

University of Kentucky
Department of
Physical Medicine and
Rehabilitation

28th Annual PM&R
Research Day
May 26, 2016

HealthSouth/Cardinal Hill
Rehabilitation Hospital
Center of Learning
Lexington, Kentucky

**CARDINAL
HILL**® REHABILITATION
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College of Medicine

PROGRAM AND ABSTRACTS

28th Annual

Physical Medicine and Rehabilitation Research Day

May 26, 2016

Cardinal Hill Rehabilitation Hospital

Lexington, KY





28th Annual

**Physical Medicine and Rehabilitation
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**UNIVERSITY OF KENTUCKY
DEPARTMENT OF PHYSICAL MEDICINE & REHABILITATION
28th ANNUAL RESEARCH DAY AGENDA**

**CARDINAL HILL REHABILITATION HOSPITAL
CENTER OF LEARNING
May 26, 2016**

7:00 a.m. – 8:00 a.m. Dr. Julie Silver Roundtable with Residents
(Cardinal Hill Boardroom)

8:15 a.m. – 8:30 a.m. Opening Remarks (CL3):
Susan McDowell, MD
Associate Professor and Chair
Physical Medicine and Rehabilitation

PM&R RESIDENT RESEARCH PRESENTATIONS – CL3

8:30 a.m. – 8:45 a.m. Amy Hiller, DO, Physical Medicine & Rehabilitation
“Factor V Leiden in Young Adult Male with Ischemic Stroke:
A Case Study”

8:45 a.m. – 9:00 a.m. Clay Guynn, DO, Physical Medicine & Rehabilitation
“A Rare Cause of Dorsoradial Wrist Pain”

9:00 a.m. – 9:15 a.m. Prasanth Bobby Katta, JD, DO, Physical Medicine & Rehab
“Paradoxical Effect of Baclofen in Cerebral Palsy Patient”

9:15 a.m. – 9:30 a.m. Andrew Savoie, DO, Physical Medicine & Rehabilitation
“Retrospective Review of Rehabilitation Patients who Required
Blood Transfusions Following Admission to Acute Rehabilitation:
A Quality Improvement Project”

9:30 a.m. – 9:45 a.m. ***BREAK***

9:45 a.m. – 10:00 a.m. Todd Hollen, DO, Physical Medicine & Rehabilitation
“Reduction of Urinalysis Time from Order Initiation to Results”

10:00 a.m. – 10:15 a.m. Raechel Percy, DO, Physical Medicine & Rehabilitation
“Prevention and Treatment of Friction Blisters: A Qualitative
Systematic Review”

10:15 a.m. – 10:30 a.m. Walter Wofford, MD, Physical Medicine & Rehabilitation
“Hallucinations Induced by Oral Baclofen Taper Following
Intrathecal Pump Placement”

10:30 a.m. – 10:45 a.m. Namrata Raut, MD, Physical Medicine & Rehabilitation
“Functional Improvement in Spinal Abscess Patients with
Substance Abuse History”

UNIVERSITY OF KENTUCKY
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28th ANNUAL RESEARCH DAY AGENDA
(Continued)

LUNCH & POSTER PRESENTATIONS

11:00 a.m. – 12:00 p.m.

Buffet Lunch (CL2)
Poster Presentations (CL1)

POSTER PRESENTATIONS – CL1

- 1 Vinod Muniswamy, MD, MPH, Physical Medicine & Rehabilitation
“Modulating Neuropathic Pain with Transcranial Direct Current Stimulation: Preliminary Findings from an Ongoing Study”
- 2 Vittal R. Nagar, MD, PhDc, Physical Medicine & Rehabilitation
“The Influence of Phantom Limb Pain on Functional Improvement in Lower Limb Amputation Patients During Acute Inpatient Rehabilitation”
- 3 Jamie Key, DO, Physical Medicine & Rehabilitation
“A Retrospective Review of Rehabilitation Patients with Stroke who Required Return to Acute Care Hospital”
- 4 Anne Fleischer, PhD, OT/L, CLT-LANA
Occupational Science and Occupational Therapy Dept., ECU
“Exploratory Study of Breast Cancer Survivors’ Lived Experience: Activity Engagement During and after Breast Cancer Treatment”
- 5 Suzanne Doolen, PhD, UK Department of Physiology
“FTY720 Reduces Neuropathic Pain Behaviors in a Mouse Model of Multiple Sclerosis by a Sphingosine-1 Phosphate Receptor 1-Dependent Inhibition of Central Sensitization in the Dorsal Horn”
- 6 Clay Guynn, DO, Physical Medicine & Rehabilitation
“A Rare Cause of Dorsoradial Wrist Pain”
- 7 Namrata Raut, MBBS, Physical Medicine & Rehabilitation
“Ulnar Neuropathy at the Elbow (UNE): Contribution of Ultrasonographic Examination when Electrodiagnostic Studies are Limited by the Presence of Polyneuropathy”
- 8 Vinod Muniswamy, MD, MPH, Physical Medicine & Rehabilitation
“Non-invasive Brain Stimulation Paired with Locomotor Training Improves Strength after Motor Complete Spinal Cord Injury”
- 9 Vittal R. Nagar, MD, PhDc, Physical Medicine & Rehabilitation
“Opioid Use in Chronic Pain Patients with Chronic Kidney Disease – A Systematic Review”

**UNIVERSITY OF KENTUCKY
DEPARTMENT OF PHYSICAL MEDICINE & REHABILITATION
28th ANNUAL RESEARCH DAY AGENDA
(Continued)**

POSTER PRESENTATIONS – CL1 (Continued)

- 10 Vittal R. Nagar, MD, PhDc, Physical Medicine & Rehabilitation
“The Effect of Current Low Back Pain on Volitional Preemptive Abdominal Activation during a Loaded Functional Reach Activity”
- 11 Pransath Bobby Katta, JD, DO, Physical Medicine & Rehab
“Combination Strategies for Chronic Pain Management and Central Nervous System Side Effects”
- 12 Pransath Bobby Katta, JD, DO, Physical Medicine & Rehab
“Neuropathic Pain in High Level Spinal Cord Injury Effectively Controlled by Spinal Cord Stimulator”

FEATURE SPEAKER – CL3 & CL4

12:00 p.m. – 1:00 p.m. Julie Silver, MD
Associate Professor
Associate Chair, Strategic Initiatives
Harvard Medical School
Department of Physical Medicine and Rehabilitation

“The Role of Prehabilitation and Rehabilitation in High-Quality Cancer Care”

CLOSING REMARKS – CL3

1:00 p.m. – 1:30 p.m. Closing Remarks
Robert Nickerson, MD,
Associate Professor and Residency Program Director
Physical Medicine and Rehabilitation

PM&R Resident Presentations

ORAL PRESENTATIONS

Presenter:

Abstract Presentation:

Amy Hiller, DO

"Factor V Leiden in Young Adult Male with Ischemic Stroke: A Case Study"

Clay Guynn, DO

"A Rare Cause of Dorsoradial Wrist Pain"

Prasanth Bobby Katta, JD, DO

"Paradoxical Effect of Baclofen in Cerebral Palsy Patient"

Andrew Savoie, DO

"Retrospective Review of Rehabilitation Patients who Required Blood Transfusions Following Admission to Acute Rehabilitation: A Quality Improvement Project"

Todd Hollen, DO

"Reduction of Urinalysis Time From Order Initiation to Results"

Raechel Percy, DO

"Prevention and Treatment of Friction Blisters: A Qualitative Systematic Review"

Walter Wofford, MD

"Hallucinations Induced by Oral Baclofen Taper Following Intrathecal Pump Placement"

Namrata Raut, MD

"Functional Improvement in Spinal Abscess Patients with Substance Abuse History"

PM&R RESIDENT PRESENTATION

Factor V Leiden in Young Adult Male with Ischemic Stroke: A Case Study

Presenter:

Amy Hiller, DO¹

Collaborators:

Suneetha Madhu, MD², Erika Erlandson, MD¹

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²University of Kentucky

Abstract Text:

Introduction: Factor V Leiden mutation is found in 5.2% of Caucasian population. It is a known risk factor for venous thrombosis, nearly 10-26 % of venous thrombo-embolism patients have underlying factor V Leiden mutation. There is a weak association between arterial thrombosis and factor V Leiden mutation especially in patients with premature myocardial infarction. Studies suggest there is a highly increased risk of ischemic cerebrovascular events in women up to 60 years who smoke and have factor V Leiden mutation.

Methods: This is a case report of rehabilitation outcomes in a young patient who suffered stroke. His demographics, clinical symptomatology, cerebral imaging and clinical outcomes were noted.

Results: 32 y/o male, a chronic smoker and alcohol abuse, with family history of factor V Leiden mutation, presented with sudden onset of complete right hemiplegia with global aphasia. His rehabilitation outcomes will be presented and discussed.

