



Original research

A Pilot Study Using a Standardized Method of Measuring Distress Demonstrates Higher Levels in Septic Revisions

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ARTICLE INFO

Article history:

Received 10 February 2023

Received in revised form

16 September 2023

Accepted 20 September 2023

Available online 10 November 2023

Keywords:

PJI

Distress

Quality of life

ABSTRACT

Background: Combined Orthopaedic Infectious Disease Clinics facilitate care for prosthetic joint infection (PJI) patients similar to multidisciplinary care in cancer centers. The National Comprehensive Cancer Network developed a standardized distress thermometer (DT) to measure distress in cancer patients. We propose using this tool to assess distress in PJI patients.

Methods: In this pilot study, a retrospective review of patients treated in our combined clinic over 2 years was conducted. In addition to providing information surrounding their treatment, patients completed a questionnaire and DT, adapted with permission from the National Comprehensive Cancer Network. DT scores were compared to a chronologically collected matched aseptic control group.

Results: There were 122 patients in the septic group and 40 patients in the aseptic group. On a scale of 0–10 (10, the highest level of distress), the septic group reported a mean DT score of 6.18 (± 3.2), which was significantly higher than the aseptic mean score of 3.33 (± 2.06) [$P < .0001$]. Over 75% of patients in the septic group reported a DT score ≥ 4 , the cutoff used in most cancer centers to warrant additional support. Twenty-one percent of the septic group (26/122) reported extreme distress (defined as a score ≥ 10) compared to 0/40 of aseptic patients.

Conclusions: Patients treated for PJI experience significantly higher levels of distress compared to aseptic revision patients. More attention is needed to measure and clinically address distress. Improved screening for distress would allow us to provide more comprehensive care and possibly improve compliance, outcomes, and resources available for the treatment of PJI patients.

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Introduction

The morbidity and mortality rates from prosthetic joint infections (PJIs) are high and comparable to some malignancies. In fact, the 5-year mortality for a total knee arthroplasty infection is estimated to be between 15% and 25%, which is higher than the expected mortality from breast and prostate cancer [1–3].

Most commonly, the standard of care treatment for a PJI includes surgical debridement and a prolonged course of antimicrobials [4]. Depending on the type of surgical debridement and the organism isolated, the failure rate varies from 13% to 84% [5,6]. Patients who

develop relapsed infections often require additional surgery and longer courses of both intravenous (IV) and oral antimicrobials, which are associated with additional side effects. Intravenous antimicrobials have toxicities similar to chemotherapy including neutropenia, fatigue, nausea and vomiting, and diarrhea [7]. PJI impacts not only a patient's mobility but all aspects of a patient's life. The distress experienced by patients undergoing treatments for cancer is well studied [8,9]; however, not enough attention has been paid to this aspect of care for PJI patients. Even though a recent study has demonstrated that PJI patients undergoing 2-stage revision have 4 times higher prevalence of preoperative depressive symptoms than patients undergoing aseptic revision, we have not determined the best way to screen and treat distress in the PJI population [10].

The National Comprehensive Cancer Network (NCCN) recommends routine screening for distress in all cancer patients [11]. The NCCN defines distress as a multifactorial unpleasant emotional

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experience of a psychological (cognitive, behavioral, emotional), social, and/or spiritual nature that may interfere with the ability to cope effectively with cancer, its physical symptoms, and its treatment [12]. Approximately 7% of the general population experiences distress at a given time, while 25%-60% of cancer patients report distress during their care [8]. Patients with high levels of distress are less adherent to treatment, have a poorer quality of life, and have poorer survival rates [13]. Basch showed that, by identifying distress early, clinical interventions such as symptom management, counseling, chemotherapy dose modifications, and referrals are pursued and lead to improved quality of life and survival [14]. The NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines) recommend utilization of a standardized distress thermometer (DT) to assess patients' current distress [11,15].

Currently, there is no standardized tool being used to assess distress in the comprehensive care of patients with PJI. With permission from the NCCN, we adapted their DT to be used in PJI patients. The DT has been validated in the oncology population but has not been validated in the total joint population. No validation study was performed as this was a pilot study. Although somewhat intuitive based on clinical experience, there is currently no literature supporting the increased distress during the treatment course for PJI. The purpose of this pilot study was to compare DT scores in patients undergoing septic revision and patients undergoing aseptic revision, as well as to determine what psychosocial and physical factors may contribute to high DT scores. We also looked at secondary outcome measures including the Hip Disability and Osteoarthritis Outcome Score for Joint Replacement (HOOS JR) or Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS JR). We hypothesized that patients undergoing septic revision would experience significantly higher rates of distress compared to those undergoing aseptic revision.

