACKGROUND:

Variation in referral rates for physical therapy exists at both the individual physician and practice levels.

OBJECTIVE:

The purpose of this study was to explore the influence of physician and practice characteristics on referral for physical therapy in patients with traumatic lower-extremity injury.

DESIGN:

A cross-sectional survey was conducted.

METHODS:

In 2007, a Web-based survey questionnaire was distributed to 474 surgeon members of the Orthopaedic Trauma Association. The questionnaire measured physician and practice characteristics, outcome expectations, and attitude toward physical therapy. Referral for physical therapy was based on case vignettes.

RESULTS:

The response rate was 58%. Surgeons reported that 57.6% of their patients would have a positive outcome from physical therapy and 24.2% would have a negative outcome. The highest physical therapy expectations were for the appropriate use of assistive devices (80.7%) and improved strength (force-generating capacity) (76.4%). The lowest outcome expectations were for improvements in pain (35.9%), coping with the emotional aspects of disability (44.1%), and improvements in workplace limitations (51.4%). Physicians reported that 32.6% of their patients referred for physical therapy would have no improvement beyond what would occur with a surgeon-directed home exercise program.

Multivariate analyses showed positive physician outcome expectations to have the largest effect on referral for physical therapy (odds ratio=2.7, $P<.001$).

CONCLUSIONS:

The results suggest that orthopedic trauma surgeons refer patients for physical therapy based mostly on expectations for physical and motor outcomes, but may not be considering pain relief, return to work, and psychosocial aspects of recovery. Furthermore, low referral rates may be attributed to a preference for surgeon-directed home-based rehabilitation. Future research should consider the efficacy of physical therapy for pain, psychosocial and occupational outcomes, and exploring the differences between supervised physical therapy and physician-directed home exercise programs.

GUIDELINES

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