Key Words: Ischemic Stroke, Factor V Leiden, Adult

NOTES

PM&R RESIDENT PRESENTATION

A Rare Cause of Dorsoradial Wrist Pain

Presenter:

Clay Guynn, DO¹

Collaborators:

Wade Rankin, DO², Kelly Evans-Rankin, MD²

Departmental Affiliations:

¹Department of Physical Medicine & Rehabilitation, University of Kentucky, Lexington, KY

²Department of Family and Community Medicine, University of Kentucky, Lexington, KY

Abstract Text:

Preiser's disease and Kienbock's disease are rare wrist pathologies that should be in the differential for a patient presenting with dorsoradial wrist pain. The diseases involve avascular necrosis of the scaphoid and lunate bone and can be treated differently: both operatively and non-operatively depending on individual cases. This case presentation will illustrate the presentation, evaluation, and treatment of a patient who presented with wrist pain and was ultimately diagnosed with Preiser and Kienbock disease. The patient's outcome and current status as well as information that the clinician should know when assessing and treating the aforementioned diseases will be discussed. These are important diseases to understand and be aware of because many potential complications can be avoided with earlier diagnosis and intervention, thereby preventing morbidity for the patient.

Key Words: Dorsoradial Wrist Pain, Preiser's Disease, Kienbock's Disease

NOTES

PM&R RESIDENT PRESENTATION

Paradoxical Effect of Baclofen in Cerebral Palsy Patient

Presenter:

Prasanth Bobby Katta, JD, DO¹

Collaborators:

Keaton S. Smetana, PharmD², Erika Erlandson, MD¹

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Pharmacy, University of Kentucky, Lexington, KY

Abstract Text:

Patient is a 22-year-old female with a history of Cerebral Palsy with spastic diplegia. Onabotulinum toxin A injections successfully controlled her spasticity in her lower extremities from age five but over time did not provide effective spasticity and pain control. She was unable to tolerate oral baclofen due to adverse side effects and agreed to patient to an intrathecal baclofen trial and pump placement. Expectedly, as intrathecal baclofen dosage increased, patient also reported significant improvements in spasticity. However, once patient reached a threshold dosage, her improvement in spasticity began to slow and eventually her spasticity worsened. From this point, as dosage increased, so did her performance in ambulation distance and speed. A rarely reported paradoxical baclofen reaction was suspected, and dosage was decreased. After the decrease, her ambulation and balance improved and he pain diminished. This was again replicated during her acute rehabilitation hospitalization effectively proving that Baclofen was the likely cause, an assertion supported by the Naranjo Scale. Ultimately, patient's intrathecal pump was filled with a combination of baclofen and hydromorphone and her dosage was titrated to a level to control her spasticity and manage her pain. This allowed her to participate in therapy and make significant gains in her functional abilities. After significant search efforts, we present this case today as the first case report describing a paradoxical effect to Intrathecal Baclofen in a Cerebral Palsy patient.

Key Words: Cerebral Palsy, Baclofen, Paradoxical, Spasticity, Naranjo scale, Intrathecal

NOTES

PM&R RESIDENT PRESENTATION

Retrospective Review of Rehabilitation Patients Who Required Blood Transfusions Following Admission to Acute Rehabilitation: a Quality Improvement Project

Presenter:

Andrew Savoie, DO^{1,2}

Collaborators:

Erika Erlandson, MD^{1,2}

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Cardinal Hill Rehabilitation Hospital, Lexington, KY

Abstract Text:

A retrospective chart review will be used to determine factors that place rehabilitation patients at risk for requiring blood transfusions after admission to an inpatient rehabilitation facility (IRF). The study will include 14 patients admitted to IRF from January 2016 and March 2016 who required blood transfusions. During this time there was an increased need for transfusions, and this need places patients at a greater risk for further medical complications, may result in their inability to participate in therapy, and poses barriers such as increased costs for the rehabilitation facility. The study will compare patient primary diagnoses, presence of cardiovascular comorbidities, anticoagulation status, and hemoglobin levels prior to and following IRF admission. The project is designed to identify risk factors for blood transfusion during IRF admission that should be addressed prior to discharge from Acute Care Facility (ACF). If a set of risk factors can be identified, the current protocol for transition of care may be updated to require a standard for acute anemia prior to transfer. After initiation of an updated protocol, another review of facility transfusion requirements will be done to evaluate for improvement in transfusion requirements at the IRF.

Key Words: Rehabilitation, Blood Transfusion, Anemia

NOTES

PM&R RESIDENT PRESENTATION

Reduction of Urinalysis Time From Order Initiation to Results

Presenter:

Todd Hollen, DO¹

Collaborators:

Erika Erlandson, MD¹

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

Background: Following a stroke, one dysfunction that often occurs is a neurogenic bladder. Patient's often have not had their neurogenic bladder addressed during acute hospitalization and many develop urinary retention. Therefore during rehabilitation admission each stroke patient has a urinalysis as part of their initial work up on admission.

Hypothesis: Reduction in time from urinalysis initiation to results will result starting antibiotics earlier therefore reducing need for send outs and not having urines sitting in the refrigerator overnight will reduce the amount of unnecessary starting of antibiotic due to microbial overgrowth due to delayed analysis.

Objective: The aims of this study are 1) reduce the amount of time it takes for completion of urinalysis

Design: Review of urinalysis order times initiated and reported on admitted patients on stroke unit during the period from 4/28-6/14/2016 as a control group. Control group was then compared to the intervention with patients admitted on 6/15-30/2016 on the stroke unit. Average times from initiation of order to reporting time, average initiation of order to collection time, average time from collection to reporting and average times in lab to reporting times were compared.

Study Population: Perspective pilot study of admitted patients on stroke unit during the period from 4/28-6/12/2016

Intervention: Urinalysis ordered during daytime lab hours only will be collected by staff and carried to the lab. Once in the lab staff will sign in specimen and lab staff will sign affirming receipt of the specimen. The hand-off and accepting signature will be signed on a sign-in sheet made with excel spreadsheet.

Outcomes Measured:

Average time from Order initiation to urinalysis reporting

Average time from collection to urinalysis reporting

Average time from specimen arriving to urinalysis reporting

Expected Outcome:

Reduction of time from initiation of urinalysis order to urinalysis reporting

Reduction of time from urinalysis order initiation to collection

Reduction of time urine specimen arrives in lab, analysis and reporting

Key Words: Stroke, Urinalysis, Urinary Tract Infections

NOTES

PM&R RESIDENT PRESENTATION

Prevention and Treatment of Friction Blisters: A Qualitative Systematic Review

Presenter:

Raechel Percy, DO¹

Collaborators:

Robert M. Worthing, MD², Jeremy D. Joslin, MD³

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Physical Medicine and Rehabilitation, VAMC, Lexington, KY

³Department of Emergency Medicine, SUNY Upstate Medical University, Syracuse, NY

Abstract Text:

Objective: The purpose of this review was to conduct a systematic search and qualitative analysis of literature on the prevention and treatment of friction blisters in wilderness/outdoor pursuits.

Methods: A search of PubMed/MEDLINE, EMBASE, and Cochrane Trials was conducted using serial PICO question format. Title, abstract, and full text articles were screened by two authors using predetermined inclusion/exclusion criteria to identify prospective controlled trials investigating prevention and treatment methods for friction blisters involving the foot. Only blisters associated with wilderness/outdoor pursuits (running, hiking, marching, etc.) were considered. Extraction of predetermined data set was accomplished using a piloted form. A qualitative review of identified articles was conducted utilizing SIGN (Scottish Intercollegiate Guidelines Network) checklist for assessment of risk of bias.

Results: Literature search resulted in 603 discrete articles. 11 were identified for inclusion in systematic review. Of those included, 5 investigated sock systems, 3 antiperspirants, 2 barriers, and 1 cyanoacrylates. Four were determined to be low quality of risk control. Only 3 articles were determined to be high quality (low risk of bias). Heterogeneity among study design and intervention precluded meta-analysis.

Conclusions: Despite the high frequency and associated cost, evidence in support of prevention and treatment methods to address friction blisters of the foot remains poor.

Key Words: Blister, Foot, (Ultra) Marathon, Running, Hiking, Military

NOTES

PM&R RESIDENT PRESENTATION

Hallucinations Induced by Oral Baclofen Taper Following Intrathecal Pump Placement

Presenter:

Walter Wofford, MD¹

Collaborators:

Sara Salles, DO¹, Joe Springer, PhD¹

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

Abstract Text:

Background: Debilitating spasticity affects a wide range of patients including those who have suffered SCI, TBI, cerebral palsy, and MS, to name a few. Oral baclofen therapy is a common treatment for patients who suffer from debilitating spasticity; however, many patients find even with a maximized oral anti-spasticity regimen their spasticity remains poorly controlled. Delivery via Intrathecal baclofen pump is regarded as a safe alternative that provides doses directly to the intrathecal space, sparing most people central effects. The process of identifying, implanting, and titrating pumps varies. Typically, a patient undergoes pump implantation and has oral regimen weaned while intrathecal dosing is increased. Withdrawal syndrome from oral and intrathecal baclofen have each individually been well described in the literature, although, to our knowledge there has yet to be a report of withdrawal from oral baclofen in the setting of new pump implantation.

Methods: Case report

Findings: A 42 year old male undergoing acute inpatient rehabilitation after baclofen pump placement developed visual and auditory hallucinations abruptly during weaning of his oral baclofen and titration of his intrathecal dosing. Other causes of hallucinations were ruled out and it was determined patient's withdrawal syndrome was due to the oral baclofen. Patient was placed again on oral baclofen with plans for extended taper with subsequent resolution of his symptoms.