Material and methods

This study was approved by the institutional review board at our institution (IRB# 2009116583). A survey was administered to all PJI patients who had been treated at our tertiary referral center's Combined Orthopaedic Infectious Disease Clinic from 2018 to 2020. A total of 263 patients were mailed a survey and DT. For the purposes of this pilot study, the questionnaire was administered to patients throughout the continuum of the care pathway. The survey (Appendix A) included questions regarding current antimicrobial use, recurrence of infection, number of joint surgeries, return to work, and history of anxiety and/or depression. Patients were also asked to complete a HOOS JR or KOOS JR depending on the involved joint. Low HOOS and KOOS JR scores indicate higher levels of pain and poor function. To understand the limitations of survey response rates, a chronologically collected age- and sex-matched aseptic revision population whose data were collected prospectively was used as a comparison group.

The NCCN DT was adapted with permission from NCCN (Fig. 1). Patients were asked to assess the amount of distress they experienced over the course of their PJI care. The overall DT score is a scale from 0 (indicating no distress) to 10 (indicating extreme distress). Patients were also asked to complete the DT problem list, which assesses problems in the categories of practical problems, family problems, emotional problems, spiritual/religious concerns, and physical problems. In the aseptic group, DT scores were averaged over a 1-year follow-up period; this mean was used for comparison to the septic group.

In addition to the surveys completed by patients, a chart review of all patients was conducted. Categories that were assessed in the chart review included demographic data, comorbidities as identified in their medical record at the time of questionnaire receipt,

