Interventional Efforts to Reduce Psychological Distress After Orthopedic Trauma: A Systematic Review

James C. Kirven, BS · Joshua S. Everhart, MD, MPH · Alex C. DiBartola, MD, MPH · Jeremy Jones, MD · David C. Flanigan, MD · Ryan Harrison, MD

Received: 23 June 2019/Accepted: 9 October 2019/Published online: 4 December 2019
© Hospital for Special Surgery 2019

Abstract *Background:* Unanticipated severe injury to part of the musculoskeletal system, referred to as orthopedic trauma, can be debilitating. It can also be accompanied by equally debilitating psychological distress, but little is known about the effective interventions for psychological sequelae of orthopedic trauma. *Questions/Purposes:* We sought to determine the effectiveness of interventions on psychological outcomes, such as post-traumatic stress disorder (PTSD), depression, and pain catastrophizing (feelings of helplessness, excessive rumination, and exaggerated description of pain), after major orthopedic trauma. *Methods:* Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement as guidelines, we systematically searched Scopus, PubMed, and Google Scholar. Studies included for review were English-language interventional studies in an orthopedic trauma population that included assessment of post-injury

psychological distress or disability as either a primary or secondary aim. *Results:* Twelve studies were identified, including six randomized trials, three prospective cohort studies, and three retrospective cohort studies. Study sample sizes ranged from 48 to 569 patients, the mean age ranged from 29 to 52.8 years, and the percentage of male patients ranged from 38 to 90%. We examined four categories of interventions. Peer group treatment (one study) significantly reduced rates of depression but had low participation rates. Brief interventions to teach coping and self-efficacy skills (two studies) decreased depression, pain catastrophizing, and anxiety scores while increasing self-efficacy on short-term follow-up. Individualized counseling and rehabilitation (four studies) resulted in a consistent reduction in the risk of PTSD. Early amputation was found to result in lower rates of PTSD than limb salvage in US military personnel (four studies). One study examined surgeons' confidence in dealing with possible psychological distress; surgeons who participated in a program on collaborative care were significantly more confident that they could help their patients with such issues. *Conclusion:* Interventional strategies, including group interventions, brief individual interventions, longitudinal counseling, and consideration of early amputation in selected populations have proved effective in reducing negative psychological sequelae of major orthopedic trauma. Further research that determines the effects of interventions in this population is needed.

Level of Evidence: Level III: Systematic Review

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s11420-019-09731-w>) contains supplementary material, which is available to authorized users.

J. C. Kirven, BS · J. S. Everhart, MD, MPH ·
A. C. DiBartola, MD, MPH · J. Jones, MD · D. C. Flanigan, MD ·
R. Harrison, MD (✉)
Department of Orthopaedics, Ohio State University Wexner Medical
Center,
725 Prior Hall,
Columbus, OH 43210, USA
e-mail: ryan.harrison@osumc.edu

J. C. Kirven, BS · D. C. Flanigan, MD
Sports Medicine, Ohio State University Wexner Medical Center,
Columbus, OH, USA

D. C. Flanigan, MD
Cartilage Restoration Program, Ohio State University Wexner
Medical Center,
Columbus, OH, USA

Keywords orthopedic trauma ·
post-traumatic stress disorder · psychological distress ·
psychosocial intervention · amputation

Introduction

Orthopedic trauma, a severe injury to part of the musculoskeletal system, is often both debilitating and expensive. Adverse effects on patients' lifestyles and mobility are often

accompanied by equally debilitating psychological distress. In particular, post-traumatic stress disorder (PTSD), depression, and pain catastrophizing (feelings of helplessness, excessive rumination, and exaggerated description of pain) are common psychological sequelae of orthopedic trauma [1, 2, 5, 7, 11, 14, 18, 19, 28, 30, 31, 35]. In addition to their high incidence, these psychological stressors have been shown to be associated with increased disability during recovery of function and mobility [14, 20, 22], increased long-term pain levels [2, 5], increased opioid use [24, 26], and decreased physical function at 1 to 2 years after injury [31]. Also, PTSD and depression at 1 week and 3 months after injury have been associated with increased disability at 12 months [21].

Psychological distress after orthopedic trauma has been shown to be an issue over both the short and long term. A systematic review and meta-analysis completed by Muscatelli et al. found that after orthopedic injury, nearly a third of patients suffer from depression and more than a quarter suffer from PTSD [19]. Research exploring the prevalence of psychological distress after orthopedic trauma has found values ranging from 20 [7] to 52.7% [6] of patients, depending on type of injury and measurement criteria, with PTSD, depression, and other forms of psychological distress found at clinically significant rates [6, 7, 11, 18].

Not only has the prevalence of psychological distress after orthopedic trauma been well described but also many different risk factors and screening tools have been assessed. Pain catastrophizing, which can be measured with the 13-item Pain Catastrophizing Scale [29], has been found to be associated with greater pain intensity and disability [31], as well as higher pain levels and lower physical health scores at 1 year [2]. There are many other risk factors for the development of psychological distress after orthopedic injuries, including female sex [14], younger age [24], and lower social support and income [6] levels. Injury-specific risk factors include concomitant traumatic brain injury [25] and mechanisms of injury involving gunshot wounds [24] or interpersonal assault [1].