Conclusion: To our knowledge, this is the first reported case of oral baclofen withdrawal syndrome developing in a patient immediately status post intrathecal baclofen pump placement due to routine medication adjustment.

Key Words: Baclofen Pump, Spasticity, Hallucinations

NOTES

PM&R RESIDENT PRESENTATION

Functional Improvement in Spinal Abscess Patients with Substance Abuse History

Presenter:

Namrata Raut, MD¹

Collaborators:

Vittal R. Nagar, MD^{1,2}, Joe E. Springer, PhD^{1,2}, Sara Salles, DO^{1,2}

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Cardinal Hill Rehabilitation Hospital, Lexington, KY

Abstract Text:

Objective: To compare functional improvement after acute inpatient rehabilitation in spinal epidural abscess (SEA) patients with a history of intravenous substance abuse (IVSA) to SEA patients without IVSA.

Design: Retrospective review

Methods: 28 SEA patients from 01/2012 to 9/2015 (45-month period), divided into 2 groups: 13 with IVSA and 15 without IVSA were investigated. Both groups received acute inpatient rehabilitation at free-standing rehabilitation hospital. Functional performance was defined by Functional Independence Measure (FIM) scores.

Results: A 2 (Substance Use) X 2 (rehabilitation status) mixed design analysis of variance (ANOVA) for all patients for total, motor, or cognitive FIM scores did not demonstrate any significant interactions. However, significant main effects for rehabilitation status at admission versus discharge were found for total FIM scores ($F [1, 1] = 50.162, P = <0.05$; discharge 73.43 ± 13.97) versus admission (46.96 ± 13.96)), FIM motor scores ($F [1, 1] = 44.26, P = <0.05$; discharge 43.50 ± 11.64) versus admission (22.76 ± 11.64)), and FIM cognitive scores ($F [1, 1] = 17.85, P = <0.05$; discharge 29.94 ± 5.08) versus admission (24.2 ± 5.08)). Length of stay: IVSA was 22.6 days and no IVSA was 21 days; Morphine equivalents: IVSA 113.75 and no IVSA 93.8; Level of abscess: IVSA: Cervical-38.46%, Thoracic -53.84%, Lumbar -7.6% whereas for no IVSA: Cervical-13.3%, Thoracic - 66.6%, Lumbar- 2.0%; Age: IVSA patients were younger, only 30.7% were above 40 years where as with no IVSA group 80% patients were above 40 years of age.

Conclusions: Effective acute inpatient rehabilitation in SEA substance abuse patients improves functional recovery similar to non-substance abuse patients.

Key Words: Spinal Abscess, Substance Abuse, Functional Improvement

NOTES

POSTER PRESENTATIONS

<u>Presenter</u>	<u>Poster #</u>	<u>Poster Presentation Title</u>
Vinod Muniswamy, MD, MPH	1	Modulating Neuropathic Pain with Transcranial Direct Current Stimulation: Preliminary Findings from an Ongoing Study
Vittal R. Nagar, MD, PhDc	2	The Influence of Phantom Limb Pain on Functional Improvement in Lower Limb Amputation Patients During Acute Inpatient Rehabilitation
Jamie Key, DO	3	A Retrospective Review of Rehabilitation Patients with Stroke who Required Return to Acute Care Hospital
Anne Fleischer, PhD, OT/L,CLT-LANA	4	Exploratory Study of Breast Cancer Survivors' Lived Experience: Activity Engagement During and after Breast Cancer Treatment
Suzanne Doolen, PhD	5	FTY720 Reduces Neuropathic Pain Behaviors in a Mouse Model of Multiple Sclerosis by a Sphingosine-1 Phosphate Receptor 1-Dependent Inhibition of Central Sensitization in the Dorsal Horn
Clay Guynn, DO	6	A Rare Cause of Dorsoradial Wrist Pain
Namrata Raut, MBBS	7	Ulnar Neuropathy at the Elbow (UNE): Contribution of Ultrasonographic Examination when Electro-diagnostic Studies are Limited by the Presence of Polyneuropathy
Vinod Muniswamy, MD, MPH	8	Non-invasive Brain Stimulation Paired with Locomotor Training Improves Strength after Motor Complete Spinal Cord Injury
Vittal R. Nagar, MD, PhDc	9	Opioid Use in Chronic Pain Patients with Chronic Kidney Disease – A Systematic Review
Vittal R. Nagar, MD, PhDc	10	The Effect of Current Low Back Pain on Volitional Preemptive Abdominal Activation during a Loaded Functional Reach Activity
Pransath Bobby Katta, JD, DO	11	Combination Strategies for Chronic Pain Management and Central Nervous System Side Effects
Pransath Bobby Katta, JD, DO	12	Neuropathic Pain in High Level Spinal Cord Injury Effectively Controlled by Spinal Cord Stimulator

POSTER PRESENTATION - 1

Modulating Neuropathic Pain with Transcranial Direct Current Stimulation: Preliminary Findings from an Ongoing Study

Presenter:

Vinod Muniswamy, MD, MPH¹

Collaborators:

Elizabeth Powell, MS¹, Sara Salles, DO¹, Paul Sloan, MD², Lumy Sawaki, MD, PhD¹

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Anesthesiology/Pain Medicine, University of Kentucky, Lexington, KY

Abstract Text:

Introduction:

Chronic pain impacts millions of people, affecting their physical and emotional functioning and quality of life. Neuropathic pain is an example of maladaptive pain with disruption of normal pain signaling and sensitization or spontaneous neuronal activity in the nervous system. Examples of neuropathic pain include phantom limb pain (PLP), complex regional pain syndrome (CRPS), and neuropathic pain following spinal cord injury (SCI). Recently, non-invasive brain stimulation techniques such as transcranial direct current stimulation (tDCS) have emerged as promising interventions to modulate neuropathic pain. Most studies have applied tDCS over either dorsolateral prefrontal cortex (DLPFC) or primary motor cortex (M1). No studies have collected multiple baseline measures, including quality-of-life measures or systematic evaluation of the differential effects of tDCS stimulation sites.

The first aim is to determine the effect of tDCS on pain and quality of life. A second aim is to determine the specificity of tDCS site for modulation of pain and quality of life.

Methods:

This pilot, randomized, prospective, sham-controlled study of patients with chronic pain (PLP, CRPS, or neuropathic pain following SCI) was conducted following IRB approval. Each subject participated in 4 evaluation sessions (including 2 baseline evaluations) and 10 tDCS sessions. Outcome measures included the McGill Pain Questionnaire and the SF-36. Subjects were randomly assigned to 1 of the following 3 groups:

Group 1: anodal tDCS over DLPFC

Group 2: anodal tDCS over M1

Group 3: sham tDCS over M1

Results:

Nine subjects have been enrolled, with 3 in each group. Subjects randomly assigned to the anodal M1 condition had different baseline scores on the McGill Pain Questionnaire than the other 2 groups. After intervention, subjects in the anodal DLPFC group showed more improvement on the McGill Pain Questionnaire than subjects who received sham tDCS to M1 or anodal tDCS to M1 (which led to no improvement). There was substantial variability of results with regard to the effects of intervention on SF-36.

Conclusion:

Preliminary findings indicate that tDCS applied over DLPFC may yield more benefit as measured by the McGill Pain Questionnaire than either active or sham tDCS applied over M1, although there appears to be a moderate placebo effect. Due to variable results on SF-36, impact of intervention on quality-of-life remains inconclusive. We plan to increase the sample size and conduct a multicenter prospective study to enable more definitive conclusions. Overall, our results indicate the need for further research on tDCS as a clinical intervention to decrease chronic pain.

Key Words: CRPS, Neuropathic Pain, Transcranial Stimulation

POSTER PRESENTATION - 2

The Influence of Phantom Limb Pain on Functional Improvement in Lower Limb Amputation Patients during Acute Inpatient Rehabilitation

Presenter:

Vittal R. Nagar, MD, PhD¹

Collaborators:

Lumy Sawaki, MD, PhD¹, Sara Salles, DO¹, C.R. James², J.M. Brismée², P.S. Sizer²

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Rehabilitation Sciences, Texas Tech University Health Sciences Center, Lubbock, TX

Abstract Text:

Introduction: The purpose of this study was to examine whether phantom limb pain appropriately treated with pain management affects functional performance of lower extremity amputation patients during acute inpatient rehabilitation in a free-standing rehabilitation hospital.

Methods: Retrospective review of patients admitted for acute inpatient rehabilitation after lower extremity amputation at a free-standing rehabilitation hospital from 01/2013 to 5/2015 (29-month period) was investigated. The phantom limb pain patients were treated with one or combination of the following medications, Tylenol, Gabapentin, Pregabalin, Tricyclic antidepressant, Opioids, Selective serotonin reuptake inhibitors, Selective serotonin/norepinephrine reuptake inhibitor and Nonsteroidal anti-inflammatory drugs. Functional performance was defined by total Functional Independence Measure (FIM) scores as well as motor and cognitive subset scores.