Study ID: _____

Distress Thermometer and Problem List for Patients

Adapted for patients with prior prosthetic joint infection

<p>DISTRESS THERMOMETER</p> <p>Instructions: Please circle the number (0–10) that best describes how much distress you experienced over the course of your prosthetic joint infection care.</p> <div style="text-align: center; margin-top: 20px;"> </div>	<p>PROBLEM LIST Please indicate if any of the following has been a problem for you during the course of your prosthetic joint infection care. Be sure to check YES or NO for each.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <p>YES NO Practical Problems</p> <p><input type="checkbox"/> <input type="checkbox"/> Child care</p> <p><input type="checkbox"/> <input type="checkbox"/> Housing</p> <p><input type="checkbox"/> <input type="checkbox"/> Insurance/financial</p> <p><input type="checkbox"/> <input type="checkbox"/> Transportation</p> <p><input type="checkbox"/> <input type="checkbox"/> Work/school</p> <p><input type="checkbox"/> <input type="checkbox"/> Treatment decisions</p> <p>Family Problems</p> <p><input type="checkbox"/> <input type="checkbox"/> Dealing with children</p> <p><input type="checkbox"/> <input type="checkbox"/> Dealing with partner</p> <p><input type="checkbox"/> <input type="checkbox"/> Ability to have children</p> <p><input type="checkbox"/> <input type="checkbox"/> Family health issues</p> <p>Emotional Problems</p> <p><input type="checkbox"/> <input type="checkbox"/> Depression</p> <p><input type="checkbox"/> <input type="checkbox"/> Fears</p> <p><input type="checkbox"/> <input type="checkbox"/> Nervousness</p> <p><input type="checkbox"/> <input type="checkbox"/> Sadness</p> <p><input type="checkbox"/> <input type="checkbox"/> Worry</p> <p><input type="checkbox"/> <input type="checkbox"/> Loss of interest in usual activities</p> <p><input type="checkbox"/> <input type="checkbox"/> Spiritual/religious concerns</p> <p>Other Problems: _____</p> </td> <td style="width: 50%; vertical-align: top;"> <p>YES NO Physical Problems</p> <p><input type="checkbox"/> <input type="checkbox"/> Appearance</p> <p><input type="checkbox"/> <input type="checkbox"/> Bathing/dressing</p> <p><input type="checkbox"/> <input type="checkbox"/> Breathing</p> <p><input type="checkbox"/> <input type="checkbox"/> Changes in urination</p> <p><input type="checkbox"/> <input type="checkbox"/> Constipation</p> <p><input type="checkbox"/> <input type="checkbox"/> Diarrhea</p> <p><input type="checkbox"/> <input type="checkbox"/> Eating</p> <p><input type="checkbox"/> <input type="checkbox"/> Fatigue</p> <p><input type="checkbox"/> <input type="checkbox"/> Feeling swollen</p> <p><input type="checkbox"/> <input type="checkbox"/> Fevers</p> <p><input type="checkbox"/> <input type="checkbox"/> Getting around</p> <p><input type="checkbox"/> <input type="checkbox"/> Indigestion</p> <p><input type="checkbox"/> <input type="checkbox"/> Memory/concentration</p> <p><input type="checkbox"/> <input type="checkbox"/> Mouth sores</p> <p><input type="checkbox"/> <input type="checkbox"/> Nausea</p> <p><input type="checkbox"/> <input type="checkbox"/> Nose dry/congested</p> <p><input type="checkbox"/> <input type="checkbox"/> Pain</p> <p><input type="checkbox"/> <input type="checkbox"/> Sexual</p> <p><input type="checkbox"/> <input type="checkbox"/> Skin dry/itchy</p> <p><input type="checkbox"/> <input type="checkbox"/> Sleep</p> <p><input type="checkbox"/> <input type="checkbox"/> Substance use</p> <p><input type="checkbox"/> <input type="checkbox"/> Tingling in hands/feet</p> </td> </tr> </table>	<p>YES NO Practical Problems</p> <p><input type="checkbox"/> <input type="checkbox"/> Child care</p> <p><input type="checkbox"/> <input type="checkbox"/> Housing</p> <p><input type="checkbox"/> <input type="checkbox"/> Insurance/financial</p> <p><input type="checkbox"/> <input type="checkbox"/> Transportation</p> <p><input type="checkbox"/> <input type="checkbox"/> Work/school</p> <p><input type="checkbox"/> <input type="checkbox"/> Treatment decisions</p> <p>Family Problems</p> <p><input type="checkbox"/> <input type="checkbox"/> Dealing with children</p> <p><input type="checkbox"/> <input type="checkbox"/> Dealing with partner</p> <p><input type="checkbox"/> <input type="checkbox"/> Ability to have children</p> <p><input type="checkbox"/> <input type="checkbox"/> Family health issues</p> <p>Emotional Problems</p> <p><input type="checkbox"/> <input type="checkbox"/> Depression</p> <p><input type="checkbox"/> <input type="checkbox"/> Fears</p> <p><input type="checkbox"/> <input type="checkbox"/> Nervousness</p> <p><input type="checkbox"/> <input type="checkbox"/> Sadness</p> <p><input type="checkbox"/> <input type="checkbox"/> Worry</p> <p><input type="checkbox"/> <input type="checkbox"/> Loss of interest in usual activities</p> <p><input type="checkbox"/> <input type="checkbox"/> Spiritual/religious concerns</p> <p>Other Problems: _____</p>	<p>YES NO Physical Problems</p> <p><input type="checkbox"/> <input type="checkbox"/> Appearance</p> <p><input type="checkbox"/> <input type="checkbox"/> Bathing/dressing</p> <p><input type="checkbox"/> <input type="checkbox"/> Breathing</p> <p><input type="checkbox"/> <input type="checkbox"/> Changes in urination</p> <p><input type="checkbox"/> <input type="checkbox"/> Constipation</p> <p><input type="checkbox"/> <input type="checkbox"/> Diarrhea</p> <p><input type="checkbox"/> <input type="checkbox"/> Eating</p> <p><input type="checkbox"/> <input type="checkbox"/> Fatigue</p> <p><input type="checkbox"/> <input type="checkbox"/> Feeling swollen</p> <p><input type="checkbox"/> <input type="checkbox"/> Fevers</p> <p><input type="checkbox"/> <input type="checkbox"/> Getting around</p> <p><input type="checkbox"/> <input type="checkbox"/> Indigestion</p> <p><input type="checkbox"/> <input type="checkbox"/> Memory/concentration</p> <p><input type="checkbox"/> <input type="checkbox"/> Mouth sores</p> <p><input type="checkbox"/> <input type="checkbox"/> Nausea</p> <p><input type="checkbox"/> <input type="checkbox"/> Nose dry/congested</p> <p><input type="checkbox"/> <input type="checkbox"/> Pain</p> <p><input type="checkbox"/> <input type="checkbox"/> Sexual</p> <p><input type="checkbox"/> <input type="checkbox"/> Skin dry/itchy</p> <p><input type="checkbox"/> <input type="checkbox"/> Sleep</p> <p><input type="checkbox"/> <input type="checkbox"/> Substance use</p> <p><input type="checkbox"/> <input type="checkbox"/> Tingling in hands/feet</p>
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Figure 1. Ortho Distress Thermometer Adapted with permission from the NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines) for Distress Version 1.2020. 2020 National Comprehensive Cancer Network, Inc. All rights reserved. The NCCN Guidelines and illustrations herein may not be reproduced in any form for any purpose without the express written permission of NCCN. To view the most recent and complete version of the NCCN Guidelines, go online to <https://nccn.org/>. The NCCN Guidelines are a work in progress that may be refined as often as new significant data becomes available.

Charlson comorbidity index (CCI), number and type of surgeries, and antimicrobial usage patterns. The information obtained by chart review was recorded in REDCap (Research Electronic Data Capture) along with the patients' survey results.

Statistical analysis

Standardized statistical analyses were performed on the data set. Simple summary statistics are reported in table format. Student's t-tests and analysis of variance were completed for continuous variables using JMP-V16 statistical software (SAS Institute, Cary, NC). Correlation analysis was used to assess the association among the various treatment parameters.

Results

Demographics

A total of 263 patients were identified as being treated for PJI in the combined clinic between 2018 and 2020; however, given the retrospective nature of this questionnaire, 36 of the 263 (13%) were deceased at the time of review. Of the surviving 227 patients, 122 (53.7%) responded. The mean age of participants was 66.13 years. Mean body mass index (BMI) was 35.37. Fifty-six of the 122 participants (45.9%) were male. There were 84 patients in the total knee revision group and 38 patients in the total hip revision group.

Forty patients met inclusion criteria in the matched aseptic control group. The screen failure rate was 4 out of 44 patients recruited (9.1%). The mean age for the control group was 65.99 years, while the mean BMI was 32.90. Nineteen of the 40 participants (47.5%) were male. There were 23 patients in the total knee revision group and 17 patients in the revision hip group.

