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Abstract

Background: Music therapy (MT) has been shown to improve outcomes for patients with sickle cell disease (SCD) and patients with hematologic and/or oncologic conditions excluding SCD (HemOnc) in prior randomized trials. While few studies have described the clinical delivery (ie, volume, clinical settings, patient characteristics, referrals, and session characteristics) of MT and examined its real-world effectiveness, no studies have compared responses between hematology/oncology populations. The purpose of this study was to examine the clinical delivery and effectiveness of MT at a freestanding academic cancer center and compare the effectiveness of MT on pain, anxiety, and fatigue between adult patients in the HemOnc and SCD groups.

Methods: A retrospective review was conducted of all MT sessions provided at a freestanding academic cancer center between January 2017 and July 2020. The unadjusted single-session effects of MT on pain, anxiety, and fatigue were assessed among patients reporting symptoms ≥ 1 out of 10 on a 0 to 10 scale. Adjustments were made for multiple sessions on the same patient using a mixed model to compare pre-session and change scores between the HemOnc and SCD groups. Patients' comments were analyzed using conventional qualitative content analysis.

Results: Music therapists provided 4002 sessions to 1152 patients including 1012 in the HemOnc group and 140 in the SCD group. In the combined sample, statistically significant reductions in pain (1.48 units), anxiety (2.58 units), and fatigue (0.84 units) were observed, with changes in pain and anxiety exceeding clinically significant thresholds. After adjustment, the SCD group reported significantly greater pre-session pain (7.22 vs 5.81) and anxiety (6.11 vs 5.17) as well as greater anxiety reduction (2.89 vs 2.23) than the HemOnc group. Patients' comments contained themes including enjoyment, gratitude, and improvements in mood, pain, and anxiety.

Conclusions: This study supports the delivery and clinical effectiveness of MT for addressing the needs of patients throughout their course of treatment at an academic cancer center and justifies the inclusion of individuals with SCD within integrative oncology services.

Keywords

music therapy, electronic health record, pain, anxiety, fatigue, sickle cell disease

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Introduction

Patients with cancer and/or hematologic conditions such as sickle cell disease (SCD) often experience significant symptomatic burdens from pain, anxiety, and fatigue as well as psychosocial challenges throughout treatment.^{1,2} To address these challenges and support patients as they receive medical care, many comprehensive cancer centers have integrated evidence-based interventions including music therapy (MT) within their services. MT is the clinical and evidence-based use of music interventions to accomplish

individualized goals within a therapeutic relationship by a credentialed professional (ie, Music Therapist-Board Certified (MT-BC)) who has completed an approved MT

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program.³ A recent review of cancer center websites found that MT was available in 74.5% of National Cancer Institute (NCI)-designated Comprehensive Cancer Centers and 55% of Community Hospitals.⁴ Institutions including Atrium Health Levine Cancer Institute,⁵ MD Anderson Cancer Center,⁶ and Memorial Sloan Kettering Cancer Center^{7,8} provide individualized and group MT services upon referral from the medical team and in collaboration with other integrative therapies including acupuncture, meditation, massage therapy, and art therapy. These services are delivered throughout the cancer center in both inpatient and outpatient settings. In response to COVID-19, many MT programs within cancer centers adapted their services for the virtual environment.⁹⁻¹¹

Randomized controlled trials (RCT) and systematic reviews have demonstrated the safety and efficacy of music interventions for addressing the physical and psychosocial needs of patients with hematologic and oncologic conditions.¹²⁻¹⁷ These music interventions include MT provided by MT-BCs and music medicine (ie, listening to pre-recorded music offered by medical staff who are not MT-BCs). A recent systematic review of 81 music intervention (38 MT and 43 music medicine) trials with 5576 participants found that music interventions may have positive effects on anxiety, depression, hope, pain, and fatigue in adults with cancer as compared to standard care.¹³ Significant improvements in outcomes including anxiety, depression, pain, fatigue, and quality of life were more consistent (ie, lower I^2 statistic) across studies of MT than studies of music medicine.¹³ For patients with SCD, recent mixed methods RCTs have demonstrated the efficacy of a single electronic music improvisation session for addressing acute pain¹⁸ and a 6-session MT protocol for improving self-efficacy and quality of life.¹⁹ This evidence base has contributed to organizations including the National Comprehensive Cancer Network recommending MT for addressing distress (ie, anxiety and depression) and nausea/vomiting within their 2021 Clinical Practice Guidelines for the Use of Integrative Medicine for Supportive Cancer Care.¹

Within the framework for clinical research proposed by the National Center for Complementary and Integrative Health, National Institutes of Health, once clinical efficacy is established, then the research focus shifts to assessing effectiveness of intervention delivery.²⁰ Intervention delivery characteristics include the volume of services provided, the clinical settings (eg, inpatient, outpatient, and virtual) in which they are provided, the demographic and clinical characteristics of patients receiving services, referral characteristics (eg, referring provider type and reason for referral), and the characteristics (eg, length, goals, and interventions) of the sessions provided. Therefore, even with systematic reviews^{13,21,22} and numerous RCTs^{14,16,18,23-26} supporting the efficacy of MT in hematology and oncology, evaluations of

its real-world clinical effectiveness within cancer centers are now warranted.

To-date, few clinical effectiveness studies of medical MT in oncology have been published. A retrospective study of MT among 96 inpatients at an academic cancer center found that patients reported statistically and clinically significant improvement in Edmonton Symptom Assessment Scale (ESAS) mean scores including anxiety (-2.3), drowsiness (-2.1), depression (-2.1), nausea (-2.0), fatigue (-1.9), pain (-1.8), shortness of breath (-1.4), and appetite (-1.1).⁶ Two comparative studies found that (1) when compared to receptive MT (ie, patients listening while the MT-BC provides music and/or guided relaxation), active MT interventions (ie, patients participating through singing, instrument playing, writing, and/or movement) were associated with 0.88-unit greater reduction in cancer-related fatigue among 236 patients reporting moderate-to-severe fatigue⁷; and (2) when compared to massage therapy, MT was associated with a 1.2-unit greater reduction in depression among 452 patients (357 massage therapy and 95 MT patients) reporting moderate-to-severe depression.⁸ Finally, 2 retrospective reviews of MT found (1) statistically significant improvements in pain, anxiety, depression, nausea, mood, facial expression, body movement, and verbalization among 268 patients with cancer²⁷; and (2) significant improvements in pain, anxiety, depression, shortness of breath, and mood among 293 patients (93% oncology) receiving palliative care.²⁸

While these publications are important, they do not capture the entire scope of how, where, and why MT is delivered across the continuity of hematology and oncology care. Additionally, though several NCI-designated Comprehensive Cancer Centers provide services to patients with SCD,²⁹ no literature describing the clinical effectiveness of MT among this population has been published. Given the significant pain burden,³⁰ frequency and severity of vaso-occlusive crises,³¹ barriers to accessing nonpharmacologic pain management,³² and structural racism³³ affecting adults with SCD, it is important to understand the effectiveness of MT within this specific population as distinct from patients with other hematologic and/or oncologic conditions.