Results: A 2 (pain) X 2 (rehabilitation status) mixed design analysis of variance (ANOVA) for all patients for total, motor, or cognitive FIM scores did not demonstrate significant interactions. Regarding total FIM scores, a significant main effect was observed for rehabilitation status ($F [1, 1] = 434.44$, $P = <0.05$), where the scores were greater at discharge (87.61 ± 16.84) versus admission (58.08 ± 14.66) (Figure 1). Regarding motor FIM scores, a significant main effect was observed for rehabilitation status ($F [1, 1] = 358.71$, $P = <0.05$), where scores were greater at discharge (57.12 ± 13.49) versus admission (36.19 ± 10.87). Regarding cognitive FIM scores, a significant main effect was found for rehabilitation status ($F [1, 1] = 297.47$, $P = <0.05$), where scores were greater at discharge (30.48 ± 5.34) versus admission (21.89 ± 5.90). A 2 (pain) x 2 (type of amputation) between-subjects ANOVA did not demonstrate any significant interactions or main effects for FIM efficiency scores (FIM gain/length of stay).

Conclusions: Effective pain management in phantom limb pain patients improves functional recovery similarly to non-phantom limb pain patients during acute inpatient rehabilitation for lower extremity amputation. Future studies investigating pain, quality of life and patient satisfaction in lower extremity amputation patients are warranted. Inpatient rehabilitation with appropriate pain management appears crucial for achieving favorable functional outcomes in lower extremity amputation patients.

Key Words: Phantom Limb Pain, Lower Limb Amputation, Acute Inpatient Rehabilitation, Chronic Pain, Functional Recovery

POSTER PRESENTATION - 3

A Retrospective Review of Rehabilitation Patients with Stroke who Required Return to Acute Care Hospital

Presenter:

Jamie Holt Key, DO¹

Collaborators:

Erika Erlandson, MD¹, David Akers²

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Statistics, University of Kentucky, Lexington, KY

Abstract Text:

Objective:

- Investigate causes for return to acute care hospital (RTACH) for evaluation during a rehabilitation admission for patients with stroke.
- Identify risk factors for readmission to acute care in this population.

Design:

- Retrospective chart review.

Setting:

- Acute Inpatient Rehabilitation Hospital; Acute Care Hospital

Participants:

- Patients admitted to a stroke rehabilitation unit between July, 2012 and November, 2013 who required RTACH.

Main Outcome Measures:

- Reason for RTACH, etiology of stroke, presence of aphasia and dysphagia, weekday vs. weekend transfer, anticoagulation status, length of stay, age, and functional independence measure scores.

Level of Evidence:

- Level IV

Results:

- A total of 63 patients with stroke required RTACH during the documented time interval; 37 (59%) were readmitted to acute care. All patients with sepsis (n=7) and 75% (n=18) of patients with aphasia who required RTACH were readmitted (p=0.02). In addition, 73% (n=27) of patients identified as critical transfers (those with sepsis, neurologic changes, or cardiac symptoms) required readmission to acute care. A total of 70% (n=26) of those readmitted had a diagnosis of dysphagia. Finally, all of the patients readmitted to acute care (n=37) had a significantly shorter length of stay in rehab prior to transfer (p=0.02).

Conclusions:

- Risk factors for readmission to acute care include sepsis, neurologic changes, cardiac symptoms, aphasia, dysphagia, and shorter length of rehabilitation stay prior to transfer.
- These factors will be used to generate a risk stratification protocol for discharge planning and transition of care. This protocol will be used to identify patients with stroke who are at high risk for readmission to acute care in efforts to decrease healthcare costs, minimize setbacks and lost days in rehab, thereby improving overall outcomes.

Key Words:

- Stroke Rehabilitation, Readmission, Dysphagia, Return to Acute Care

POSTER PRESENTATION - 4

Exploratory Study of Breast Cancer Survivors' Lived Experience: Activity Engagement During and after Breast Cancer Treatment

Presenter:

Anne Fleischer, PhD, OT/L, CLT-LANA¹

Collaborators:

Robin Cooper, PhD², Max Ito, PhD, OTR/L³, Doris Brown, MD, PhD⁴

Departmental Affiliations:

¹Occupational Science and Occupational Therapy Department, Eastern Kentucky University

²Conflict Resolution Studies, Nova Southeastern University

³Occupational Therapy, Nova Southeastern University

⁴Radiation Oncology, Wake Forest University

Abstract Text:

Objective: Describe breast cancer survivors' experiences participating in important activities during and after breast cancer treatment.

Design: Concurrent mixed method design using interpretative phenomenological analysis for qualitative and descriptive statistics for quantitative

Setting: Cancer Center

Participants: Ten survivors diagnosed with Stage I, II, or III breast cancer, consecutively received surgery, chemotherapy, and radiation therapy, 40 and 65 years of age

Main Outcome Measure: Activity Card Sort modified (ACSm) and emergent themes from each interview

Results: The proportion of activity participation incrementally increased from the end of radiation therapy to 6-months post-treatment (63%, 61%, 81%, 84%). Seventy-five percent of important activities were either instrumental or social activities, and remaining 25% were low- or high-demand leisure activities at each time point. Fatigue, fear of infection and side effects, and personal and treatment stresses seemed to reduce activity participation during radiation therapy; and strategies to reduce stress and treatment side effects, looking toward future, and making personal changes seemed to encourage it. At 6-months post-treatment, appreciation for life, family and work, and desire to make lifestyle changes seemed to encourage activity participation. Current cancer status appeared to either encourage or discourage participation in important activities.

Conclusions: Results from this study cannot be generalized to all breast cancer survivors. Some observations require further investigation because of its possible application to oncology rehabilitation, including teaching adaptive strategies, fatigue education, stress management, and life style support. Additional research is needed on interventions to improve social and high-demand leisure activities, particularly for single mothers.

Key Words: Everyday Occupations, Side Effects, Social Support

POSTER PRESENTATION - 5

FTY720 Reduces Neuropathic Pain Behaviors in a Mouse Model of Multiple Sclerosis by a Sphingosine-1 Phosphate Receptor 1-Dependent Inhibition of Central Sensitization in the Dorsal Horn

Presenter:

Suzanne Doolen, PhD¹

Collaborators:

Tommaso Lannitti¹, Renee R. Donahue¹, Bradley K. Taylor¹

Departmental Affiliations:

¹Department of Physiology, University of Kentucky

Abstract Text:

Multiple sclerosis (MS) is an autoimmune-inflammatory neurodegenerative disease that leads to severe neurological and cognitive deficits. These are often accompanied by a debilitating neuropathic pain. Disease-modifying agents slow the progression of MS and prevent relapses, yet it remains unclear which if any of them can also reduce neuropathic pain in MS. We explored the analgesic potential of fingolimod (FTY720), because its primary target, the sphingosine-1-phosphate 1 receptor (S1PR1), was recently shown to modulate spinal pain transmission. We used a mouse model of experimental autoimmune encephalomyelitis (EAE, using immunization with myelin oligodendrocyte glycoprotein 35-55 (MOG₃₅₋₅₅)), modified to avoid frank paralysis and thus allow for assessment of withdrawal behaviors to somatosensory stimuli. In EAE mice, FTY720 reduced behavioral signs of neuropathic pain (mechanical and cold hypersensitivity) in a dose-dependent and reversible manner. This lasted for several days, consistent with its time course of functional antagonism. FTY720 also reduced cellular markers of central sensitization of neurons in the dorsal horn of the spinal cord: glutamate-evoked Ca²⁺ signaling and stimulus-evoked phospho-extracellular signal-related kinase ERK (pERK) expression, as well as upregulation of astrocytes (GFAP) and macrophage/microglia (Iba1) immunoreactivity. The S1PR1 antagonist W146 reversed the antihyperalgesic effects of FTY720. Both EAE and FTY720 changed hyperalgesia before modifying motor function, suggesting that pain-related effects and clinical neurological deficits were modulated independently. We conclude that FTY720 acts at S1PR1 to reduce behavioral signs of pain in multiple sclerosis by reversing central sensitization of spinal nociceptive neurons.

Key Words: Neuropathic Pain, Multiple Sclerosis, Central Sensitization

POSTER PRESENTATION - 6

A Rare Cause of Dorsoradial Wrist Pain

Presenter:

Clay Guynn, DO¹

Collaborators:

Wade Rankin, DO², Kelly Evans-Rankin, MD²

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Family and Community Medicine, University of Kentucky, Lexington, KY

Abstract Text:

Preiser's disease and Kienbock's disease are rare wrist pathologies that should be in the differential for a patient presenting with dorsoradial wrist pain. The diseases involve avascular necrosis of the scaphoid and lunate bone and can be treated differently: both operatively and non-operatively depending on individual cases. This case presentation will illustrate the presentation, evaluation, and treatment of a patient who presented with wrist pain and was ultimately diagnosed with Preiser and Kienbock disease. The patient's outcome and current status as well as information that the clinician should know when assessing and treating the aforementioned diseases will be discussed. These are important diseases to understand and be aware of because many potential complications can be avoided with earlier diagnosis and intervention, thereby preventing morbidity for the patient.