The demographic data are summarized in [Table 1](#). The septic and aseptic groups were similar with respects to mean age, BMI, sex, mean number of surgeries, CCI, percent returned to work, history of depression, and history of anxiety.

Distress score

On a scale of 0-10, the mean DT score in the septic group was significantly higher at 6.18 (± 3.2) compared to the aseptic group at 3.33 (± 2.06) [$P < .0001$]. In the septic group, 94 of 122 (77%) reported a DT score ≥ 4 , which is the cutoff used in the oncology literature for patients to receive additional support and services to alleviate their distress. Only 11 of the 40 aseptic patients (27.5%) reported a DT score ≥ 4 ($P < .0001$). Of the 122 septic patients surveyed, 26 (21.3%) reported a DT score of 10, which is "extreme distress," while none of the aseptic patients reported a score of 10. [Figure 2a](#) and [b](#) show the distribution of DT scores in both groups. Increasing patient age was associated with higher DT scores in the septic group ($P = .011$) but not in the aseptic group ($P = .759$). [Table 2](#) demonstrates a breakdown of the DT scores in both groups.

Other factors

Other factors that may contribute to high DT scores including CCI, readmission to the hospital, and ability to return to work were investigated. In both the septic and aseptic groups, there was no correlation between patients' CCI and their DT scores ($P = .732$, $P = .327$). Hospital readmission did not affect DT scores ($P = .983$ in septic group, $P = .419$ in aseptic group). In the septic group, patients who were able to return to work had significantly lower DT scores than patients who were unable to return to work ($P = .031$). In the aseptic group, there was no difference in DT scores between patients who returned to work and those that did not ($P = .115$).

Table 1
Demographic data.

Demographic data and other patient factors	Septic group	Aseptic group	P value
Number of patients	122	40	
Mean age (y)	66.13 (± 10.80)	65.99 (± 10.84)	.9443
Mean BMI (kg/m ²)	35.37 (± 7.734)	32.90 (± 7.525)	.0796
Percent male participants	45.9%	47.5%	.9781
Number in knee group	84 (68.9%)	23 (57.5%)	
Number in hip group	38 (31.1%)	17 (42.5%)	
Mean number of surgeries per patient	4.393 (± 4.261)	3.108 (± 3.108)	.0449 ^a
Charlson comorbidity index	3.713	3.250	.1899
Percent who returned to work	38.71%	42.86%	>.9999
Percent readmitted	78.69%	5.00%	<.0001 ^a
Percent with history of depression	36.07%	40.00%	.6548
Percent with history of anxiety	29.75%	37.50%	.4334
Average weeks of IV antibiotics per patient	6.0	N/A	
Number of patients requiring >6 wk of IV antibiotics	20 (16.4%)	N/A	
Number of patients requiring 3 or more courses of IV antibiotics	36 (29.5%)	N/A	

^a Indicates significant difference.

Problem list

The problem list categorizes problems into 5 major categories: practical problems, family problems, emotional problems, spiritual/religious concerns, and physical problems. In analyzing the problem list, we focused on patients in the septic and aseptic group with DT scores ≥ 4 . The most common problems included pain, worry, and getting around. [Table 3](#) shows a breakdown of the top 3 problems in each category in both the septic and aseptic groups. Additional breakdown of the problem list is included in [Appendix B](#).

History of anxiety or depression

In the septic group, 36 patients (29.5%) reported a history of anxiety, while 44 (36.1%) reported a history of depression. Patients with a diagnosis of anxiety had significantly higher DT scores than patients who did not ($P = .014$). Patients with a diagnosis of depression had significantly higher DT scores than patients not diagnosed with depression ($P = .001$).

In the aseptic group, 15 (37.5%) reported a history of anxiety, and 16 (40.0%) reported a history of depression. There was no difference in DT scores for the aseptic patients with a history of anxiety or depression ($P = .225$, $P = .390$).

Surgical data

On average, patients surveyed from the septic group had undergone 4.4 surgeries (± 4.3), which included the primary joint revision followed by any subsequent surgeries. The type of surgery was categorized as debridement antibiotics and implant retention (DAIR), single-stage, 2-stage, fusion, amputation, Girdlestone, spacer exchange, and other. DT scores were compared among the different types of surgery. Patients who underwent the Girdlestone procedure reported the highest DT scores with a mean DT score of 8.0 ([Table 4](#)). In the aseptic group, patients had undergone 3.1 surgeries (± 3.0), which included the primary joint revision. On average, DT scores were collected 412 days from the patient's last surgery for infection (SD 440).