To address these gaps, we are currently conducting a large research project entitled *Effectiveness of Medical Music Therapy Practice: Integrative Research using the Electronic Health Record* (EMMPIRE). The first aim of EMMPIRE is a retrospective study examining the delivery (ie, volume, clinical settings, patient characteristics, referrals, and session characteristics) and effectiveness of MT throughout 10 medical centers in the University Hospitals (UH) Health System. The purpose of this specific EMMPIRE retrospective study was to examine the clinical delivery and effectiveness of MT at a freestanding academic cancer center and compare the effectiveness of MT on pain,

anxiety, and fatigue between patients with SCD and patients with hematologic/oncologic conditions excluding SCD (HemOnc).

Methods

Participants and Design

This study is a retrospective review of all individualized MT sessions provided to adult patients (ages 18 and older) with hematologic (ie, International Classification of Diseases 10th Revision (ICD-10) code D50-D89) and/or oncologic (ie, ICD-10 code C00-D49) conditions receiving care at the UH Seidman Cancer Center (UHSCC) main campus between January 1, 2017 and July 30, 2020. Patients receiving MT who did not have a hematologic or oncologic diagnosis were excluded from analysis.

Setting and Care Delivery

UHSCC is a freestanding cancer center located on the main campus of UH Cleveland Medical Center in Cleveland, Ohio. This campus is surrounded by medically underserved, low-income neighborhoods largely populated by Black/African American residents.³⁴ UHSCC is part of the NCI-designated Case Comprehensive Cancer Center, which is consistently ranked by U.S. News & World Report as one of the nation's top 30 cancer centers. Between January 2017 and July 2020, 15,740 patients received treatment at the UHSCC main campus. The UHSCC main campus facility includes (1) specialty inpatient floors for stem cell transplant, medical oncology, surgical oncology, and women's oncology; (2) outpatient infusion, radiation, and clinical consult areas; and (3) patient resources including a wig salon, resource library, healing garden, and meditation room.

MT services at UHSCC are provided by MT-BCs or music therapy interns (MTIs) supervised by MT-BCs during their 6-month internships. During the 3.5-year retrospective study, 19 individuals (8 MT-BCs and 11 MTIs) with a range of clinical experience (ie, less than 1 year to over 35 years) provided MT services. These therapists applied various theoretical orientations (eg, humanistic, cognitive-behavioral, and music-centered) to their practice. Data on specific theoretical orientations applied to MT interventions were not collected as part of this retrospective study.

The MT program at UHSCC is integrated throughout the facility. Using technology, the music therapists at UHSCC adapt MT interventions for various clinical environments. By providing sessions through the privacy of headphones, these adaptations have included hosting electronic drum circles, facilitating electronic music improvisation sessions for pain management through iPads,¹⁸ and recording personalized music exercises and songwriting projects in a mobile recording studio to address coping and quality of life.¹⁹ This music technology also enabled a rapid pivot to

virtual MT delivery in March 2020 at the beginning of the COVID-19 pandemic.¹¹ Thus, this retrospective review includes sessions delivered both in-person and virtually.

While the MT program serves all patients with hematologic and oncologic conditions receiving care at UHSCC, a particular focus of the program has been on serving adults with SCD. This clinical focus has included providing inpatient care; group programming to enhance the transition from pediatric to adult care³⁵; and outpatient care in the acute care clinic,¹⁸ infusion center, and hematology clinic.¹⁹

Music therapists at UHSCC collaborate with the medical team (eg, physicians, advanced practice providers, nurses, social workers, chaplains, art therapists, and acupuncturists) to address patients' symptoms and enhance psychosocial support. MT services are initiated via electronic health record (EHR) referrals from the medical team. Collaborative care is facilitated through weekly interdisciplinary team meetings, co-treatments, and frequent communication with referring providers.

The focus of each MT session, including goals and interventions, are determined by the music therapist in a collaborative therapeutic relationship with the patient following an assessment of the patient's coping skills, music preferences, and symptoms (if applicable). Each session may have one or more goals (eg, coping, pain management, and anxiety reduction) and include multiple music interventions (eg, active music making, songwriting, and music-assisted relaxation and imagery). After the MT session, the music therapists document the details of the MT intervention and clinical outcomes in the EHR. During the retrospective study period, assessment of patients' symptoms was not established as a clinical expectation in all MT sessions. In most cases, if patients reported a particular symptom (ie, pain, anxiety, or fatigue) during the music therapist's assessment, that symptom was assessed and documented using the appropriate ESAS scale and documented in the EHR. The ESAS has been used in several prior MT studies in oncology.⁶⁻⁸

Ethics and Permissions

This study was approved by the UH Cleveland Medical Center Institutional Review Board (STUDY20191213) as a retrospective chart review with a waiver of informed consent. This study was conducted in accordance with the Declaration of Helsinki.

Data Collected

We extracted the following data from all EHR records meeting eligibility criteria: (1) demographic information including age, sex, race, ethnicity, and primary insurance; (2) clinical characteristics including ICD-10 codes for all hematologic and oncologic diagnoses, discharge location, and length of stay; (3) MT referral data including referral date and time, credentials of referring providers, and reason

for referral; and (4) MT documentation data including session beginning and end time, conflict(s) of service (ie, an attempt was made to see a patient but a session did not occur due to the patient being away from their room, asleep, busy, or undergoing a procedure), session goal(s), MT intervention(s) utilized, session characteristics (eg, virtual vs in-person), session narrative, patient-reported outcomes (PROs) (ie, ESAS scores of pain, anxiety, and fatigue), whether the patient fell asleep in response to MT, and patients' comments regarding the MT session. Demographic data including sex, race, and ethnicity were extracted exactly as they were entered into the EHR by medical staff and may not have reflected the gender, racial, and/or ethnic identities of the patients included in this study.³⁶

Data Analysis

Quantitative analysis. Descriptive statistics were calculated for patient demographics (ie, age, sex, race, ethnicity, primary insurance), clinical characteristics (ie, inpatient length of stay, hematology and/or oncology diagnosis), and MT intervention characteristics (ie, length, virtual delivery, goals, and interventions). To compare demographics and session characteristics between the HemOnc (ie, no SCD diagnosis present in EHR) and SCD (ie, SCD diagnosis present in EHR) groups, we used chi-square and 2-sided Fisher's Exact tests for categorical variables and 2-sided independent samples *t*-tests for continuous variables.