Key Words: Dorsoradial Wrist Pain, Preiser's Disease, Kienbock's Disease

POSTER PRESENTATION - 7

Ulnar Neuropathy at The Elbow (UNE): Contribution Of Ultrasonographic Examination When Electrodiagnostic Studies Are Limited By The Presence Of Polyneuropathy

Presenter:

Namrata Raut, MBBS¹

Collaborators:

Oscar Ortiz Vargas, MD²

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Physical Medicine and Rehabilitation, VAMC, Lexington, KY

Abstract Text:

Case Diagnosis: Left UNE secondary to osteophyte in the cubital tunnel

Case Description: 78-year-old right-handed male sent to our clinic for electrodiagnostic evaluation (EDX) of UNE. He reported a 6-month progressive history of left grip weakness, numbness, and severe burning pain to 4th and 5th digits. He also reported similar but milder symptoms in the right hand. His past medical, surgical, and family history was unremarkable except for a left 3rd trigger finger release and traumatic osteoarthritis of his left wrist. Physical exam of the left hand revealed: atrophy of intrinsic hand muscles with motor strength 4/5, and decreased sensation over palmar surface of medial 5th and 4th digits. Tinel's sign was elicited at the elbow.

EDX were most consistent with generalized axonal polyneuropathy, but inconclusive for diagnosis of UNE. Ultrasonographic examination of ulnar nerve revealed a focal enlargement at the cubital tunnel entrance (cross sectional area 20 mm², swelling ratio 2.5), and bony periosteal changes from medial epicondyle causing flattening of the ulnar nerve.

Discussion: UNE is the second most common entrapment neuropathy of the upper limb. Decreased sensation or dysesthesias in fourth or fifth digits are the primary complaint, often coupled with pain in the medial aspect of the elbow. Although this entrapment can be suspected clinically, EDX is necessary to confirm the diagnosis.

EDX can have a limited value or fail to confirm the diagnosis due to the presence of additional neuropathies or polyneuropathy, as it happened in this case. In these circumstances, ultrasonography can satisfactorily confirm the diagnosis and reveal the causes of nerve compression when structural abnormalities or space-occupying lesions are present

Ultrasound increased the diagnostic sensitivity of the EDX testing for UNE from 78% up to 98% per study by Beekman et al.

Conclusions: Ultrasound is a readily available diagnostic tool that can be used by physiatrists to complement EDX testing.

Key Words: Ulnar Neuropathy, Polyneuropathy

POSTER PRESENTATION - 8

Non-invasive Brain Stimulation Paired with Locomotor Training Improves Strength after Motor Complete Spinal Cord Injury

Presenter:

Vinod Muniswamy, MD, MPH¹

Collaborators:

Cheryl Carrico, MS, OT/L¹, Kenneth Chelette, MS¹, Cara Lee, PT, DPT², Elizabeth Powell, MS¹, Lumy Sawaki, MD, PhD¹

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²College of Health Sciences, University of Kentucky, Lexington, KY

Abstract Text:

The central nervous system has the ability for degrees of reorganization formerly thought to occur only during the early post-natal period. It is now believed that this capacity for plastic change plays a crucial role in recovery of function after neurological injury. Persistent responsiveness to external sensorimotor stimuli and resultant plastic change in cortical motor areas can occur after incomplete spinal cord injury (SCI) because in this condition, the spinal cord remains partially preserved and interconnected with the intact brain by unlesioned fibers. Additionally, several lines of evidence indicate that a non-invasive form of brain stimulation called transcranial direct current stimulation (tDCS) facilitates plastic change supporting motor recovery after stroke. However, there is no available data about tDCS to enhance recovery of lower extremity motor function for people with SCI. Here, we report on a single case study evaluating the effects of tDCS paired with robot-assisted treadmill training for a 24 y.o. woman who sustained motor complete SCI (C6 ASIA-B) in a motor vehicle accident 2 years prior to this study. We delivered anodal tDCS to excite the motor cortex at an intensity of 2mA for 20 minutes, 3 times a week for 12 weeks, immediately preceding robot-assisted treadmill training (Lokomat) for a total of 36 sessions. The primary outcome measure was manual muscle test (MMT) administered at baseline, immediately after the intervention period, and at 1-month follow-up. Results showed bilateral active muscle activation for the first time after injury (left lower extremity MMT: 0, 7, 11; right lower extremity MMT: 0, 7, 12). These results indicate positive clinical and translational potential of our tDCS-based intervention to enhance recovery of lower extremity motor function in cases of motor complete SCI. Further systematic evaluation is warranted to determine the beneficial impact of tDCS and locomotor training for people with severe gait deficit following SCI.

Key Words: SCI Motor Recovery, Transcranial Spinal Cord Intervention, Chronic SCI

POSTER PRESENTATION - 9

Opioid Use in Chronic Pain Patients with Chronic Kidney Disease – A Systematic Review

Presenter:

Vittal R. Nagar, MD, PhD¹

Collaborators:

P. Birthi², S. Salles¹, P. Sloan³

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Interventional Pain Management, St. Francis Medical Center, Grand Island, NE

³Department of Anesthesiology, University of Kentucky, Lexington, KY

Abstract Text:

Introduction: Chronic pain is a common and disabling symptom among patients with chronic kidney disease (CKD). ⁽¹⁾ Very few reviews with rigorous methodological quality assessment criteria have analyzed the prevalence of pain with CKD; type, dose and reason for opioid use; effectiveness of pain control and associated adverse effects of opioids in patients with CKD. Therefore, the objective of this study was to investigate the prevalence of chronic pain and current opioid management among patients with CKD.

Methods: A systematic literature search was performed for English papers, including citations from 1960 to May 2015. The studies providing appropriate study design, statistical evaluations and outcome evaluations were analyzed. ^(2, 3) The quality of each individual article was assessed by the Cochrane Review Criteria for randomized trials, and the Newcastle-Ottawa Scale for cohort studies. Main outcome measures were prevalence of opioid use, opioid dose, effectiveness of symptom control, and associated adverse events.

Results: Twelve of 131 papers met inclusion criteria. There were no randomized controlled trials (RCT) evaluable, and 12 were observational studies (Figure 1). Out of these 12 studies, 4 were of high quality, 6 were of moderate quality, and the remaining 2 were low quality studies. The studies were from different countries with a sample size ranging from 10 to 12,782. Several studies showed a high prevalence (47% to 72%) of chronic uncontrolled pain. The use of opioids for the treatment of chronic pain with CKD ranged between 18-36%. The effectiveness of different categories of opioids, dose, duration and commonly prescribed opioids varied across studies. No clear guidelines or RCTs were found regarding the management of chronic pain with opioids in CKD. It is possible, based on knowledge of opioid pharmacodynamics and pharmacokinetics, to suggest caution with certain opioids in the treatment of patients with CKD (Figure 2).

Conclusions: 1) Based on a systematic review of the current literature there is fair evidence for the high prevalence of chronic pain among patients with CKD. 2) There is fair evidence for the inadequate use of opioid therapy for the treatment of CKD patients with chronic pain. 3) Clinicians are in need of additional and well-designed RCTs that focus on the indications for opioid therapy, appropriate opioid doses and dosing intervals, outcomes with adequacy of symptom control, and reporting on the incidence of adverse side-effects. 4) Fentanyl and buprenorphine transdermal are perhaps the most safe opioids to treat chronic pain in patients with CKD.

Key Words: Opioids, Chronic Pain, Chronic Kidney Disease, Dialysis

POSTER PRESENTATION - 10

The Effect of Current Low Back Pain on Volitional Preemptive Abdominal Activation During a Loaded Functional Reach Activity

Presenter:

Vittal R. Nagar, MD, PhD¹

Collaborators:

T. Hooper², G. Dedrick³, J. Brismée², M. McGallaird⁴, P. Sizer²

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Rehabilitation Sciences, Texas Tech University Health Sciences Center, Lubbock, TX

³Doctor of Physical Therapy Program, Campbell University, Buies Creek, NC

⁴Doctor of Physical Therapy Program, Harding University, Searcy, AR

Abstract Text:

Introduction: A volitional preemptive abdominal contraction (VPAC) supports trunk stability during functional activity. Pain-free individuals can sustain VPAC during function, but such has not been reported for individuals with current low back pain (cLBP). The purposes of this study were to examine whether cLBP affects VPAC performance during a loaded functional-reach (LFR) activity.

Methods: A crossover mixed design examined the effects of the LFR activity (with 4.6kg load) and VPAC using the abdominal drawing-in maneuver (ADIM) on TrA activation. Setting was in a laboratory. Participants were 18 Controls and 17 cLBP subjects with pain ratings of 1-7/10. Interventions were blinded TrA thickness measurements were recorded from M-mode ultrasound imaging during 4 conditions (Figure 1-A&B): (1) Quiet standing (QS) without ADIM; (2) QS with ADIM; (3) LFR without ADIM; and (4) LFR with ADIM. A physical therapist with 29 years of experience collected historical and examination data. Main Outcome Measures were TrA muscle thickness (mm) representing muscle activation and selected examination data.

Results: A 2(Group) x 2(Contraction) x 2(Reach) Analysis of Variance (ANOVA) demonstrated a significant Group x Contraction interaction [$F(1, 31) = 4.499, p = 0.042$]; ADIM produced greater TrA thickness increases in PLBP subjects (2.18mm) versus Controls (1.36mm). We observed a significant main effect for Reach [$F(1, 31) = 14.989, p = 0.001$] (Figure 2-Activity mean-mm). Post-hoc comparisons demonstrated that LFR activity produced a greater TrA thickness ($6.15 \pm 2.48\text{mm}$) versus quiet standing ($5.30 \pm 2.12\text{mm}$).