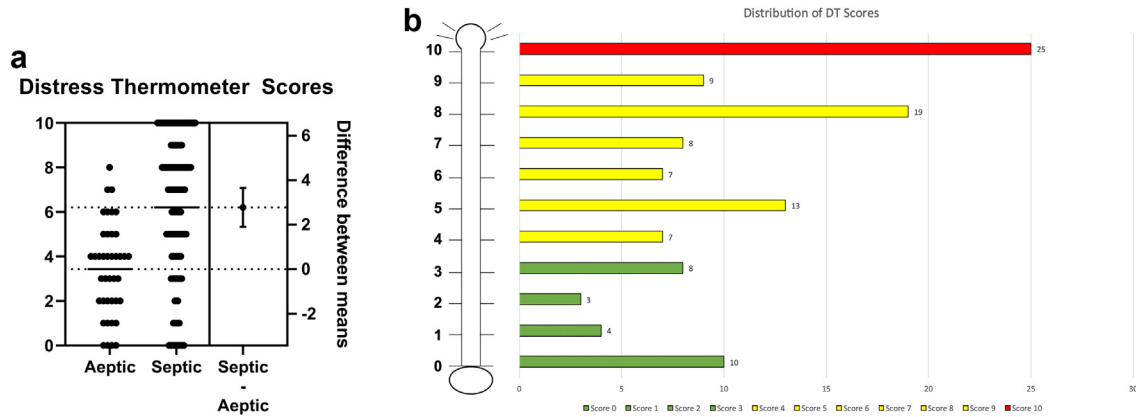


Figure 2. (a) Distribution of DT Scores. A score of ≥ 4 is considered a critical cutoff in the oncology literature. The width of distribution points is proportional to the number of points at that score. (b) Distribution of DT Scores in Septic Group. A score of ≥ 4 is considered a critical cutoff in the oncology literature; 78% of patients reported a DT score ≥ 4 .

We also evaluated mean DT scores by dividing the patients into knee septic revision, knee aseptic revision, hip septic revision, and hip aseptic revision. The mean DT score in the septic knee group was 6.1 (± 3.4), while it was 3.9 (± 2.0) in the aseptic knee group ($P = .005$). The mean DT score in the septic hip group was 6.4 (± 2.9), while it was 2.5 (± 1.9) in the aseptic hip group ($P < .0001$).

Antimicrobial data

The mean duration of IV antimicrobial therapy for a given episode of PJI was 6.0 weeks (± 1.3). The mean DT score for patients receiving 6 weeks or less of IV antimicrobials was 6.08 (± 3.2), while the mean DT score for patients receiving more than 6 weeks of IV antimicrobials was 6.7 (± 3.1) [$P = .443$]. Of the 122 patients surveyed, 36 (29.5%) required 3 or more courses of IV antimicrobials for a chronically infected joint. Interestingly, the mean DT score for patients receiving less than 3 courses of IV antimicrobials was 6.4 (± 3.1), while the mean DT score for patients receiving more than 3 courses was 6.0 (SD 3.3); this difference was not statistically significant ($P = .527$).

HOOS and KOOS JR scores

In the septic group, patients who reported lower KOOS JR scores had higher DT scores ($P = .001$). A trend was also seen in patients who reported lower HOOS JR scores; they had higher DT scores, but this correlation was not statistically significant ($P = .097$).

In the aseptic group, patients who reported lower KOOS JR scores had higher DT scores, but this finding was not statistically significant ($P = .077$). There was a significant association in patients

Table 2
Breakdown of septic and aseptic DT scores.

DT scores	Septic	Aseptic	P value
Mean DT score (SD)	6.18 (± 3.2)	3.33 (± 2.06)	<.0001
Percent of patients with DT score ≥ 4	94/122 = 77%	11/40 = 27.5%	
Percent of patients with DT score of 10	26/122 = 21.3%	0/40 = 0%	
DT score 9	8/122 = 6.6%	0/40 = 0%	
DT score 7-8	32/122 = 26.2%	3/40 = 7.5%	
DT score 5-6	21/122 = 17.2%	8/40 = 20%	
DT score 3-4	16/122 = 13.1%	16/40 = 40%	
DT score 0-2	19/122 = 15.6%	13/40 = 32.5%	

with lower HOOS JR scores and higher DT scores ($P = .0003$). Additional breakdowns on DT scores and HOOS/KOOS JR scores are included in [Appendix C](#).

Discussion

PJIs affect every aspect of a patient's life including finances, function, and emotional well-being. In our study, we found that patients with PJI are experiencing significantly higher levels of distress compared to patients undergoing aseptic revision. In fact, 77% of patients in the septic group recalled distress that would warrant intervention if detected in most cancer centers. In this pilot study, our initial hypothesis that septic patients would experience more distress than aseptic patients was demonstrated to be true. Several factors including duration of antimicrobial treatment, number of courses of antimicrobials, and hospital readmission did not appear to contribute to increased DT scores. In the septic group, we did find increased DT scores in older patients as well as patients who were unable to return to work. In this cohort, there was no correlation between number of surgeries and DT score, but there was a trend toward worsening scores in patients undergoing the

Table 3
Top 3 problems in problem list categories for patients with a DT score ≥ 4 .