Means, standard deviations, and paired *t*-tests were used to examine unadjusted single-session effects of MT on pain, anxiety, and fatigue among patients reporting symptoms ≥ 1 out of 10 on the ESAS. Effect sizes were quantified by Cohen's *d* statistic and 95% confidence interval and interpreted as small ($d=0.2$), medium ($d=0.5$), or large ($d=0.8$).³⁷ Since prior studies in integrative oncology have described changes in ESAS symptom scores ≥ 1 as clinically significant among patients with oncologic conditions,³⁸ this threshold was adopted for the current study. Adjustments for multiple sessions on the same patient were made using a mixed model including a random effect for patient. This approach allowed for summarized mean ESAS scores to (1) control for the effect of multiple sessions with a proportion of high-utilizing patients across multiple encounters and (2) compare ESAS pre-session and change scores between the SCD and HemOnc groups using *F*-tests. We analyzed descriptive statistics, means, standard deviations, and paired *t*-tests using SPSS 28.³⁹ The mixed model was generated using SAS software, Version 9.4 of the SAS System for Windows (Cary, NC).

Qualitative analysis. When patients provided particularly salient comments about their experiences with MT, therapists made notes of these comments and documented them word-for-word in a specified section of the EHR. No

specific prompts were used to collect this data, and most comments contained 1 to 2 sentences. To analyze patients' free-text comments, NVivo (released in March 2020)⁴⁰ was used to develop codes. The first author reviewed each patient comment line-by-line and independently generated the initial codes using conventional qualitative content analysis.⁴¹ Conventional qualitative content analysis was chosen as no interview prompts, keywords, or theory-derived codes were prospectively applied to the analysis, and the aim was to allow categorical descriptions of patients' MT experiences to emerge from the comments themselves.⁴¹ Following the first author's review, the third author conducted a detailed review of the initial codes. Codes and themes were refined by the first and third authors over a series of 3 meetings until consensus was achieved. The coded data were then organized into categories to identify themes, with some comments being contained in more than one theme (eg, gratitude and improvement). Matrices and charts within NVivo were used to refine themes and identify supporting quotations.

Results

Sample

Figure 1 provides a flow chart of the patients, encounters (ie, hospital admissions or outpatient clinic visits), and MT EHR documents/notes included in this analysis. Between January 2017 and July 2020, music therapists provided 4002 sessions (3079 MT intervention sessions and 923 assessment and education sessions) to 1152 adults with hematologic and/or oncologic conditions including 1012 (87.8%) patients in the HemOnc group and 140 (12.2%) patients in the SCD group.

Care Delivery

Music therapists provided care across 2400 encounters including 1645 inpatient admissions (median length of stay: 8 days) and 755 outpatient clinic visits. Inpatients seen by MT were discharged from medical oncology (43.9%), women's oncology (20.2%), stem cell transplant (18.8%), and surgical oncology (17.1%) units. Outpatient visits primarily co-occurred during visits to the medical oncology clinic/infusion center (94.0%) or radiation oncology (2.3%). Of the 4002 MT sessions, 3545 (88.6%) were provided by MT-BCs, and 457 (11.4%) were provided by MTIs.

Demographics

Table 1 summarizes the demographics and clinical characteristics of patients seen by MT over the course of the retrospective study. Patients (mean age: 57.23 ± 16.97 at first session) were mostly white (64.1%) or Black/African

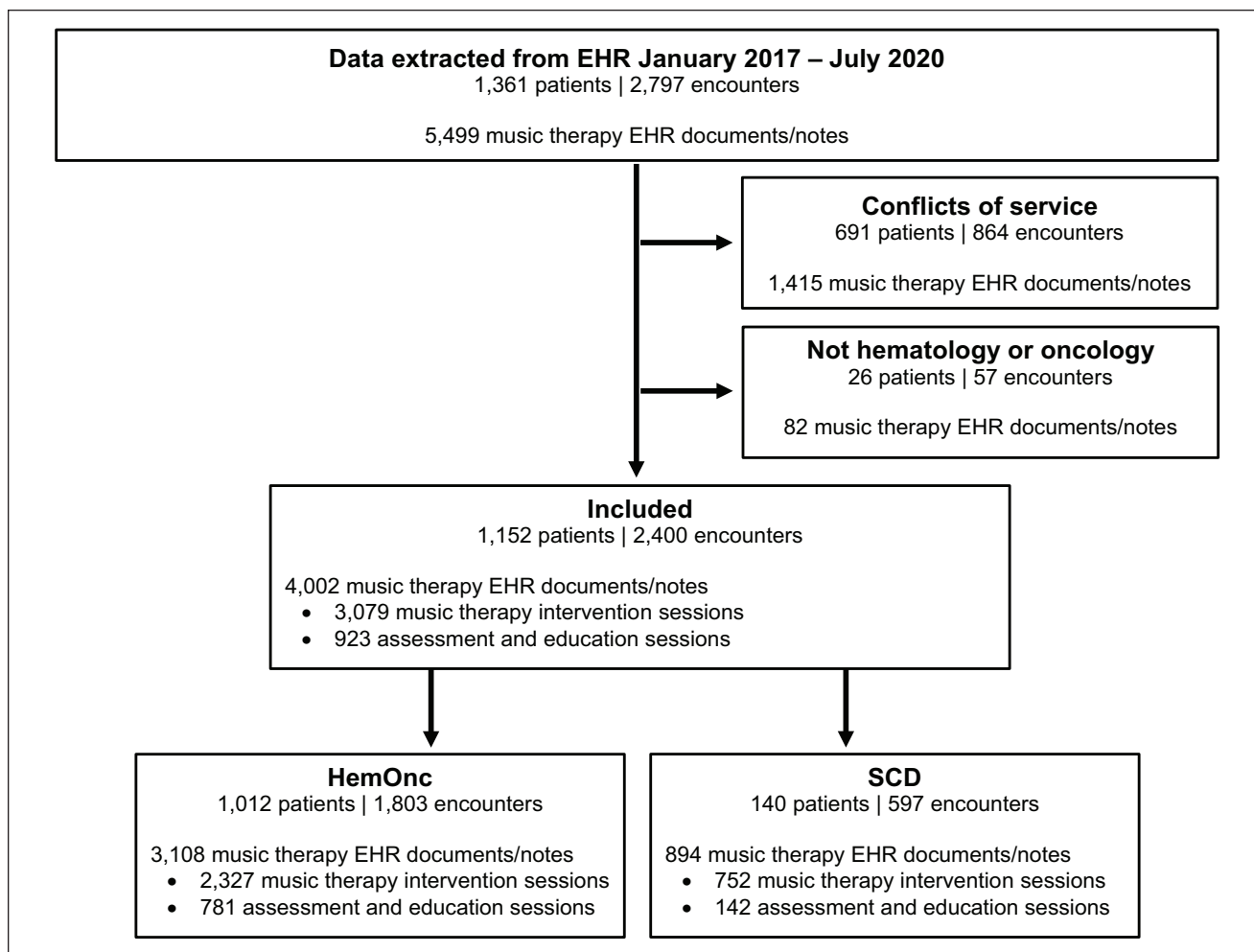


Figure 1. Flow diagram of study participants.