Conclusions: While subjects with cLBP demonstrated slightly less abdominal activation during every condition, they exhibit a greater increase in TrA activation during ADIM versus controls. Individuals can utilize the ADIM strategy as a protective VPAC response during a LFR.

Key Words: Low Back Pain, Volitional Preemptive Abdominal Activity, Functional Reach, Ultrasound

POSTER PRESENTATION - 11

Combination Strategies for Chronic Pain Management and Central Nervous System Side Effects

Presenter:

Pransath Bobby Katta, JD, DO¹

Collaborators:

Vittal R Nagar, MD¹, Vinod Muniswamy, MD¹, Paul Sloan, MD²

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Department of Anesthesiology, University of Kentucky, Lexington, KY

Abstract Text:

Short Description: Literature supporting combination strategies for chronic pain management is commonly used in clinical practice. Clinicians treating the chronic pain patient population with combination strategies should have constant vigilance and perform re-evaluations to avoid any adverse effects.

Background: The combination of analgesics for chronic pain management may be associated with central nervous system (CNS) side-effects. There are only a few reviews highlighting this topic. This review will enrich our understanding of the role of co-analgesia and CNS dysfunction in chronic pain population. This will provide an approach by which these patients may be effectively managed by appropriate treatments.

Purpose: The aim of the study was to analyze the contemporary literature on the use of combination medications for chronic pain, and to identify medication combinations that increase the risk for CNS side effects.

Procedures: This is a narrative review. The review included relevant literature identified through searches of PubMed, Cochrane, Clinical trials and EMBASE from 1960 to September, 2015.

Conclusion: Eight clinical trials and six reviews met inclusion criteria. Multiple, good quality studies demonstrated the superior efficacy of combination strategies supporting the use of two medications for chronic pain management. However, the number of available studies for any one specific combination is limited, and trial size and duration of treatment are small. So this precludes the recommendation of any one specific drug combination for any type of chronic pain management.

Key Words: Chronic Pain Management, CNS Side Effects, Combination Strategies

POSTER PRESENTATION - 12

Neuropathic Pain in High Level Spinal Cord Injury Effectively Controlled by Spinal Cord Stimulator

Presenter:

Pransath Bobby Katta, JD, DO¹

Collaborators:

Vittal R Nagar, MD¹, Vinod Muniswamy, MD¹, Luis Vascello, MD², Sara Salles, DO¹

Departmental Affiliations:

¹Department of Physical Medicine and Rehabilitation, University of Kentucky, Lexington, KY

²Baptist Health Pain Management, Lexington, KY

Abstract Text:

Background: Neuropathic pain is common in individuals with spinal cord injury (SCI). To date, studies recommend non-interventional pain management in these patients, with limited literature supporting the use of spinal cord stimulator (SCS) to treat neuropathic pain.

Purpose: To investigate the efficacy of a SCS for treatment of neuropathic pain in a patient with SCI.

Procedure: 57 year old male with C4-American-Spinal-Injury-Association (ASIA) classification-C SCI secondary to fall from a truck platform in 2009 resulting in spastic tetraplegia and severe neuropathic pain. An intrathecal baclofen pump was placed in 2012 for spasticity management. Patient complained of right lower extremity chronic neuropathic pain (RLECNP) that persisted from his initial injury. Conservative therapies addressing RLECNP failed including gabapentin, pregabalin, amitriptyline, buprenorphine, a transcutaneous electrical nerve stimulation unit, oxycodone/acetaminophen and intrathecal baclofen pump with baclofen and bupivacaine. The patient found relief with a trial exposure to a SCS and underwent subsequent implantation in 2014 to control his pain. Ultimately, his RLECNP was well controlled with small gabapentin dose and all opiate medications were discontinued.

Conclusion: This case suggests the need to explore use of SCS in the treatment of neuropathic pain. The novel use of SCS to address this pain after failure of non-interventional modalities would greatly improve patient quality of life.

Short Description: 57 year old male C4-Asia-C with resultant neuropathic pain in his right lower extremity after failing non-interventional modalities for pain relief found relief with novel use of spinal cord stimulator.

Key Words: Neuropathic Pain, Spinal Cord Stimulator, SCS, Cervical Spine, Spasticity Management

KEYNOTE SPEAKER PRESENTATION

“The Role of Prehabilitation and Rehabilitation in High-Quality Cancer Care”



Julie Silver, MD

Julie Silver, MD is an Associate Professor and the Associate Chair for Strategic Initiatives at Harvard Medical School in the Department of Physical Medicine and Rehabilitation. Dr. Silver has written many scientific reports on cancer rehabilitation, prehabilitation and survivorship care that have been published in both oncology and rehabilitation medicine journals including *Cancer*, *Supportive Care in Cancer*, *CA: A Cancer Journal for Clinicians*, *American Journal of Physical Medicine and Rehabilitation* and *Physical Medicine and Rehabilitation*. Dr. Silver is well-known for her ground-breaking work on “impairment driven cancer rehabilitation” which was initially published in the journal *CA: A Cancer Journal for Clinicians*--a high impact factor oncology journal that is published by the American Cancer Society. Impairment-driven cancer rehabilitation was subsequently incorporated into the American Cancer Society's Facts & Figures for the first time in 2015. Dr. Silver developed the STAR Program certification which is an evidence-based and best practices model for cancer rehabilitation care that has been adopted by hundreds of hospitals throughout the United States and featured by the Discovery Channel in the TV show *Innovations*. She is the Survivorship section editor for the journal *Value Based Cancer Care* and is also an award-winning author. Her books include *Before and After Cancer Treatment: Heal Faster, Better, Stronger* (Johns Hopkins Press) and *What Helped Get Me Through: Cancer Survivors Share Wisdom and Hope* (American Cancer Society). She is a founding chair of the American Congress of Rehabilitation Medicine's Cancer Rehabilitation Group. Her work in cancer rehabilitation has been recognized by the American Cancer Society (Lane Adams Quality of Life Award), Massachusetts General Hospital (The One Hundred) and *The Boston Globe* (Top Innovator in Medicine). Dr. Silver is currently affiliated with several Harvard teaching hospitals including Spaulding Rehabilitation, Massachusetts General and Brigham and Women's Hospitals. Her work has been featured in many media outlets including the *New York Times*, *Wall Street Journal*, *Boston Globe*, *LA Times*, *USA Today*, *London Times* and *NPR*.

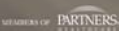
NOTES





Prehabilitation and Rehabilitation in High Quality Cancer Care

Julie K. Silver, MD
Associate Professor and Associate Chair, Harvard Medical School
Department of Physical Medicine & Rehabilitation & Spaulding Rehabilitation Hospital



Disclosures

Founder, Oncology Rehab Partners which has developed the STAR Program® (Survivorship Training and Rehabilitation) certifications for hospitals and cancer centers in the United States that provide a comprehensive model for cancer prehabilitation and rehabilitation.




How many cancer survivors have impairments and should be referred for rehabilitation?

A. Up to 20%
 B. Approx 25-50%
 C. Approx 65-90%






How many cancer survivors have impairments and are referred for rehabilitation?

- A. Less than 10%
- B. Approx 25-50%
- C. Approx 65-90%



Gap in Care

Research shows that *the majority* of cancer patients need rehabilitation medical care, and there are many unmet needs.

Silver JK, Bains J, Mayer RS. Impairment-driven cancer rehabilitation: An essential component of quality care and survivorship. CA Cancer J Clin. 2013 Sep;63(5):295-317.

NIH & Cancer Rehabilitation

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REHABILITATION MEDICINE

[» Cancer Rehabilitation Conference](#)

Clinical Integration Work Group

Save the Date - Cancer Rehabilitation Conference

This conference is being hosted by the Rehabilitation Department of the NIH Clinical Center and is co-sponsored by the National Cancer Institute and the National Center for medical Rehabilitation Research.

When: Monday, June 8 to Tuesday, June 9, 2015

Where: Natcher Auditorium
National Institutes of Health



Cancer Rehabilitation

"Cancer rehabilitation is medical care that should be integrated throughout the oncology care continuum and delivered by trained rehabilitation professionals who have it within their scope of practice to diagnose and treat patients' physical, psychological and cognitive impairments in an effort to maintain or restore function, reduce symptom burden, maximize independence and improve quality of life in this medically complex population."

Silver JK, Raj VS, Fu JB, Wisotzky EM, Smith SR, Kirch RA. Cancer rehabilitation and palliative care: Critical components in the delivery of high-quality oncology services. *Support Care Cancer*. 2015;(23):3633-43.






Cancer Prehabilitation

"Prehabilitation is a process on the cancer continuum of care that occurs between the time of cancer diagnosis and the beginning of acute treatment and includes physical and psychological assessments that establish a baseline functional level, identify impairments, and provide interventions that promote physical and psychological health to reduce the incidence and/or severity of future impairments."

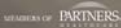
Silver JK, Baima J, Mayer RS. Impairment-driven cancer rehabilitation: an essential component of quality care and survivorship. *CA Cancer J Clin*. 2013;63(5):295-317.








Exercise, Wellness & Impairment-Driven Cancer Rehabilitation



What is the difference between **impairment-driven cancer rehabilitation** and **general exercise** that promotes strength and aerobic fitness?