Understanding these risk factors can help guide screening, but there are also validated psychometric screening tools that can be used efficiently with all orthopedic trauma patients. For example, Hanley et al. found the four-item Primary Care PTSD screening tool to be nearly as effective as the 17-item PTSD Checklist—Civilian Version screening for PTSD, with a significantly lower survey burden [13]. These screening tools and risk factors help increase the effectiveness of psychometric screening.

What has been described and reviewed thoroughly is the prevalence of psychological distress after orthopedic trauma, along with risk factors, screening tools, and the possibility of negative outcomes after orthopedic trauma. The purpose of this study is to systematically review the current literature on the effectiveness of different interventions on psychological outcomes after major orthopedic trauma. By pairing effective interventions with the many screening tools available, practitioners will be able to use a psychosocial perspective to improve care in patients with orthopedic trauma.

Materials and Methods

We conducted searches of PubMed, Scopus, and Google Scholar databases on September 1, 2017, adhering to the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Fig. 1) [17]. Search terms included the following: (Orthopedic trauma or “traumatic injury” or “musculoskeletal trauma”) AND (PTSD OR Depression OR pain catastrophizing OR Anxiety OR psychiatric). The search was performed using the Medical Subject Headings advanced search tool. We also searched the reference lists of key publications by hand and then reviewed titles and abstracts for the following inclusion criteria:

1. It is an original research involving orthopedic trauma
2. There is assessment of post-injury psychological distress or disability as either a primary or secondary study aim
3. There is assessment of treatment effects on psychosocial sequelae after orthopedic trauma
4. The study is reported in manuscript form in a peer-reviewed publication (meeting abstracts, posters, and thesis papers were excluded)
5. The study reports original research in English

Duplicates and studies not obviously meeting the five criteria were excluded. The full manuscripts of those remaining were reviewed to determine whether their characteristics matched the aims of the current review. These studies were then evaluated for quality of evidence according to the Methodological Index for Non-randomized Studies (MINORS) criteria, which have been shown to be a reliable and valid assessment of quality with both comparative and noncomparative outcome studies. A maximum score of 16 is possible for noncomparative studies; a maximum of 24 is possible for comparative studies [27]. Because of significant inter-study heterogeneity of study design and outcome measures, a meta-analysis could not be performed. Inter-study heterogeneity also limited the ability to compare certain results, particularly quantitative outcomes, across the included studies.

Results

Search Strategies

Searches of PubMed, Scopus, and Google Scholar databases yielded 969 studies, after duplicates were excluded. After review of the titles and abstracts, 719 studies were excluded because they were not relevant to orthopedic trauma; 112 additional studies were excluded because they failed to meet other inclusion criteria, including relevance to psychological outcomes in orthopedics. We identified 38 studies that pertained to orthopedic trauma and psychological distress, disability, or other psychosocial sequelae. Twenty-six of those studies were excluded because they did not address the impact of specific interventions on psychosocial issues, yielding a total of 12 studies for inclusion in the review.

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart of study

Study Characteristics

Of the 12 studies included for review, six were randomized, controlled trials [9, 23, 32, 36–38], three were prospective cohort studies [8, 10, 33], and three were retrospective cohort studies [12, 15, 16] (Table 1). All studies included both sexes and were specific to traumatic orthopedic injuries, although there was substantial heterogeneity regarding body parts, severity of injuries, and interventions studied. The studies' sample sizes ranged from 48 to 569 patients [32, 33], mean ages of patients ranged from 29 to 51.82 years [16, 32], and the percentage of male patients ranged from 38 to 90% [16, 32]. We have grouped the studies here according to type of treatment or intervention, as well as type of surgery and surgeons' level of confidence (one study), as they were reported in the studies.

Peer Focus Group Treatment

Peer groups consisting of fellow patients who experienced orthopedic trauma have been found to be an effective

resource for patients beyond their care team (Table 2). Wegener et al. describe a program called the Trauma Support Network (TSN), consisting of peer visitation and family support for orthopedic trauma patients [34]. The effectiveness of the TSN was evaluated by Castillo et al., who found a 49% decrease in the odds of depression in the TSN group, as compared with a control group, with no other significant differences between groups [10]. The authors note that a major limitation of the study is that the TSN had a low participation rate: only 3% of patients attended classes, and 27% received the family handbook. They state that this is likely due to the study's being performed during the TSN rollout but also note that other such support networks also have a low participation rates.