Abbreviations: EHR, electronic health record; HemOnc, patients with hematologic and oncologic conditions excluding sickle cell disease; SCD, sickle cell disease.

American (34.2%), Non-Hispanic (98.2%), female (58.2%), and insured under Medicare (43.9%), private insurance (27.7%), or Medicaid (23.9%). Patients in the SCD group were significantly younger (32.04 vs 60.71, $P < .001$), identified as Black/African American at a higher rate (99.3% vs 25.2%, $P < .001$), and had a higher prevalence of Medicaid coverage (54.3% vs 19.7%, $P < .001$) than patients in the HemOnc group.

Clinical Characteristics

Common neoplasm diagnoses included cancers of the digestive organs (20.8%), malignant hematology (16.8%), cancers of the respiratory/intrathoracic (9.2%) organs, and cancers of the head and neck (8.2%). Common benign hematology diagnoses present in both the HemOnc and SCD groups included aplastic/nutritional anemias (52.8%) and coagulation disorders (18.8%).

Referrals

Among 1667 MT referrals documented in the EHR, patients were primarily referred by advanced practice providers (39.1%), physicians (23.2%), or nurses (18.1%) for coping (47.7%), anxiety reduction (17.5%), mood modification (7.6%), and/or pain management (7.2%).

Music Therapy Session Characteristics

Table 2 summarizes the characteristics of the 3079 MT intervention sessions delivered during the retrospective study. On average, 3.28 ± 4.35 MT interventions were provided to each patient over the course of the retrospective study, with the number being significantly higher ($P < .001$) in the SCD group (5.78 ± 7.82) than the HemOnc group (2.87 ± 3.31). In the combined sample, music therapists primarily addressed goals including coping (53.5%), pain management (17.1%), anxiety reduction (14.5%), and self-expression (10.2%).

Table 1. Demographic and Clinical Characteristics.

Variables	All patients (N = 1152)		HemOnc (n = 1012)		SCD (n = 140)		P-value
Age (years), mean \pm SD	57.23 \pm 16.97		60.71 \pm 14.61		32.04 \pm 10.27		<0.001 ^c
Sex ^a , n (%)							.790 ^d
Female	671	(58.2)	588	(58.1)	83	(59.3)	
Male	481	(41.8)	424	(41.9)	57	(40.7)	
Race ^a , n (%)							<.001 ^d
White	739	(64.1)	739	(73.0)	0	(0.0)	
Black/African American	394	(34.2)	255	(25.2)	139	(99.3)	
Other race	11	(1.0)	10	(1.0)	1	(0.7)	
Declined/missing/unknown	2	(0.2)	2	(0.2)	0	(0.0)	
Asian	5	(0.4)	5	(0.5)	0	(0.0)	
American Indian/Alaska Native	1	(0.1)	1	(0.1)	0	(0.0)	
Ethnicity ^a , n (%)							0.812 ^d
Non-Hispanic	1131	(98.2)	992	(98.0)	139	(99.3)	
Declined/missing	10	(0.9)	9	(0.9)	1	(0.7)	
Hispanic or Latino	11	(0.9)	11	(1.1)	0	(0.0)	
Primary Insurance, n (%)							<.001 ^d
Medicare	506	(43.9)	457	(45.2)	49	(35.0)	
Private	319	(27.7)	306	(30.2)	13	(9.3)	
Medicaid	275	(23.9)	199	(19.7)	76	(54.3)	
Missing ^b	16	(1.4)	15	(1.5)	1	(0.7)	
Other/Self-Pay	36	(3.1)	35	(3.5)	1	(0.7)	
Neoplasm Dx, n (%) ^e							
Digestive organs	240	(20.8)	240	(23.7)	0	(0.0)	
Malignant hematology	193	(16.8)	193	(19.1)	0	(0.0)	
Respiratory/intrathoracic organs	106	(9.2)	106	(10.5)	0	(0.0)	
Head and neck	94	(8.2)	94	(9.3)	0	(0.0)	
Female genital organs	85	(7.4)	85	(8.4)	0	(0.0)	
Breast	52	(4.5)	52	(5.1)	0	(0.0)	
Renal/urinary tract	39	(3.4)	39	(3.9)	0	(0.0)	
Male genital organs	36	(3.1)	36	(3.6)	0	(0.0)	
Soft tissue	22	(1.9)	22	(2.2)	0	(0.0)	
Thyroid/other endocrine glands	17	(1.5)	17	(1.7)	0	(0.0)	
Other	190	(16.5)	190	(18.8)	0	(0.0)	
Benign Hematology Dx, n (%) ^e							
Sickle cell disease	140	(12.2)	0	(0.0)	140	(100.0)	
Aplastic/nutritional anemias	608	(52.8)	574	(56.7)	34	(24.3)	
Coagulation disorders	217	(18.8)	195	(19.3)	22	(15.7)	
Other blood or immune disorders	62	(5.4)	62	(6.1)	0	(0.0)	

Abbreviations: HemOnc, patients with hematologic and/or oncologic conditions excluding sickle cell disease; SCD, sickle cell disease; Dx, diagnosis; SD, standard deviation ^aSex, ethnicity, and race, including multi-racial, were reported exactly as they were entered into the EHR and may not accurately reflect patients' gender, racial, and/or ethnic identities. ^bInsurance information was not available for all hospital admissions in the retrospective analysis at the time the data was extracted from the EHR. Missing insurance information does not indicate that the patients were uninsured. ^cResult of 2-sided independent samples t-test. Bold values highlight differences where $P < 0.05$. ^dResult of chi-square test. ^ePatients may have had more than 1 neoplasm and/or benign hematology diagnosis during the retrospective study. To preserve patient anonymity, diagnoses groups ≤ 5 were rounded down to 0.