Apples and oranges are both on the list of things that are good for cancer survivors but eating an apple is not the same as eating an orange. To the educated consumer, these are very different foods.

SPAULDING
REHABILITATION NETWORK

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Impairments in Cancer Survivors

In a study of 163 women with metastatic breast cancer:

1. What percent had impairments?
2. How many total impairments were documented?
3. What percent of women received rehabilitation treatment as outpatients?

Answers:

92% of the women had impairments
530 impairments were documented
<2% of the impairments were treated

Chevillet AL, et al. Prevalence and treatment patterns of physical impairments in patients with metastatic breast cancer. J Clin Onc 2008.

In a study of 529 older adults with cancer:

1. How many of these patients should have been sent for PT/OT for their functional deficits?
2. What percent received PT/OT?

Answers:

341 survivors (65%) had potentially modifiable functional deficits and needed PT/OT
9% received OT/PT

Pergolotti M et al. The prevalence of potentially modifiable functional deficits and the subsequent use of occupational and physical therapy by older adults with cancer. J Geriatr Onc 2015.

Cancer rehabilitation is medical care

SPAULDING
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TEACHING HOSPITAL

Impairment-Driven Cancer Rehabilitation

2013

2014

2015

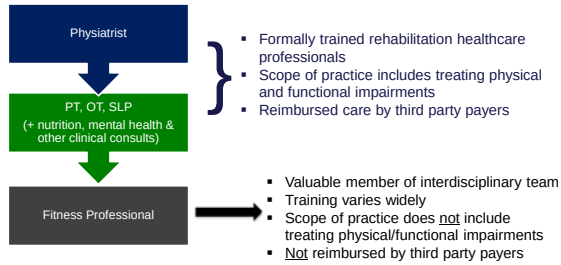
Silver JK, Balma J, Mayer RS (2013) Impairment-driven cancer rehabilitation: An essential component of quality care and survivorship. CA Cancer J Clin 63 (5):296-317.

Parikh RB, Kirch RA, Braxley CW. Advancing a quality-of-life agenda in cancer advocacy. JAMA Oncology (May 21, 2015).

SPAULDING
REHABILITATION NETWORK

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What does a best practices cancer rehabilitation model look like?



Distress, Disability, Financial Toxicity & Quality of Life

Distress & Disability

- Symptom distress predicts long-term health and well-being in allogeneic stem cell transplantation survivors.**
 Berman M¹, Wilson S², Berman L³, Berman M⁴, Chou S⁵, Sauer J⁶, Hunsberger M⁷, Dittus L⁸, Berman M⁹, Berman L¹⁰, Berman M¹¹, Berman L¹²
- Quality of life and physical performance and activity of breast cancer patients after adjuvant treatments.**
 Costantino M¹, Costantino M², Sparano A³, Sparano A⁴, Sparano A⁵, Sparano A⁶, Sparano A⁷, Sparano A⁸, Sparano A⁹, Sparano A¹⁰, Sparano A¹¹, Sparano A¹²
- Is psychological distress in people living with cancer related to the fact of diagnosis, current treatment or level of disability? Findings from a large Australian study.**
 Berman L¹, Berman L², Berman L³, Berman L⁴, Berman L⁵, Berman L⁶, Berman L⁷, Berman L⁸, Berman L⁹, Berman L¹⁰, Berman L¹¹, Berman L¹²
- Mental and physical health-related quality of life among U.S. cancer survivors: population estimates from the 2010 National Health Interview Survey.**
 Berman L¹, Berman L², Berman L³, Berman L⁴, Berman L⁵, Berman L⁶, Berman L⁷, Berman L⁸, Berman L⁹, Berman L¹⁰, Berman L¹¹, Berman L¹²

"...physical symptom distress negatively affected all outcomes..."

"Physical performance and activity level were the only factors that correlated positively to QOL."

"The risk of psychological distress...relates much more strongly to their level of disability..."

Many more cancer survivors had poor QOL due to physical problems than emotional ones.



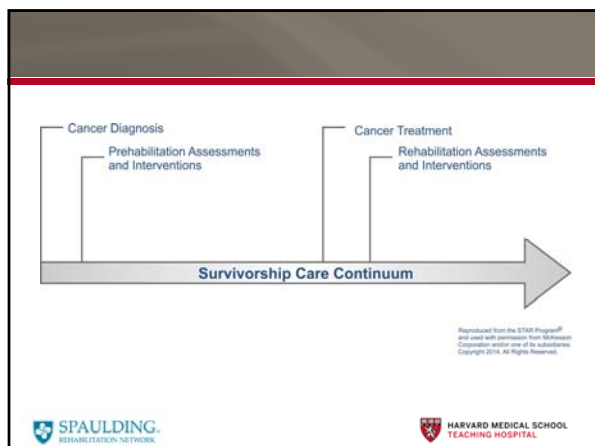
Excellent health-related quality of life outcomes are impossible to achieve if survivors live with unnecessary pain, fatigue and disability. Impairment-driven cancer rehabilitation is the next frontier in survivorship care.

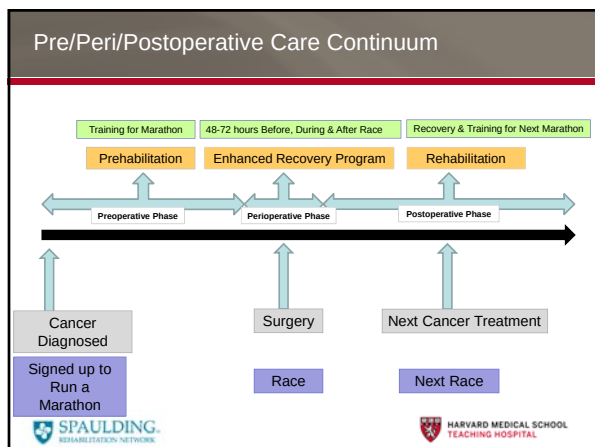


Cancer rehabilitation is not optional

The screenshot shows the American College of Surgeons Cancer Program Accreditation website. It features a navigation menu on the left with items like "Eligibility Requirements", "Program Management", and "About Accreditation". The main content area displays a flowchart for the accreditation process, including "Standard 3.1 Patient Navigation Process", "Standard 3.2 Psychosocial distress Screening", and "Standard 3.3 Survivorship Care Plan". A central box highlights "Eligibility Requirement (E11) Rehabilitation". The bottom of the page includes logos for "SPAULDING REHABILITATION NETWORK" and "HARVARD MEDICAL SCHOOL TEACHING HOSPITAL".

Cancer Prehabilitation





Contents lists available at SciVerse ScienceDirect

Surgical Oncology

journal homepage: www.elsevier.com/locate/suronc

Review

A systematic review of pre-surgical exercise intervention studies with cancer patients

Favil Singh^{a,b,*}, Robert U. Newton^{a,b}, Daniel A. Galvão^a, Nigel Spry^{a,c,d}, Michael K. Baker^{a,b,e,f}

^aEdith Cowan University Health and Wellness Institute, Edith Cowan University, 270 Joondalup Drive, Joondalup, Perth, Western Australia 6027, Australia
^bSchool of Exercise and Health Sciences, Edith Cowan University, 270 Joondalup Drive, Joondalup, Perth, Western Australia 6027, Australia
^cDepartment of Radiation Oncology, Sir Charles Gombert Hospital, Hospital Avenue, Nedlands, Perth, Western Australia 6009, Australia
^dFaculty of Medicine, University of Western Australia, 355 Stirling Highway, Crawley, Perth, Western Australia 6009, Australia
^eAdair Institute, Sydney Medical School, University of Sydney, 50/54 Parramatta Road, Camperdown, New South Wales 2050, Australia
^fSchool of Exercise Science, Australian Catholic University, 254 Barker Road, Donkeyholme, New South Wales 2213, Australia

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 Colorectal

ABSTRACT

Background: Recent reviews suggest that enhancing fitness and functional capacity prior to surgery can accelerate post-surgery recovery and reduce mortality. However, the effect of pre-surgical exercise interventions in cancer patients is not fully explained. The aim of this paper is to systematically review the available literature regarding pre-surgery exercise training intervention in cancer patients and examine their effects on physiological outcomes as well as quality of life (QOL) and length of hospital stay.

Methods: Relevant studies were identified through a search on MEDLINE, PubMed, AMED, MEDLINE Daily Update, CINAHL and SPORTDiscus. All randomised controlled trials (RCTs) and non-RCTs that had some form of physical exercise undertaken prior to surgery were included. Descriptive characteristics such as participant characteristics, study design, type of cancer, length of study and primary outcomes were extracted. Methodological rigour was assessed using a modified Delphi List. Due to the heterogeneity and the dearth of pre-surgical studies, we were limited to a systematic review rather than a meta-analysis.

Results: Eighteen studies were included, consisting of a total of 986 participants. Lung cancer studies were the predominant group represented. Most of the studies prescribed an aerobic intervention program done prior to surgery. Mode, frequency, duration, and intensity of exercise intervention varied across the different cancer groups. The majority of studies showed preliminary positive change in clinical outcomes with significant improvements in the rate of recurrence, functional walking capacity and cardiorespiratory fitness.

Conclusion: Pre-surgical exercise may benefit cancer patients through positive effects on function and physical capacity. Surgical oncologists may consider pre-surgical exercise interventions as a potential adjunct therapy to improve patients' outcomes.