Coping and Self-Efficacy Skills

A relatively inexpensive treatment option is patient education and training around coping skills and self-efficacy (Table 3). These were explored by Vranceanu et al. as "mind-body skills," involving relaxation response and

Table 1 Study characteristics

Author	Journal	Year	No. of patients	Study design	Age in years, range
Bosse et al. [8]	New England Journal of Medicine	2002	569	Prospective cohort	16–69
Browne et al. [9]	Disability and Rehabilitation	2013	142	RCT	–
Castillo et al. [10]	Journal of Trauma and Acute Care Surgery	2013	251	Prospective cohort	18–69
Doukas et al. [12]	Journal of Bone and Joint Surgery (American Edition)	2013	324	Retrospective cohort	≥ 18
Hoogendoorn et al. [15]	Injury	2001	64	Retrospective cohort	–
Ladlow et al. [16]	Journal of Bone and Joint Surgery (American Edition)	2016	100	Retrospective cohort	–
Ponzer et al. [23]	Journal of Trauma	2000	151	RCT	15–65
Vranceanu et al. [32]	Injury	2015	48	RCT	≥ 18
Wegener et al. [33]	Journal of Orthopaedic Trauma	2017	95	Prospective cohort	–
Wong et al. [36]	Journal of Advanced Nursing	2010	126	RCT	–
Zatzick et al. [37]	Annals of Surgery	2013	207	RCT	≥ 18
Zatzick et al. [38]	Archives of General Psychiatry	2004	120	RCT	≥ 18

Author	Age in years, mean	Study category	Primary endpoints
Bosse et al. [8]	35.8/35.2	Early amputation vs. limb salvage	SIP, limb status, rehospitalization
Browne et al. [9]	36	Counseling and rehabilitation	Pain, depression, PTSD, mobility
Castillo et al. [10]	36.9/38	Peer focus group treatment	Depression, anxiety, self-efficacy, health status, patient activation
Doukas et al. [12]	–	Early amputation vs. limb salvage	SMFA, depression, PTSD, pain, PPAQ
Hoogendoorn et al. [15]	39.9/39.4/50.6	Early amputation vs. limb salvage	Function, NHP, SF-36, study-designed questionnaire
Ladlow et al. [16]	29	Early amputation vs. limb salvage	6MWT, DMRC Mobility and ADL, PHQ-9, GAD-7 scale, mental health support, pain scores
Ponzer et al. [23]	40/42	Counseling and rehabilitation	Psychiatric complaints, length of sick leave, SF-36 subscores: general health, vitality
Vranceanu et al. [32]	51.82	Coping and self-efficacy skills	Disability (SMFA), pain (NAS), coping, mood
Wegener et al. [33]	39/40.5	Surgeon confidence	Confidence, beliefs
Wong et al. [36]	54.4	Coping and self-efficacy skills	Pain, anxiety, self-efficacy
Zatzick et al. [37]	38.5	Counseling and rehabilitation	PTSD, functional limitations
Zatzick et al. [38]	37.1/44.4	Counseling and rehabilitation	PTSD, alcohol abuse or dependence

SIP Sickness Impact Profile, RCT randomized, controlled trial, PTSD post-traumatic stress disorder, SMFA Short Musculoskeletal Function Assessment, PPAQ Paffenbarger Physical Activity Questionnaire, NHP Nottingham Health Profile, SF-36 36-item Short Form Health Survey, 6MWT 6-minute walk test, DMRC Defense Medical Rehabilitation Centre, ADL activities of daily living, PHQ-9 Patient Health Questionnaire, GAD-7 generalized anxiety disorder 7-item, NAS numerical analogue scale

Table 2 Peer focus group treatment study

Author	Primary endpoints	Intervention	Follow-up	Conclusions
Castillo et al. [10]	Depression, anxiety, self-efficacy, health status, patient activation	TSN	6 months	49% reduction in odds of depression in TSN group

TSN Trauma Support Network

cognitive behavioral strategies, in patients with acute fractures who were at risk for chronic pain and disability. They found that there was an overall statistically significant difference in post-intervention disability (measured using the Short Musculoskeletal Function Assessment; F_1 score for difference = 9.75; $p = 0.05$; partial $\eta^2 = 0.31$), pain catastrophizing (measured using the Pain Catastrophizing Scale; F_1 score = 13.65; $p = 0.001$; partial $\eta^2 = 0.32$), pain anxiety (measured by the Pain Anxiety Scale; F_1 score = 28.53; $p < 0.001$; partial $\eta^2 = 0.50$), depression (measured using the Center for Epidemiologic Studies Depression Scale; F_1 score = 7.82, $p = 0.009$; partial $\eta^2 = 0.21$), and PTSD (measured using the PTSD checklist for civilians; F_1 score = 7.14, $p = 0.01$; $\eta^2 = 0.20$) [32]. The study was significantly limited by a small sample size ($N = 48$) but offers promise in terms of future research and implementation. Educational intervention was also explored by Wong et al., who randomly assigned patients to either a “usual care” control group or an experimental group, in which patients underwent an educational intervention along with usual care. The educational intervention was a 30-min education module to enhance patients’ self-efficacy; they were given information about pain and the use of analgesics, as well as training in breathing exercises. They found that at 3 months of follow-up, the intervention group had significantly lower anxiety ($F_{5,119} = 71.19$; $p < 0.001$) and significantly greater self-efficacy ($F_{1,123} = 4.25$; $p = 0.048$) [36].