Fatigue reduction was only a goal within 3 (0.2%) MT sessions. The following goals were significantly more prevalent ($P < .001$) in the SCD group than the HemOnc group: coping (60.4% vs 51.3%), pain management (47.6% vs 7.2%), self-expression (15.0% vs 8.7%), and stress reduction (16.0% vs 2.6%). Goals more prevalent ($P < .001$) within the HemOnc group included normalization (4.9% vs 0.3%), family support (4.5% vs 0.8%), relaxation (4.0% vs 1.2%), and spiritual support (3.2% vs 0.1%).

Within the MT interventions (mean length: 31.50 \pm 14.27 minutes), music therapists primarily used music listening (live or recorded) (39.5%), active music making (32.6%), and songwriting (13.9%). There were no significant differences in MT intervention length between the HemOnc and SCD groups. Due to the COVID-19 pandemic, 174 (5.7%) MT interventions were delivered virtually from March 2020 through the end of the retrospective study (July 2020). Virtual MT sessions were significantly

Table 2. Music Therapy Intervention Characteristics.

Variables ^a	All MT Interventions (N=3079)	HemOnc MT Interventions (n=2327)	SCD MT Interventions (n=752)	P-value
Intervention length (min), mean ± SD	31.50 ± 14.27	31.41 ± 14.77	31.76 ± 12.64	0.557 ^c
Interventions per patient, mean ± SD	3.28 ± 4.35	2.87 ± 3.31	5.78 ± 7.82	<0.001 ^c
Virtual delivery ^d , n (%)	174 (5.7)	119 (5.1)	55 (7.3)	.029 ^b
Top 10 goals addressed, n (%)				
Coping	1647 (53.5)	1193 (51.3)	454 (60.4)	<.001 ^b
Pain management	526 (17.1)	168 (7.2)	358 (47.6)	<.001 ^b
Anxiety reduction	447 (14.5)	324 (13.9)	123 (16.4)	.108 ^b
Self-expression	315 (10.2)	202 (8.7)	113 (15.0)	<.001 ^b
Mood modification	191 (6.2)	152 (6.5)	39 (5.2)	.193 ^b
Stress reduction	181 (5.9)	61 (2.6)	120 (16.0)	<.001 ^b
Normalization	115 (3.7)	113 (4.9)	2 (0.3)	<.001 ^b
Family support	110 (3.6)	104 (4.5)	6 (0.8)	<.001 ^b
Relaxation	103 (3.3)	94 (4.0)	9 (1.2)	<.001 ^b
Spiritual support	76 (2.5)	75 (3.2)	1 (0.1)	<.001 ^b
Interventions utilized, n (%)				
Music listening (live or recorded)	1215 (39.5)	1115 (47.9)	100 (13.3)	<.001 ^b
Active music making	1003 (32.6)	588 (25.3)	415 (55.2)	<.001 ^b
Songwriting	428 (13.9)	225 (9.7)	203 (27.0)	<.001 ^b
Listening and supportive presence	416 (13.5)	394 (16.9)	22 (2.9)	<.001 ^b
Music-assisted relaxation and imagery	189 (6.1)	153 (6.6)	36 (4.8)	.081 ^b
Song recording	79 (2.6)	39 (1.7)	40 (5.3)	<.001 ^b
Other ^e	221 (7.2)	203 (8.7)	18 (2.4)	<.001 ^b

Abbreviations: HemOnc, patients with hematologic and oncologic conditions excluding sickle cell disease; SCD, sickle cell disease; min, minutes; SD, standard deviation; MT, music therapy. ^aMore than one goal and music therapy intervention could have been included in a single music therapy session. ^bResult of 2-sided Fisher's exact test. ^cResult of 2-sided independent samples t-test. ^dVirtual sessions began to be delivered in March 2020 at the beginning of the COVID-19 pandemic. ^eOther interventions included music-assisted life review, lyric analysis, therapeutic music video creation, therapeutic instrumental instruction, and neurologic music therapy techniques.

more common ($P = .029$) in the SCD group (7.3%) than the HemOnc group (5.1%). The following MT interventions were significantly more prevalent ($P < .001$) in the SCD group than the HemOnc group: active music making (55.2% vs 25.3%), songwriting (27.0% vs 9.7%), and song recording (5.3% vs 1.7%). MT interventions more prevalent ($P < .001$) within the HemOnc group included music listening (live or recorded) (47.9% vs 13.3%), listening and supportive presence (16.9% vs 2.9%), and all other MT interventions (eg, music-assisted life review, lyric analysis, and therapeutic music video production) (8.7% vs 2.4%).

Effects on Patient-Reported Outcomes

Table 3 summarizes the effectiveness of MT on pain, anxiety, and fatigue. Complete pre- and post-session scores were available for pain (786 sessions), anxiety (653 sessions), and fatigue (131 sessions). After adjusting for repeated measures, patients in the SCD group reported significantly higher ($P < .001$) pre-session pain (7.22 vs 5.81) and anxiety (6.11 vs 5.17) than patients in the HemOnc group. In the combined unadjusted sample (ie, SCD and

HemOnc), statistically significant ($P < .001$) mean changes in pain (-1.48 ± 1.60), anxiety (-2.58 ± 1.94), and fatigue (-0.84 ± 1.76) were observed, with the changes in pain and anxiety being clinically significant (ie, ≥ 1 unit change). Large effect sizes were found for pain (-0.92) and anxiety (-1.33), while the effect on fatigue was small (-0.48). Clinically significant reductions in symptoms were reported within 71.2% of sessions with patients reporting pain, 90.8% of sessions with patients reporting anxiety, and 42.0% of sessions with patients reporting fatigue. When stratified by SCD and HemOnc, these statistically significant reductions in scores were consistent within the unadjusted and adjusted groups.

After adjustment, patients in the SCD group reported significantly greater changes in anxiety (-2.89 vs -2.23) than patients in the HemOnc group. The mixed model predicted the following adjusted rates of clinically significant (ie, ≥ 1 unit) reductions: (1) 61.9% of patients in the HemOnc group and 65.1% of patients in the SCD group reporting pre-session pain ≥ 1 ; (2) 99.4% of patients in the HemOnc group and 100% of patients in the SCD group reporting pre-session anxiety ≥ 1 ; and (3) 25.6% of patients

Table 3. Effectiveness of Music Therapy on Pain, Anxiety, and Fatigue.