Problem list	Percentage septic patients with DT score ≥ 4	Percentage aseptic patients with DT score ≥ 4
Top 3 practical problems		
Transportation	37.2% (35/94)	5.6% (1/18)
Treatment decisions	33.0% (31/94)	0% (0/18)
Insurance/financial	29.8% (28/94)	0% (0/18)
Top 3 family problems		
Dealing with partner	18.1% (17/94)	5.6% (1/18)
Family health issues	17.0% (16/94)	11.1% (2/18)
Dealing with children	11.7% (11/94)	0% (0/18)
Top 3 emotional problems		
Worry	75.5% (7/94)	61.1% (11/18)
Loss of interest	58.5% (55/94)	33.3% (6/18)
Depression	57.4% (54/94)	44.4% (8/18)
Top 3 physical problems		
Pain	78.7% (74/94)	77.8% (14/18)
Getting around	74.5% (70/94)	33.3% (6/18)
Fatigue	70.2% (66/94)	72.2% (13/18)

Table 4
DT score by type of surgery.

Type of surgery	Number of patients	Mean DT score	Std error	Lower 95%	Upper 95%	P value ^a
Aseptic	40	3.3	0.47	2.40	4.27	1.000
DAIR	25	5.6	0.60	4.46	6.83	.023 ^a
Single stage	17	5.5	0.73	4.03	6.91	.107
Two stage	53	6.3	0.41	5.49	7.12	<.0001 ^a
Fusion	7	7.3	1.13	5.05	9.53	.0123 ^a
Amputation	5	6.2	1.34	3.55	8.85	.290
Girdlestone	6	8.0	1.23	5.58	10.42	.004 ^a
Spacer exchange	8	6.6	1.06	4.53	8.72	.0394 ^a
Other	1	3.0	3.00	-2.93	8.93	1.000

^a P values were calculated using Dunnett's methods for ANOVA comparing all other surgical groups to the aseptic group. Other was a patient managed non-operatively with IV antimicrobials alone.

Girdlestone procedure and joint arthrodesis. Vincenten et al. [16] compared quality of life scores in patients undergoing the Girdlestone procedure and amputation, but to our knowledge, no studies have compared quality of life in patients undergoing DAIR, single-stage revision, and 2-stage revision. We expected that patients requiring more aggressive surgeries with longer recovery times (such as a 2-stage revision) would have higher DT scores. In this study, patients who underwent DAIR had lower DT scores compared to patients who underwent 2-stage revisions; however, the difference was not statistically significant. This result may be attributed to the limited number of patients and the potential for recall bias in this current study construct, and it is worthy of further investigation.

It was anticipated that patients requiring more than 6 weeks of IV antimicrobials would experience higher levels of distress, but the data did not support this supposition. Also, it was expected that patients requiring 3 or more courses of prolonged antimicrobials would have higher DT scores, but there was no significant difference in DT scores between the 2 groups. In the septic group, patients with histories of anxiety and/or depression had significantly higher DT scores compared to patients with no history of anxiety and/or depression. Patients in the septic group who were able to return to work had significantly lower DT scores than patients unable to return to work.

PJI has a huge financial burden. From 2001 to 2009, the annual cost of revisions for PJI increased from \$320 million to \$566 million [17]. One model estimates that a total hip arthroplasty infection in the United States has a base cost of \$390,307 per episode of care [18]. These cost estimates often underestimate the personal financial hardships experienced by patients and their families. Functional status is also affected by PJI and varies based on the type of surgery and recurrence of infection. In the United States, 2-stage revisions are most commonly used to treat PJI, but they also have the highest impact on patient mobility [19]. Another surgical treatment, debridement antibiotics and implant retention (DAIR), typically has a lower procedure-related mortality and quicker recovery time but a higher risk of infection recurrence [20]. PJI also negatively impacts health-related quality of life scores [21]. In a qualitative study of PJI patients and their experiences, several patients reported depression and suicidal ideation [19].

Currently, even in multidisciplinary clinics that care for PJI patients, distress is not being monitored routinely. Patients suffering from high levels of distress may benefit from services that are not currently being offered in these multidisciplinary clinics [22,23]. There are a few studies that have examined quality of life scores in patients with PJI. For example, a recent study compared quality of life by World Health Organization Quality of Life Brief Version

(WHOQOL-BREF) scores in patients who underwent Girdlestone resection arthroplasty to patients who underwent amputation and patients with a myocardial infarction [16]. Patients who underwent the Girdlestone procedure had significantly lower WHOQOL-BREF scores compared to the other 2 groups [16]. While the WHOQOL-BREF instrument has physical health, psychological, social relationships, and environmental domains, it is a difficult instrument to implement widely in a clinic and does not measure the particular issues with which PJI patients struggle including antibiotic side-effects. One could argue that the DT problem list could be further refined to better target symptoms and problems experienced by the total joint population.

The HOOS and KOOS JR surveys include questions about pain and function of daily living. Some of these issues are addressed in the DT, but the DT is more comprehensive covering practical, family, emotional, and physical problems. We found that low HOOS and KOOS JR scores, which indicate higher levels of pain and poor function correlate with higher DT scores ($P = .0090$ and $P < .0001$, respectively). Patients with high DT scores reported similar problems in the DT problem list. Some of the most common problems reported were worry, pain, and getting around.