Counseling and Rehabilitation

Studies analyzing the effects of counseling and rehabilitation focused on trained providers, including psychologists, nurses, and orthopedic surgeons, being involved with support and counseling for orthopedic trauma patients (Table 4). Ponzer et al. compared patients who underwent a psychosocial support program with patients in a control group. They found that the control group had a greater

risk of having psychiatric symptoms (odds ratio [OR] = 2.74; confidence interval = 1.00 to 7.51), and a greater risk of having a poorer quality of life, as measured using the 36-item Short Form Health Survey subscores on general health (OR = 2.3) and vitality (OR = 2.45) [23]. Zatzick et al. in 2004 looked at the effectiveness of collaborative care (CC) on PTSD and alcohol abuse [38] and in 2013 looked at the effectiveness of stepped care exclusively on PTSD [37]. In the 2004 study, the CC intervention included continuous post-injury case management; motivational interviews targeting alcohol use and dependence; and evidence-based pharmacotherapy, cognitive behavioral therapy, or both. They found that CC patients were significantly less symptomatic with regard to PTSD (mean = -0.67 ; standard error [SE] = 0.27; $p = 0.01$) and alcohol misuse or dependence (mean = -2.12 ; SE = 1.07; $p = 0.048$), as compared with usual care patients [38]. In the 2013 study, Zatzick et al. evaluated the effectiveness of a similar model, stepped care, in orthopedic trauma patients. Stepped care included care management, psychopharmacology, and cognitive behavioral therapy. At 1 year after injury, stepped care patients had significantly reduced PTSD symptoms, as compared with controls, both clinically and statistically [37]. In a pilot trial, Browne et al. explored the use of a multidisciplinary intervention (MI), including assessment and treatment by physical medicine and rehabilitation physicians, physiotherapists, occupational therapists, and clinical psychologists. They found that, as compared with control patients, those who underwent the MI received greater relief from pain treatment and needed fewer general medical care visits. Also, none of the MI patients who were “not at risk” for PTSD or depression at baseline developed symptoms, in contrast to 24% of the control patients who were not at risk. However, this study did conclude that MI was not superior to usual care in reducing pain severity, psychological symptom severity, and functional outcomes, as compared with overall group outcomes [9].

Table 3 Coping and self-efficacy skills studies

Author	Primary endpoints	Intervention	Follow-up	Conclusions
Vranceanu et al. [32]	Disability (SMFA), pain (NAS), coping, mood	Mind–body skills, cognitive behavioral strategies	NR	Statistically significant difference after intervention, with respect to SMFA, PCS, PAS, CES-D, PTSD
Wong et al. [36]	Pain, anxiety, self-efficacy	30-min self-efficacy-enhancing educational intervention	3 months	Intervention group had significantly lower anxiety and higher self-efficacy

SMFA Short Musculoskeletal Function Assessment, NAS numerical analogue scale, NR not reported, PCA Pain Catastrophizing Scale, PAS Pain Anxiety Scale, CES-D Center for Epidemiologic Studies Depression Scale, PTSD post-traumatic stress disorder, NR not reported

Table 4 Counseling and rehabilitation

Author	Primary endpoints	Intervention	Follow-up	Conclusions
Browne et al. [9]	Pain, depression, PTSD, mobility	Multidisciplinary intervention at 1 month and 3 months after injury (PM&R treatment, PT, OT, psychotherapeutic treatment)	6 months	Intervention group had lower pain scores, fewer primary care visits, less PTSD and depression
Ponzer et al. [23]	Psychiatric complaints, length of sick leave, SF-36 subscores: general health, vitality	Psychosocial support program	12 months	Control group had OR of 2.74 for psychiatric complaints and ORs of 2.3 for poorer general health and 2.45 for lower vitality score on SF-36
Zatzick et al. (2013) [37]	PTSD, functional limitations	Stepped care (psychopharmacology and CBT)	1, 3, 6, 9, 12 months	Intervention patients had lower PTSD symptoms at 12 months
Zatzick et al. (2004) [38]	PTSD, alcohol misuse or dependence	Collaborative care (case management, motivation interviews, pharmacotherapy and/or CBT)	1, 3, 6, 12 months	Collaborative care group was less symptomatic with respect to PTSD and alcohol abuse

PTSD post-traumatic stress disorder, *PM&R* physical medicine and rehabilitation, *PT* physical therapy, *OT* occupational therapy, *SF-36* 36-item Short Form Health Survey, *OR* odds ratio, *CBT* cognitive behavioral therapy

Early Amputation Versus Salvage Procedures

Another aspect of treatment to consider is the operation that the patient undergoes, particularly for severe orthopedic injuries, which might be treated with either limb salvage or amputation. There are multiple studies showing that, from a psychosocial perspective, there is little difference between early amputation and limb salvage, although such studies have low power (Table 5). Both