Variable	All MT Interventions with PROs		HemOnc MT Interventions with PROs		SCD MT Interventions with PROs		P-value
	n (pts)	n (pts)	Unadjusted outcome	Adjusted outcome ^a	Unadjusted outcome	Adjusted outcome ^a	
Pain	786 (270)	268 (158)			518 (112)		
Pre \geq 1, mean \pm SD [SE] ^c	6.95 \pm 2.12		5.89 \pm 2.34	5.81 [0.18]		7.49 \pm 1.76	7.22 [0.14]
Post, mean \pm SD [SE]	5.47 \pm 2.46		4.47 \pm 2.58	4.36 [0.20]		5.99 \pm 2.23	5.70 [0.17]
Change, mean \pm SD [SE] ^d	-1.48 \pm 1.60		-1.43 \pm 1.83	-1.44 [0.14]		-1.50 \pm 1.47	-1.51 [0.10]
Effect size, d [95% CI] ^e	-0.92 [-1.01, -0.84]		-0.78 [-0.91, -0.64]			-1.02 [-1.13, -0.92]	
$\Delta \leq -1$, % (sessions) [pts] ^f	(71.2%)		(62.7%)	[61.9%]		(75.7%)	[65.1%]
$\Delta \leq -1$, % pts 95% CI				56.1%, 67.8%			61.0%, 69.2%
Anxiety	653 (257)	327 (175)			326 (82)		
Pre \geq 1, mean \pm SD [SE] ^c	5.74 \pm 2.53		5.21 \pm 2.62	5.17 [0.17]		6.26 \pm 2.33	6.11 [0.18]
Post, mean \pm SD [SE]	3.15 \pm 2.44		2.95 \pm 2.57	2.91 [0.17]		3.36 \pm 2.30	3.18 [0.19]
Change, mean \pm SD [SE] ^d	-2.58 \pm 1.94		-2.26 \pm 1.89	-2.23 [0.13]		-2.91 \pm 1.94	-2.89 [0.15]
Effect size, d [95% CI] ^e	-1.33 [-1.44, -1.23]		-1.20 [-1.34, -1.05]			-1.50 [-1.66, -1.34]	
$\Delta \leq -1$, % (sessions) [pts] ^f	(90.8%)		(89.0%)	[99.4%]		(92.6%)	[100.0%]
$\Delta \leq -1$, % pts 95% CI				98.5%, 100.0%			100.0%, 100.0%
Fatigue	131 (75)	90 (54)			41 (21)		
Pre \geq 1, mean \pm SD [SE] ^c	5.92 \pm 2.45		6.10 \pm 2.59	6.22 [0.32]		5.51 \pm 2.10	5.54 [0.42]
Post, mean \pm SD [SE]	5.08 \pm 2.72		5.48 \pm 2.67	5.61 [0.34]		4.20 \pm 2.64	4.14 [0.58]
Change, mean \pm SD [SE] ^d	-0.84 \pm 1.76		-0.62 \pm 1.29	-0.61 [0.19]		-1.32 \pm 2.44	-1.34 [0.46]
Effect size, d [95% CI] ^e	-0.48 [-0.66, -0.30]		-0.48 [-0.70, -0.26]			-0.54 [-0.86, -0.21]	
$\Delta \leq -1$, % (sessions) [pts] ^f	(42.0%)		(37.8%)	[25.6%]		(51.2%)	[53.7%]
$\Delta \leq -1$, % pts 95% CI				16.5%, 34.6%			38.4%, 68.9%

Abbreviations: CI, confidence interval; HemOnc, patients with hematologic and oncologic conditions excluding sickle cell disease; SCD, sickle cell disease; SE, standard error; MT, music therapy; PROs, patient-reported outcomes; pts, patients; Δ , change. ^aWe adjusted for multiple sessions on the same patient using a mixed model including a random effect for patient. ^bResult of F-test comparing adjusted means between groups in the mixed model. ^cExcludes sessions with missing post-session scores. ^dBold mean values represent significant result ($P < .001$) of 2-sided paired samples t-test. ^eWithin groups paired samples Cohen's d and 95% CI. ^fUnadjusted rates in parentheses represent the percent of sessions in which the single session change was ≤ -1 . Adjusted rates of change in brackets represent the percent of patients where the predicted point estimate at the patient level was ≤ -1 . ^gResult of comparing the risk difference of adjusted change ≤ -1 between the HemOnc and SCD groups in the mixed model.

in the HemOnc group and 53.7% of patients in the SCD group reporting pre-session fatigue ≥ 1 . The rate of clinically significant fatigue reduction was significantly higher ($P=.002$) in the SCD group than the HemOnc group. Additionally, patients fell asleep in response to 113/3079 (3.7%) MT interventions.

Patients' Comments

Table 4 summarizes themes and sample quotes from 636 patient comments obtained from EHR documents. Patients reported themes including improvement (eg, mood improvement, pain relief, and stress/anxiety reduction; 158 comments), enjoyment (eg, enhanced care experience and fun; 143 comments), gratitude (128 comments), relaxation (76 comments), the need for MT services (71 comments), being able to refocus through MT (32 comments), the importance of the therapeutic relationship (30 comments), and resilience achieved through MT sessions (22 comments).

Discussion

The purpose of this retrospective study was to examine the clinical delivery and effectiveness of MT at a freestanding academic cancer center and compare the effectiveness of MT on pain, anxiety, and fatigue between the HemOnc and SCD groups. To our knowledge, this study is the largest investigation of MT within hematology and oncology reaching 1152 patients across 2400 encounters over 3.5 years. This retrospective study highlights strengths of the UHSCC MT program including its (1) integration throughout the freestanding cancer center; (2) ability to provide services throughout patients' treatment journey; (3) clinical focus on adults with SCD; (4) ability to use technology to adapt services to new environments (eg, outpatient infusion and radiation) and the clinical challenges imposed at the beginning of the COVID-19 pandemic; and (5) demonstrated clinical effectiveness, particularly in reducing acute pain and anxiety.

Similar to prior studies of MT with this population, patients in the HemOnc group had an average age of approximately 60 years^{5,7,8} and were mostly female.⁶⁻⁸ Patients with SCD were significantly younger (32 years) with a similar mean age to prior MT studies with this population.^{18,19} Black/African American patients made up a higher proportion within our combined sample (34.2%) and HemOnc group (25.2%) than prior clinical effectiveness studies of MT by Lopez et al (13.0%)⁶ and Atkinson et al (14.7%).⁷ Within the HemOnc group, patients with digestive or hematologic malignancies made up the largest proportion of neoplasm diagnoses. This finding is similar to prior studies.^{6,7} Patients with hematologic malignancies often have increased clinical contact and length of stay (ie, for stem cell transplant) that contribute to receiving additional MT services. Within the

cancer center, music therapists adhere to strict infection control precautions (eg, masking and sanitization of instruments) to provide care to immunocompromised patients with hematologic malignancies.