Some cancer centers have automatic referrals set in place for patients who answer "yes" to certain problems on the problem list. These referrals include referrals to social work, physical therapy, and mental health specialists depending on the concerns brought to light by the problem list. Consideration of similar referrals in patients with PJI's should be explored.

There are several limitations to this study. First, it was a retrospective study performed at one institution; therefore, the data may be less generalizable. However, the care provided through the combined Orthopaedic Infectious Disease Clinic provides some generalizability among physicians and surgeons in the treatment algorithm. Second, patients were asked to recall the levels of distress they experienced during their treatment course. Some of their recollections may have been influenced by recall bias; however, given a recency bias for the aseptic group, one might expect this difference to be even greater if monitored over similar time frames. Third, given the 53.7% response rate, selection bias should also be considered. It is possible that the patients who had higher distress were more likely to complete the DT. Fourth, the heterogeneity of this patient population led to a small sample size and necessitated the use of a prospective aseptic control group for a timely comparison. Fifth, the diagnosis of depression and/or anxiety was reported by patients in the survey and may not be accurate. The details of management for depression and/or anxiety were not explored in this pilot study but are worthy of consideration in future work.

Conclusions

The findings of this study highlight the distress experienced by patients undergoing treatment for PJI. Although there are inherent limitations of a retrospective study, the novel application of this metric in the setting of PJI will allow for further prospective studies where we can better evaluate the patient experience. We hope to implement distress monitoring in our clinic and monitor for distress during the PJI treatment course, just as it is monitored in cancer treatment, which will allow us to provide the care and support necessary to improve patient compliance and hopefully improve patient outcomes. A prospective study examining DT scores in PJI patients is needed to better characterize which patients are at high risk of distress; such a study would also allow us to determine if interventions may reduce patient distress. A reduction in distress could parallel findings in the cancer literature that may

improve compliance and outcomes and provide a better patient experience.

Funding

Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award Number 2U54GM104942-07. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Conflicts of interest

M. J. Dietz is a paid consultant for Heraeus Medical, has stock options in Peptilogs, receives research support from Heraeus Medical and Peptilogs, and serves as scientific advisory board member of Peptilogs and clinical practice guidelines workgroup, Dental Implants for American Academy of Orthopaedic Surgeons; all other authors declare no potential conflicts of interest.

For full disclosure statements refer to <https://doi.org/10.1016/j.artd.2023.101255>.

Acknowledgments

The research team would like to thank Michael Niemann, MD, Seneca Williams, Jennifer Eicher, Elizabeth Stewart, Erika Lorfald, and Gerrald Hobbs, PhD.

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Appendix Item A

Patient Survey

1. Are you currently being seen at WVU Medicine Orthopedics and/or Infectious Disease?
 - Yes (go to question 3) No (go to question 2)
 2. When was the last time you were seen at West Virginia University by Infectious Diseases or Orthopedics?

____/____/____ (month/day/year) approximate date is fine
 3. Are you currently receiving antibiotics?
 - Yes No (go to question 5)
 4. If you answered yes to the question above, are the antibiotics you receiving by IV (intravenous) or by mouth?
 - IV by Mouth
 5. Have you experienced any recurrence of your infection since you were last seen at WVU?
 - Yes No
 6. Have you required any additional surgeries to your hip or knee?
 - Yes (go to question 7) No (go to question 8)
 7. Was the surgery performed due to infection?
 - Yes (go to question 8) No
 8. When was the date (approximate) of your last joint surgery?

____/____/____(month/day/year)
 9. After completion of care for your prosthetic joint infection, how long was it before you returned to work?

____/____/____(month/day/year) approximate date is fine
 10. Do you recall any complications related to the treatment of your prosthetic joint infection? If so, what were they?
 - Yes (Please list below) No
-
11. Do you recall being readmitted to the hospital due to a complication related to your prosthetic joint infection?
 - Yes No
 12. Has a doctor ever diagnosed you with depression?
 - Yes No
 13. Have you ever taken medication(s) for depression?
 - Yes No
 14. Has a doctor ever diagnosed you with anxiety?
 - Yes No
 15. Have you ever taken medication(s) for anxiety?
 - Yes No
 16. Do you receive any non-drug therapies for depression or anxiety such as counseling?
 - Yes No

Appendix Item B

Practical Problems

	Septic patients		Aseptic patients	
	DT score ≥4	Percentage for DT score ≥4	DT score ≥4	Percentage for DT score ≥4
Transportation	35/94	37.2%	1/18	5.6%
Treatment decisions	31/94	33.0%	0/18	0%
Insurance/financial	28/94	29.8%	0/18	0%
Work/school	13/94	13.8%	0/18	0%
Housing	12/94	12.8%	0/18	0%
Child care	6/94	6.4%	0/18	0%