Hoogendoorn et al. and Bosse et al. found that in a civilian population, there were no differences between reported quality of life and self-reported disability [8, 15]. In an analysis of a US military population, Doukas et al. reported that patients who underwent amputation were 57% less likely to develop PTSD symptoms than those who underwent limb salvage [12]. On the other hand, Ladlow et al. reported no significant differences in mental health outcomes between amputation and limb-

Table 5 Early amputation versus salvage procedures

Author	Primary endpoints	Intervention	Follow-up	Conclusions
Bosse et al. [8]	SIP, limb status, rehospitalization	Limb salvage vs. amputation	24 months	No difference in SIP or functional outcomes between groups
Doukas et al. [12]	SMFA, depression, PTSD, pain, PPAQ	Limb salvage vs. amputation	37.5 months	Those with amputations had higher SMFA scores in all domains and lower likelihood of PTSD; no differences in depressive and pain symptoms or work/school status
Hoogendoorn et al. [15]	Function, NHP, SF-36, study-designed questionnaire	Limb salvage vs. amputation	NR	Limb salvage group had lower impairment, no difference in QOL scores on NHP and SF-36
Ladlow et al. [16]	6MWT, DMRC Mobility and ADL, PHQ-9, GAD-7, mental health support, pain scores	Limb salvage vs. amputation	NR	Delayed BKA amputation group walked further than limb salvage group, no differences in mental health outcome scores between groups

SIP Sickness Impact Profile, *SMFA* Short Musculoskeletal Function Assessment, *PTSD* post-traumatic stress disorder, *PPAQ* Paffenbarger Physical Activity Questionnaire, *NHP* Nottingham Health Profile, *SF-36* 36-item Short Form Health Survey, *NR* not reported, *QOL* quality of life, *6MWT* 6-min walk test, *DMRC* Defense Medical Rehabilitation Centre, *ADL* activities of daily living; *PHQ-9* Patient Health Questionnaire, *GAD-7* generalized anxiety disorder 7-item, *BKA* below-the-knee amputation

salvage groups in a military population in the United Kingdom (UK), although they pointed out that the UK has significant mental health resources for soldiers with catastrophic injuries [16].

Surgeons' Confidence

In order to implement many of these changes, the orthopedic surgeons in charge of patients' care need to be trained and confident in the resources they have for the psychosocial support of their patients. Providers' confidence and knowledge of potential resources for orthopedic trauma patients should increase resource use, which would likely improve psychosocial outcomes. Wegener et al. examined the impact of the Trauma Collaborative Care (TCC) program on surgeons' confidence in managing psychosocial concerns in their patients. The researchers found that the surgeons at TCC sites had a significantly greater improvement in their belief that they had strategies to help patients change their psychosocial situation, their confidence in making appropriate referrals, their belief that they had access to information to guide the management of psychosocial issues related to recovery, and their belief that asking patients about their psychosocial problems would encourage patients to take action [33].

Study Quality and MINORS Scoring

Because all of the studies included in the review were comparative studies, the highest possible MINORS score was 24. The MINORS scores for each study in each category are shown in Table 6. The mean score was 17, with the highest being 20 and the lowest 13. The most common reason for point deductions was a lack of unbiased evaluation of endpoints, with only one study employing blinding for endpoint evaluation. Other common reasons for point deduction were a greater than 5% loss to follow-up (85% of studies) and a lack of prospective determination of sample size (85% of studies). Also of note, some studies did not have a "gold standard control group" (a placebo or "nontreated" control group); in these cases, studies compared amputation with limb-salvage procedures.

Discussion

The prevalence of psychological distress after orthopedic trauma and its associated disability have been well documented. We sought to systematically review the literature to identify treatment options used to mitigate these psychosocial sequelae. We found that the most effective way to triage patients in need of psychological support and treatment is to use simple screening tools and identify common risk factors to aid in the evaluation of those needing support. Providers must also be cognizant of the many psychological tribulations that accompany orthopedic trauma so they can appropriately refer patients for evaluation and treatment.

This review has some limitations, which could be addressed by further study. The primary limitation is the lack

of studies that solely measure the effects of interventions on long-term psychological distress after orthopedic trauma. Most studies focus on screening and prevalence of psychological distress, rarely measuring effects of an intervention. In order to build effective and holistic treatments for orthopedic trauma patients, further research that determines the effects of interventions in this population is needed. Research is hampered somewhat by the unexpected nature of orthopedic trauma, but such studies are necessary if we wish to improve care in these patients.