Most MT referrals came from advanced practice providers (39.1%) including nurse practitioners and physician assistants, and referrals from advanced practice providers and nurses (57.2%) doubled the referral rate from physicians (23.2%). This finding speaks to the importance of non-physician referrals. As members of the psychosocial and medical teams, nurses and advanced practice providers are uniquely positioned to identify the acute patient/family care needs and refer patients for MT services.⁴² The top reasons for referral in this study included coping (47.7%), anxiety reduction (17.5%), mood modification (7.6%), and pain management (7.2%) and were similar to the top reasons reported by Lopez et al.⁶ These reasons align with the top MT session goals including coping (53.5%), pain management (17.1%), anxiety reduction (14.5%), and mood modification (6.2%). Our data support the effectiveness of MT sessions for meeting goals related to pain management and anxiety reduction. Given the prevalence of coping as a reason for referral and session goal, brief measures of coping pre- and post-session are needed to understand the effectiveness of MT for addressing this psychosocial domain.

Similar to prior MT research,⁶ MT sessions in this study were approximately 30 minutes long and primarily used music listening interventions (live or recorded) (39.5%). Use of active music making interventions was more common in the current study (32.6%) than the study by Lopez et al (17.7%).⁶ Though Lopez et al stated that music therapists often select less active interventions when working with more physically limited inpatient populations with high levels of distress, the UHSCC team has found in working with patients with SCD that active music making interventions can be effective for addressing severe acute pain and improving mood.¹⁸ Given recent studies demonstrating the effectiveness of active music making for reducing cancer-related fatigue compared to receptive MT,⁷ future research should compare the effectiveness of active versus receptive interventions on other PROs.

The comparison of session characteristics between HemOnc and SCD revealed differences in how MT was delivered within these 2 populations. Given that patients in the SCD group reported significantly higher pain intensity than those in the HemOnc group, it is clinically appropriate that pain management was a more common session goal in this population. Higher rates of addressing coping, self-expression, and stress reduction within the SCD population are also appropriate given the significant stressors these patients face when seeking treatment^{33,43} and the length of the therapeutic relationship patients had with the first author. Long-term therapeutic relationships encompassing

Table 4. Themes and Sample Quotes from Music Therapy Sessions (n = 636).

Theme	n ^a	Sample quote
Improvement	158	"I feel so much better now. Thank you. That was awesome."
Mood improvement	48	"I was so sad and couldn't stop crying earlier and you made me feel so much better."
Pain relief	30	"You always do this, you take me from a bad mood to a good mood."
Stress/anxiety reduction	14	"The music really makes you feel better, takes your pain away."
Enjoyment	143	"It helps me release the everyday pressure and stress that is going on."
Enhanced care experience	35	"That was awesome. Every time I see you, it's like an amusement park."
Fun	21	"This has been one of the best visits since I've been here." "You came in and made my day so much better" "It is so nice that Seidman offers this service."
Gratitude	128	"This was the most fun I've had in years. Thank you. This really helped." "That was fun! & what good exercise."
Relaxation	76	"I am so grateful for how I've been treated and for God's healing. Thank you for what you do." "Those songs were the greatest gift for both me and my family that I've ever received in my life."
Need for music therapy	71	"I can't shut my brain off. When I hear your music, I just relax completely." "That was very very relaxing and calming. My mind hasn't been that quiet in days."
Refocus	32	"You came at just the right time today! It was just what I needed." "You have helped me regain some clarity. Please come back as often as you can." "I didn't know I needed this as much as I did."
Importance of therapeutic relationship	30	"Music really takes you to another place."
Resilience	22	"You understand. This has meant a lot to me to have people who go beyond the call of duty and who care."
		"I've had a lot of hard times, but this really gives me courage. You gave me a way to articulate my feelings." "With the music and medicine, I know I will get through this. Thank you. This makes me happy."

^aSample quotes may have been relevant to more than one theme (eg, gratitude and improvement).

several sessions over multiple years are often conducive to songwriting and song recording interventions addressing self-expression, which were more prevalent in SCD than in HemOnc. The higher prevalence of active music making interventions within the SCD group was likely due to the demonstrated efficacy of these interventions for adults with SCD at UHSCC.¹⁸ Future research should examine how MT goals and interventions change over the course of patients' treatment (ie, do first sessions differ from fifth sessions?) and how the therapeutic relationship, therapists' theoretical orientations, and therapists' preferences influence the selection of goals and interventions.

When comparing adjusted PROs reported among the current sample to prior studies, patients in the HemOnc group reported higher mean pain intensity (adjusted mean = 5.81) than patients with cancer seen by MT in studies by Lopez et al (4.57)⁶ and Gallagher et al (2.8).²⁸ Patients in the HemOnc group reported anxiety levels (adjusted mean = 5.17) similar to patients with cancer seen by MT in Lopez et al (5.20),⁶ but higher than patients reporting anxiety in Gallagher et al (2.7).²⁸

Patients in the SCD group reported significantly higher pre-session pain intensity (adjusted mean = 7.22 vs 5.81) and anxiety (adjusted mean = 6.11 vs 5.17) than patients in

the HemOnc group. This pattern is consistent with a prior study comparing the experiences of Black/African American patients with SCD and cancer.⁴³ In this qualitative study and in prior mixed-methods research, patients with SCD have described their pain as "excruciating," "extreme," "stabbing," and "infinite because it never stops."^{18,43} In addition to severe pain intensity, these patients often face disease- and race-based discrimination, which are associated with greater pain burden in adults with SCD.⁴⁴ Patients with SCD have reported inadequate pain management due to healthcare providers lacking empathy for their pain condition, believing that SCD pain is less painful than cancer pain,⁴³ and accusing them of drug-seeking behavior.³³ These experiences and the stigma faced by adults with SCD⁴⁵ may explain why the SCD group reported significantly higher pre-session anxiety than the HemOnc group in this study.