Family Problems

	Septic patients		Aseptic patients	
	DT score ≥4	Percentage for DT score ≥4	DT score ≥4	Percentage for DT score ≥4
Dealing with partner	17/94	18.1%	1/18	5.6%
Family health issues	16/94	17.0%	2/18	11.1%
Dealing with children	11/94	11.7%	0/18	0%
Ability to have children	1/94	1.1%	0/18	0%

Emotional Problems

	Septic patients		Aseptic patients	
	DT score ≥4	Percentage for DT score ≥4	DT score ≥4	Percentage for DT score ≥4
Worry	71/94	75.5%	11/18	61.1%
Loss of interest	55/94	58.5%	6/18	33.3%
Depression	54/94	57.4%	8/18	44.4%
Nervousness	52/94	55.3%	7/18	38.9%
Sadness	51/94	54.2%	7/18	38.9%
Fears	51/94	54.3%	3/18	16.7%

Physical Problems

(continued)

	Septic patients		Aseptic patients	
	DT score ≥4	Percentage for DT score ≥4	DT score ≥4	Percentage for DT score ≥4
Pain	74/94	78.7%	14/18	77.8%
Getting around	70/94	74.5%	6/18	33.3%
Fatigue	66/94	70.2%	13/18	72.2%
Sleep	64/94	68.1%	9/18	50%
Feeling swollen	53/94	56.4%	4/18	0%
Bathing/dressing	53/94	56.4%	2/18	11.1%
Memory/ concentration	44/94	46.8%	3/18	16.7%
Skin dry/itchy	42/94	44.7%	7/18	38.9%
Constipation	38/94	40.4%	2/18	61.1%
Tingling in hands and feet	37/94	39.3%	6/18	33.3%
Nausea	29/94	30.9%	1/18	5.6%
Appearance	29/94	30.9%	2/18	11.1%
Eating	27/94	28.7%	3/18	16.7%
Changes in urination	21/94	22.3%	1/18	5.6%
Diarrhea	21/94	22.3%	0/18	0%
Sexual	21/94	22.3%	2/18	11.1%
Indigestion	20/94	21.3%	2/18	11.1%
Fevers	18/94	19.1%	0/18	0%
Nose dry/ congestion	16/94	17.0%	1/18	5.6%
Breathing	16/94	17.0%	2/18	11.1%
Mouth sore	12/94	12.8%	0/18	0%
Substance use	7/94	7.4%	0/18	0%

HOOS JR score	DT score	KOOS JR score	DT score
43.335	8	54.84	6
80.55	5	59.381	6
85.257	2	59.381	8
67.516	3	100	0
76.776	3	100	10
100	10	50.012	10
39.902	10	50.012	8
10	10	47.487	9
		52.465	4
		84.6	5
		52.465	5
		84.6	8
		84.6	5
		28.251	8
		65.994	3
		57.14	0
		31.307	7
		31.307	8
		84.6	4
		91.975	0
		63.776	6
		61.583	3
		0	10
		0	8
		54.84	10
		42.281	10
		70.704	0
		59.381	10
		50.012	9
		59.381	5
		91.975	10
		65.994	0
		42.281	7
		76.332	10
		63.776	10
		57.14	1
		100	6
		91.975	5
		52.465	10
		44.905	7
		73.342	0
		84.6	10
		39.625	7
		57.14	7
		63.776	8
		39.625	4
		39.625	10
		79.914	4

Appendix Item C

Septic revisions HOOS and KOOS JR scores vs DT score

HOOS JR score	DT score	KOOS JR score	DT score
29.009	10	61.583	7
76.776	6	84.6	9
85.257	4	68.284	8
36.363	10	73.342	0
85.257	2	79.914	1
52.965	7	84.6	2
61.815	8	79.914	3
61.815	8	47.487	6
92.34	6	34.174	10
55.985	5	61.583	9
92.34	3	70.704	5
70.426	8	84.6	4
76.776	7	31.307	10
92.34	7	91.975	0
55.985	1	91.975	5
80.55	5	91.975	8
64.664	9	79.914	0
58.93	8	100	9
92.34	3	79.914	8
55.985	8	42.281	10
55.985	8	73.342	5
52.965	10	59.381	0
70.426	10	63.776	3
36.363	10	44.905	9
58.93	5	47.487	10
25.103	10	42.281	8
76.776	5	63.776	0
0	1	59.381	10
100	7	57.14	8
52.965	3	68.284	5
100	8	84.6	1

Aseptic Revisions

HOOS JR score	DT score	KOOS JR score	DT score
61.82	4.2	91.98	3
73.34	4.2	44.91	4.5
73.47	3.75	65.99	5.2
92.34	1.8	63.776	4.8
49.86	4	79.91	2
61.58	4	59.38	1.4
61.82	4	68.28	2.4
39.9	5.5	84.6	2
61.82	2.5	84.6	2.75
80.55	0.333	39.63	3.6
39.63	5.5	63.78	3.3333
91.98	1.6	54.84	7.5
92.34	3.75	52.47	7.33
100	0.333	76.33	3
76.776	0.6667	65.99	5
100	0.5	63.78	5.8
61.583	6	52.47	1.5
		73.34	3.75
		54.84	7.25