The severity of the orthopedic trauma itself is the initial indication of what the patient's psychological needs might be (Fig. 2). Providers need to be aware of and vigilant for psychosocial sequelae in cases of severe trauma that necessitates either amputation or limb salvage, either of which can increase risk of disability and worsen quality of life [8]. Although it is largely undetermined whether amputation or limb salvage is a better option for patients' psychosocial health [8, 15, 16], Doukas et al. concluded that amputation improves function and lowers PTSD risk in US soldiers [12]. It is important to note the confounding differences between civilian and military populations in these studies, as well as between the UK and US military systems. The main difference that Doukas et al. note is that the US soldiers who undergo amputation have a much more focused rehabilitation course than limb salvage patients or civilians [12]. With these improved rehabilitation protocols, US military amputees are likely to return to function more effectively and thereby report a better quality of life. Also, there might be more social support given to amputees because their treatment is very visible, as compared with limb salvage. One way to improve the psychosocial scores after severe orthopedic trauma is to ensure that all patients have the most effective rehabilitation possible, so they can approach normal function quickly and fully. Also, building social support for civilians undergoing amputations or limb salvage procedures can help mitigate negative psychological outcomes in these populations. An area of further study would be the frequency of delayed amputation and the effects such delay has on patients' psychological well-being.

Irrespective of the results of the psychometric screening, providers should consider offering access to a trauma peer group resource. Peer support is an inexpensive option for patients and providers that can facilitate social support for survivors of orthopedic trauma. Those who participated in the TSN described by Castillo et al. had a 49% lower risk of depression [10]. The positive results seen in the TSN study were tempered by low participation rates, but by making peer resources available to all orthopedic trauma patients, the country's network of survivors will grow in number and in diversity. This should increase the rates of use and decrease psychosocial symptoms. With little or no overhead for providers, such groups are an effective means through which the provider can help improve social support for their patients, thereby decreasing the likelihood of psychological distress after injury and treatment.

When results of screening for psychological distress risk factors are positive, providers should pursue more structured

Table 6 MINORS scores for the included studies

	Clearly stated aim	Inclusion of consecutive patients	Prospective collection of data	Endpoint appropriate to the aim of the study	Unbiased assessment of the study endpoint	Follow-up period appropriate to the aim of the study	Loss to follow-up less than 5%	Prospective calculation of the study size	An adequate control group	Contemporary groups	Baseline equivalence of groups	Adequate statistical analysis	Total
Castillo et al. 2013 [10]	2	2	2	2	0	2	0	0	2	1	1	2	16
Ponzer et al. 2000 [23]	2	2	2	2	0	2	0	0	2	2	2	2	18
Vranceanu et al. 2015 [32]	2	2	2	2	0	2	0	0	2	2	2	2	18
Ladlow et al. 2016 [16]	2	2	0	2	0	2	2	0	1	2	0	2	15
Doukas et al. 2013 [12]	2	2	0	2	0	2	2	0	1	2	0	2	15
Browne et al. 2012 [9]	2	2	2	2	0	2	0	0	2	2	2	2	18
Wegener et al. 2017 [33]	2	2	2	2	1	2	0	0	1	2	1	2	17
Zatzick et al. 2004 [38]	2	2	2	2	0	2	0	0	2	2	2	2	18
Zatzick et al. 2013 [37]	2	2	2	2	0	2	0	2	2	2	2	2	20
Bosse et al. 2002 [8]	2	2	2	2	0	2	0	0	2	2	0	2	16
Hoogendoorn et al. 2011 [15]	2	2	0	2	0	2	0	0	1	2	0	2	13
Wong et al. 2010 [36]	2	2	2	2	0	2	0	2	2	2	2	2	20

MINORS Methodological Index for Non-randomized Studies

Fig. 2. Proposed algorithm for psychological evaluation and treatment of patients after major orthopedic trauma. *GSW* gunshot wound, *PC-PTSD* Primary Care Post-Traumatic Stress Disorder, *PHQ-2* Patient Health Questionnaire-2

psychological intervention. A relatively low-burden treatment is training and education regarding coping and self-efficacy skills. Relaxation techniques and cognitive behavioral strategies have been shown to be useful and effective in many different areas of healthcare, and particularly so in the study by Vranceanu et al., in which they were shown to significantly lessen pain catastrophizing, pain anxiety, depression, and PTSD [32]. Pain catastrophizing has been shown to be predictive of reported pain levels, physical health scores, and opioid use after surgery [3, 4]. Anxiety, depression, and PTSD are debilitating and have been shown to predict long-term disability and opioid use, specifically in patients with orthopedic injuries [21, 22, 26]. If patients are

trained in the use of self-efficacy and coping skills to prevent psychological problems, they can continue to protect themselves against long-term psychosocial sequelae after their treatment and rehabilitation are complete. This type of training can be prescribed by physicians, so a patient is not left entirely alone to find help—although the patient is responsible for using these skills effectively.

The most hands-on tools for preventing psychological distress are psychological rehabilitation and counseling. Cognitive behavioral therapy paired with pharmacotherapy and continuing case management has been shown to effectively reduce psychological distress after orthopedic trauma [37, 38]. The inclusion of multifaceted, holistic treatment by

other physicians and therapists has been shown to prevent PTSD and depression in patients who were not previously at risk for these conditions [9]. Although relatively expensive, these measures are very effective in helping to mitigate and even prevent psychological disturbance in injured patients, which is particularly helpful in higher-risk patient populations and those without strong social support systems already in place.