Despite these differences in pre-session pain and anxiety, both the HemOnc and SCD groups reported statistically significant reductions in pain and anxiety, and a subset reported pain and anxiety relief meeting clinically significant thresholds. One factor that may have contributed to patients' reported pain relief is music therapists' use of patient-preferred music, as patient preference has been shown to have a significant effect on pain intensity and pain

tolerance in a prior experimental pain stimulation study.⁴⁶ Within the HemOnc group, patients reported an adjusted mean pain reduction of 1.44 units, with 61.9% of patients reporting at least a one-unit pain reduction. This was slightly lower than the mean pain change from MT reported by Lopez et al (-1.81), where 88.9% reported at least a one-unit pain reduction.⁶ These differences may be due to pain management being less prevalent as a session goal within the HemOnc group (7.2%) than the SCD group (47.6%). The clinically significant reduction in pain observed in the combined sample (1.48 units) of 786 MT sessions provided to 270 patients is especially important given the challenges related to managing pain in this population. These findings contribute to a growing body of literature demonstrating the clinical effectiveness of single-session integrative therapies for reducing pain. These studies and reported mean pain reduction include outpatient massage (1.55 units),⁴⁷ inpatient acupuncture (1.80 units),⁴⁸ and inpatient progressive muscle relaxation and guided imagery (1.83 units).⁴⁹

As in the MT study by Lopez et al⁶ the greatest change in PROs reported in the HemOnc group was in anxiety (adjusted mean = -2.23), with 99.4% of patients reporting at least a one-unit reduction. In comparing the current findings within the HemOnc sample to other studies of integrative therapies for acute anxiety in oncology, our patients reported higher pre-session anxiety (adjusted mean = 5.17) and greater anxiety change (adjusted mean = -2.23) than prior studies of outpatient massage (2.23 pre-session, -1.34 change),⁴⁷ inpatient acupuncture (2.9 pre-session, -0.8 change),⁴⁸ and outpatient yoga (1.86 pre-session, -1.86 change).⁵⁰ Though patients in both groups reported clinically and statistically significant reductions in anxiety, patients in the SCD group reported significantly greater anxiety reduction. This finding may be due to a few factors specific to the delivery of MT at UHSCC: (1) patients in the SCD group had a consistent therapeutic relationship with the first author throughout the course of the retrospective study, and (2) there was a higher mean session-to-patient ratio in the SCD group (5.78 sessions/patient) than the HemOnc group (2.87 sessions/patient). Future research is needed to explore which musical and therapeutic factors contribute to anxiety reduction in this population and why MT is particularly effective.

In the HemOnc group, patients' reported changes in fatigue (adjusted mean = -0.61) were much lower than fatigue change reported by Lopez et al (-1.86).⁶ This difference is likely due to the low proportion of fatigue reduction as a session goal within both groups (0.1%). Though not statistically significant, patients in the SCD group reported higher fatigue reduction than patients in the HemOnc group (adjusted mean = -1.34 vs -0.61; $P = .077$), with the change in fatigue in the SCD group being clinically significant. This greater reduction in fatigue may be due to the significantly greater proportion of active music making interventions

within the SCD group than the HemOnc group (55.2% vs 25.3%) as these interventions have been found to be more effective for fatigue reduction.⁷

Themes from our qualitative analysis are similar to previous mixed-methods MT studies in this population describing the importance of the therapeutic relationship, the creativity offered through active music making, and the ability of MT to improve mood and provide an escape from treatment-related stress.^{18,26} Within hematology and oncology care, music therapists provide services that go beyond addressing the measurable acute needs for symptom management. Common interventions used in this study including active music making (32.6%) and songwriting (13.9%) require the expertise offered by music therapists.

As discussed in Bradt et al²⁶ "music therapists are trained to go beyond offering verbal support. . . they may musically accompany the patient's emotional expression, audibly reflecting the emotions and providing a safe musical container for continued exploration." Given the level of psychosocial distress among patients with hematologic and/or oncologic conditions and the potential for music-induced harm when music interventions are not carefully applied,⁵¹ it is especially important to have qualified professionals (ie, MT-BCs and their supervised interns) deliver music interventions in this setting. Future mixed-methods research with this population is recommended to explore differences in clinical response to various music interventions (ie, active vs receptive), the ways in which MT may address patients' coping skills and resilience during treatment, and whether therapist characteristics (eg, music intervention preferences and theoretical orientation) influence outcomes.

Strengths of this study include the large sample size, diversity of sociodemographic and clinical populations, novel approach to using EHR data to measure the real-world effectiveness of MT, and collection of PROs immediately before and after MT sessions. This study has several limitations. First, PROs of pain, anxiety and fatigue were not present within the entire sample of MT sessions, and our data lacked measures of other domains including nausea, depression, and wellbeing for which MT has demonstrated effectiveness in prior observational studies.^{6,8} As part of our ongoing work with the EMMPIRE study, we have put in place procedures and trainings to address this limitation by expanding PRO collection in a more routine fashion within MT sessions. Second, this study did not account for the influence of pain medications on patient outcomes. It is expected that our prospective study will include an analysis of PROs that accounts for the influence of pain medications provided to the patients by the clinical teams.⁵²

Third, this study used observational data among a convenience sample without a control group. To better understand the real-world comparative effectiveness of MT as compared to standard care, future observational studies could

consider comparing patients who received MT to propensity-score matched controls who did not receive MT during treatment at a cancer center. Fourth, there is a potential for response bias among patients reporting post-session ESAS scores as patients may have wanted to please the music therapists by reporting lower scores. Future studies could consider collecting PROs through a mobile device or having research assistants blinded to patients' participation in MT collect PROs to reduce this risk of bias.⁵³ Though observational studies are less robust than RCTs with attention control groups at controlling for placebo effects, strategies such as propensity-score matching and blinded outcome assessment would assist in determining true effects of MT interventions as compared to usual care. Importantly, data from prior RCT's¹²⁻¹⁷ support the validity of MT's efficacy beyond the placebo effect.

Fifth, this study used single item 0 to 10 ESAS scores rather than more comprehensive instruments for pain, anxiety, and fatigue. Though more comprehensive and well-validated measures for these domains such as the Patient Reported Outcome Measurement Information System (PROMIS) are available, they can be difficult to administer in the inpatient environment due to the number of items and patients' physical and psychological distress.⁵⁴ Additionally, these more robust items are often more suited toward capturing outcomes over a period of several days or weeks than capturing outcomes immediately pre- and post-session like the ESAS. Finally, this study was conducted at a tertiary freestanding academic cancer center, so the generalizability of findings to other facilities may be limited.

Conclusion

This study supports the delivery and clinical effectiveness of MT for addressing the psychosocial and physical needs of patients with hematologic and oncologic conditions throughout their course of treatment at a freestanding academic cancer center. This study also supports the inclusion of individuals with SCD within integrative oncology services such as MT. Though patients with SCD in this study reported higher pre-session pain and anxiety scores than those without SCD, they reported significantly greater anxiety reduction. Future research is needed to determine (1) which characteristics of MT interventions (eg, active vs receptive, live vs recorded, in-person vs virtual) and patients influence changes in symptoms; (2) the biological mechanisms of action that underpin the impact of MT on outcomes; (3) which factors influence patients' decisions to engage in MT services; and (4) the longitudinal impact of MT on patients' PROs during their treatment at a cancer center.

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Data Accessibility

The datasets generated and/or analyzed during the current study are not publicly available due to privacy restrictions as the databases contain information that could compromise the privacy of research participants. However, the de-identified datasets are available from the corresponding author on reasonable request.

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