One important aspect of implementing a holistic psychosocial model into the treatment of orthopedic trauma patients is the need for providers to be comfortable with referring and treating these patients appropriately. Patients who are at very high risk for psychological distress after orthopedic trauma should be in a system where the providers have both the training and the resources necessary to evaluate and effectively treat their psychosocial needs. Wegener et al. showed the increase in surgeons' confidence in treating these patients when they were enrolled in the collaborative trauma care program [33]. By increasing surgeon confidence in the treatment options, the TCC programs helped to ensure that surgeons would refer patients appropriately for psychological evaluation and treatment as needed. This suggests that patients at particularly high risk should be seen in a system with a collaborative care program. Not only are patients given the resources they need, but they are also appropriately and effectively treated and followed for longer-term or late-onset psychological sequelae.

In conclusion, there are many viable interventions to limit or even prevent psychological distress after orthopedic trauma. Patients need to be educated on the prevalence of these psychological issues, and providers should refer at-risk patients accordingly. All patients should be offered access to orthopedic trauma peer support, which costs little and improves as more patients are included. Patients with risk factors should at a minimum be given education and training in self-efficacy and coping skills. High-risk patients and those who "screen positive" for risk factors for psychological distress should be referred for further psychological evaluation and treatment in order to prevent long-term disability and psychological sequelae. In order to provide the most holistic care for patients, large trauma centers should have or be enrolled in a trauma collaborative care program. In the absence of such a program, providers should refer the highest-risk patients to trauma centers that have such care programs in place.

Compliance with Ethical Standards

Conflict of Interest: James C. Kirven, BS, Joshua S. Everhart, MD, MPH, Alex C. DiBartola, MD, MPH, Jeremy Jones, MD, and Ryan K. Harrison, MD, declare that they have no conflicts of interest. David C. Flanagan, MD, reports receiving personal fees from Ceterix Orthopaedics, Conmed, Depuy Mitek, Histogenics, Moximed, Smith & Nephew, Vericel, and Zimmer Biomet, outside the submitted work.

Human/Animal Rights: N/A

Informed Consent: N/A

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

References

1. Alarcon LH, Germain A, Clontz AS, et al. Predictors of acute posttraumatic stress disorder symptoms following civilian trauma: highest incidence and severity of symptoms after assault. *J Trauma Acute Care Surg.* 2012;72(3):629–635.
2. Archer KR, Abraham CM, Obremskey WT. Psychosocial factors predict pain and physical health after lower extremity trauma. *Clin Orthop Relat Res.* 2015;473:3519–3526.
3. Archer KR, Abraham CM, Song Y, Obremskey WT. Cognitive-behavioral determinants of pain and disability two years after traumatic injury: a cross-sectional survey study. *J Trauma Acute Care Surg.* 2012;72:473–479.
4. Archer KR, Heins SE, Abraham CM, Obremskey WT, Wegener ST, Castillo RC. Clinical significance of pain at hospital discharge following traumatic orthopaedic injury: general health, depression, and PTSD outcomes at 1 year. *Clin J Pain.* 2016;32(3):196–202.
5. Archer KR, Phelps KD, Seebach CL, Song Y, Riley LH 3rd, Wegener ST. Comparative study of short forms of the Tampa Scale for Kinesiophobia: fear of movement in a surgical spine population. *Arch Phys Med Rehabil.* 2012;93:1460–1462.
6. Becher S, Smith M, Ziran B. Orthopaedic trauma patients and depression: a prospective cohort. *J Orthop Trauma.* 2014;28:e242–e246.
7. Bhandari M, Busse JW, Hanson BP, Leece P, Ayeni OR, Schemitsch EH. Psychological distress and quality of life after orthopedic trauma: an observational study. *Can J Surg.* 2008;51:15–22.
8. Bosse MJ, MacKenzie EJ, Kellam JF, et al. An analysis of outcomes of reconstruction or amputation after leg-threatening injuries. *N Engl J Med.* 2002;347:1924–1931.
9. Browne AL, Appleton S, Fong K, et al. A pilot randomized controlled trial of an early multidisciplinary model to prevent disability following traumatic injury. *Disabil Rehabil.* 2013;35:1149–1163.
10. Castillo RC, Wegener ST, Newell MZ, et al. Improving outcomes at Level I trauma centers: an early evaluation of the Trauma Survivors Network. *J Trauma Acute Care Surg.* 2013;74:1534–1540.
11. Crichlow RJ, Andres PL, Morrison SM, Haley SM, Vrahas MS. Depression in orthopaedic trauma patients. Prevalence and severity. *J Bone Joint Surg Am.* 2006;88:1927–1933.
12. 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;95:138–145.
13. Hanley J, deRoos-Cassini T, Brasel K. Efficiency of a four-item posttraumatic stress disorder screen in trauma patients. *J Trauma Acute Care Surg.* 2013;75:722–727.
14. Holbrook TL, Hoyt DB. The impact of major trauma: quality-of-life outcomes are worse in women than in men, independent of mechanism and injury severity. *J Trauma.* 2004;56:284–290.
15. Hoogendoorn JM, van der Werken C. Grade III open tibial fractures: functional outcome and quality of life in amputees versus patients with successful reconstruction. *Injury.* 2001;32:329–334.
16. Ladlow P, Phillip R, Coppack R, et al. Influence of immediate and delayed lower-limb amputation compared with lower-limb salvage on functional and mental health outcomes post-rehabilitation in the U.K. military. *J Bone Joint Surg Am.* 2016;98:1996–2005.

17. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol*. 2009;62:e1–e34.
18. McCarthy ML, MacKenzie EJ, Edwin D, Bosse MJ, Castillo RC, Starr A. Psychological distress associated with severe lower-limb injury. *J Bone Joint Surg Am*. 2003;85:1689–1697.
19. Muscatelli S, Spurr H, O'Hara NN, O'Hara LM, Sprague SA, Slobogean GP. Prevalence of depression and posttraumatic stress disorder after acute orthopaedic trauma: a systematic review and meta-analysis. *J Orthop Trauma*. 2017;31:47–55.
20. Nota SPFT, Bot AGJ, Ring D, Kloen P. Disability and depression after orthopaedic trauma. *Injury*. 2015;46:207–212.
21. O'Donnell ML, Holmes AC, Creamer MC, et al. The role of post-traumatic stress disorder and depression in predicting disability after injury. *Med J Aust*. 2009;190:S71–74.
22. Ponsford J, Hill B, Karamitsios M, Bahar-Fuchs A. Factors influencing outcome after orthopedic trauma. *J Trauma*. 2008;64:1001–1009.
23. Ponzer S, Molin U, Johansson SE, Bergman B, Törnkvist H. Psychosocial support in rehabilitation after orthopedic injuries. *J Trauma*. 2000;48:273–279.
24. Powers MB, Warren AM, Rosenfield D, et al. Predictors of PTSD symptoms in adults admitted to a Level I trauma center: a prospective analysis. *J Anxiety Disord*. 2014;28:301–309.
25. Roden-Foreman K, Solis J, Jones A, Bennett M, et al. Prospective evaluation of posttraumatic stress disorder and depression in orthopaedic injury patients with and without concomitant traumatic brain injury. *J Orthop Trauma*. 2017;31:e275–e280.
26. Rosenbloom BN, McCartney CJL, Canzian S, Kreder HJ, Katz J. Predictors of prescription opioid use 4 months after traumatic musculoskeletal injury and corrective surgery: a prospective study. *J Pain*. 2017;18:956–963.
27. Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (MINORS): development and validation of a new instrument. *ANZ J Surg*. 2003;73:712–716.
28. Soberg HL, Bautz-Holter E, Roise O, Finset A. Mental health and posttraumatic stress symptoms 2 years after severe multiple trauma: self-reported disability and psychosocial functioning. *Arch Phys Med Rehabil*. 2010;91:481–488.
29. Sullivan MJL, Bishop S, Pivik J. The Pain Catastrophizing Scale: development and validation. *Psychol Assess*. 1995;7:524–532.
30. Vincent HK, Horodyski M, Vincent KR, Brisbane ST, Sadasivan KK. Psychological distress after orthopedic trauma: prevalence in patients and implications for rehabilitation. *PM R*. 2015;7:978–989.
31. Vranceanu AM, Bachoura A, Weening A, Vrahas M, Smith RM, Ring D. Psychological factors predict disability and pain intensity after skeletal trauma. *J Bone Joint Surg Am*. 2014;96:e20.
32. Vranceanu AM, Hageman M, Strooker J, ter Meulen D, Vrahas M, Ring D. A preliminary RCT of a mind body skills based intervention addressing mood and coping strategies in patients with acute orthopaedic trauma. *Injury*. 2015;46:552–557.
33. Wegener ST, Carroll EA, Gary JL, et al. Trauma Collaborative Care Intervention: effect on surgeon confidence in managing psychosocial complications after orthopaedic trauma. *J Orthop Trauma*. 2017;31:427–433.
34. Wegener ST, Pollak AN, Frey KP, et al. The Trauma Collaborative Care Study (TCCS). *J Orthop Trauma*. 2017;31:S78–S87.
35. Williams AE, Newman JT, Ozer K, Juarros A, Morgan SJ, Smith WR. Posttraumatic stress disorder and depression negatively impact general health status after hand injury. *J Hand Surg Am*. 2009;34:515–522.
36. Wong EM-L, Chan SW-C, Chair S-Y. Effectiveness of an educational intervention on levels of pain, anxiety and self-efficacy for patients with musculoskeletal trauma. *J Adv Nurs*. 2010;66:1120–1131.
37. Zatzick D, Jurkovich G, Rivara FP, et al. A randomized stepped care intervention trial targeting posttraumatic stress disorder for surgically hospitalized injury survivors. *Ann Surg*. 2013;257:390–399.
38. Zatzick D, Roy-Byrne P, Russo J, et al. A randomized effectiveness trial of stepped collaborative care for acutely injured trauma survivors. *Arch Gen Psychiatry*. 2004;61:498–506.