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A Randomized Control Trial in Patients Undergoing Colorectal Resection for Cancer

Chelsea Gillis, R.D., M.Sc., Chao Li, M.D., M.Sc., Lawrence Lee, M.D., M.Sc., Rashmi Awasthi, B.Sc., Berson Augustin, B.Sc., Ann Gamss, Ph.D., A. Sender Liberman, M.D., Barry Stein, M.D., Patrick Charlebois, M.D., Liane S. Feldman, M.D., Francesco Carli, M.D., M.Phil.

ABSTRACT

Background: The preoperative period (prehabilitation) may represent a more appropriate time than the postoperative period to implement an intervention. The impact of prehabilitation on recovery of functional exercise capacity was thus studied in patients undergoing colorectal resection for cancer.

Methods: A parallel-arm single-blind superiority randomized controlled trial was conducted. Seventy-seven patients were randomized to receive either prehabilitation (n = 38) or rehabilitation (n = 39). Both groups received a home-based intervention of moderate aerobic and resistance exercises, nutritional counseling with protein supplementation, and relaxation exercises initiated either 4 weeks before surgery (prehabilitation) or immediately after surgery (rehabilitation), and continued for 8 weeks after surgery. Patients were managed with an enhanced recovery pathway. Primary outcome was functional exercise capacity measured using the validated 6-min walk test.

Results: Median duration of prehabilitation was 24.5 days. While awaiting surgery, functional walking capacity increased (±220 m) in a higher proportion of the prehabilitation group compared with the rehabilitation group (53 vs. 15%, adjusted $P = 0.006$). Complication rates and duration of hospital stay were similar. **The difference between baseline and 8-week 6-min walking test was significantly higher in the prehabilitation compared with the rehabilitation group (+23.7 m [SD, 54.8] vs. -21.9 m [SD, 80.7]; mean difference [95% CI, 13.9 to 77.6]). A higher proportion of the prehabilitation group were also recovered to or above baseline exercise capacity at 8 weeks compared with the rehabilitation group (84 vs. 62%, adjusted $P = 0.049$).**

Conclusions: Meaningful changes in postoperative functional exercise capacity can be achieved with a prehabilitation program. (*JAMA SURGERY* 2014; 121:937-47).

REVIEW ARTICLE

Prehabilitation to Enhance Perioperative Care

Francesco Carli, MD, MSc, FRCA, FRCC^{1,2,3,4}, Celena Scheede-Bergdahl, MSc, PhD^{5,6}

KEYWORDS

- Surgery • Elderly • Cancer • Prehabilitation • Exercise • Nutrition

KEY POINTS

- Despite advances in surgical care, there remain patients with suboptimal recovery: elderly patients, especially those with cancer and limited protein reserve are at highest risk for negative postoperative outcomes.
- Although more traditional approaches have targeted the postoperative period for rehabilitation, it has been shown that the preoperative period is most effective for intervention.
- Surgical prehabilitation is an emerging concept, deriving from the realization that effective perioperative care must include in addition to the clinical and pharmacological optimization of the surgical preparation, preoperative physical, nutritional and psychological optimization.

THE STRESS OF SURGERY AND TRAJECTORY OF RECOVERY

Tissue trauma, physical inactivity, sleep deprivation and psychological distress represent major stresses to the body in turn, immediate systemic changes are initiated.

SPAUDLING REHABILITATION NETWORK HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

Journal of Oncology Navigation & Survivorship- August 2014

AONN+ Annual Navigation and Survivorship Conference Poster Abstract

Prehabilitation Improves the Physical Functioning of a Newly Diagnosed Lung Cancer Patient Before and After Surgery to Allow for a Safe Surgical Resection and Decreased Hospital Length of Stay: A Case Report

Elizabeth Hunt, RN, MSN, CCRN, CCM, Kristen VanderWipe, PT, Bobbi Stokes, PTA, Regina Kenner, RN, Kathryn Dorval, MS, CCC-SLP, Melissa Cordes, RN, BSN, MBA

May Washington Healthcare

Background: Patients diagnosed with cancer often present with decreased functional status because of age, deconditioning, and comorbidities, all factors that may influence overall intervention as a potential treatment option. The Service

Alberta Cancer Survivor

SPAUDLING REHABILITATION NETWORK HARVARD MEDICAL SCHOOL TEACHING HOSPITAL



Does the location of pre/rehabilitation services delivery matter?

Where is my patient getting high quality cancer care?

Within the Oncology/Surgery Department (Onsite)

Within the Rehabilitation Medicine Department (Onsite but different department)

Within the hospital system but not under Oncology or Rehab Med Departments (Onsite but decentralized location)

Community based (Offsite)

The farther the patient is from the oncologist/surgeon, the less control the physician has over care delivery.

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Palliative Care vs. Cancer Rehabilitation Key Differences

Palliative Care	Cancer Rehabilitation
- High symptom burden - Focuses on pain but also nausea and other GI symptoms - Priority is patient and family values that include spiritual issues - Physicians often not trained in procedures including Edx, TPIs, etc.	- May be one symptom or impairment (eg, carpal tunnel syndrome) - Generally not focused on nausea and other GI symptoms - Priority is patient function - Physiatrists trained in procedures including Edx and injections

Silver JK, Raj VS, Fu JB, Wisotzky EM, Smith SR, Kirch RA. Cancer rehabilitation and palliative care: Critical components in the delivery of high-quality oncology services. *Support Care Cancer*. 2015 Aug 28.

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Survivorship Care

Intervention for Treatment Related Side Effects

Palliative Care

Vocational Services

Surveillance of Cancer or Cancer Recurrence

Cancer Rehabilitation

Pastoral/Spiritual Care

Assistance with Medical Insurance & Disability

Psychosocial Services

Complementary & Integrative Services

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What do CAPs Mean?

Old Standard of Care

- Too few patients were referred for cancer rehab treatment with licensed/board certified rehabilitation healthcare professionals.
- Those who were referred often had many, many visits.

New Standard of Care = Accountable Care

- Refer many more patients for cancer rehab for treatment with licensed/board certified rehabilitation healthcare professionals.
- Treat them for fewer visits.



Medical Knowledge

"From the rehabilitation professional perspective, treatment options are continually changing, requiring maintenance of current knowledge for a large array of cancer types, treatments, and level of disability."



Aromatase inhibitors may cause physical impairments in:

- A. Joints
- B. Tendons
- C. Nerves

SCHOOL

How does this tie into CMS?

- Drug-induced tendinopathy is an underestimated problem
- 4 classes of drugs cause problems—recent addition is **aromatase inhibitors (AI)**

(AIs, statins, glucocorticoids and quinolones)

- 50% of patients may have musculoskeletal (MSK) problems
- 20% may discontinue drug due to MSK problems
- 60% of symptoms in the hands and wrists
- 90% or more show periarticular changes on ultrasound
- 50% may have baseline problems that worsen with starting an AI
- 2 months—mean time from treatment initiation to symptom onset or worsening
- Prior chemotherapy, particularly a taxane, increases the risk of MSK problems
- MSK problems include trigger fingers, DeQuervain's tenosynovitis, and tenosynovitis of finger extensors and flexors



Kirchgesner T, Larbi A, Omoumi P, et al. Drug-induced tendinopathy: from physiology to clinical applications. *Joint Bone Spine*. Dec 2014;81(6):485-492.





Case

Bethany is a 53-year-old woman who recently underwent surgery for breast cancer. She is having some problems with her arm and shoulder. She's back at work, but her boss has informed her that he's not happy with how much leave Bethany has taken. According to a study released in Feb 2013 in the journal *Breast*, will her arm problems likely lead to more absences from work?



"Breast and arm symptoms are as strongly associated with being on sick leave as types of breast and/or axillary surgery. Early self-reported symptoms are important to consider in guidelines for sick leave and rehabilitation after breast cancer surgery."

Wennman-Larsen A, et al. Sickness absence in relation to breast and arm symptoms shortly after breast cancer surgery. *Breast*. 2013 Feb 11.



Arch Phys Med Rehabil. 2015 Dec;96(12):2163-8. doi: 10.1016/j.apmr.2015.08.026. Epub 2015 Sep 4.
Discrepant Trajectories of Impairment, Activity, and Participation Related to Upper-Limb Function in Patients With Breast Cancer.

Yang L.J., Knaflitz G., Kim S.H., Lee J.H.

Author information

Abstract

OBJECTIVES: To explore upper limb disability with respect to health outcomes, operationalized by Disabilities of the Arm, Shoulder, and Hand, and to identify factors associated with each element of upper limb disability over a 2-year period in breast cancer survivors.

DESIGN: Prospective cohort study.

SETTING: University hospital cancer center.

PARTICIPANTS: Individuals (N=191) recruited from all the patients with newly diagnosed breast cancer before cancer surgery at a university hospital between April 2006 and March 2007.

INTERVENTIONS: Not applicable.

MAIN OUTCOME MEASURES: We evaluated demographics, social variables, and upper limb disability in a baseline assessment preoperatively. Follow-up evaluations were conducted in outpatient clinics 3 months after surgery and at 12 and 24 months after surgery. Linear regression models with the generalized estimating equations of the compound symmetry covariance structure were used.

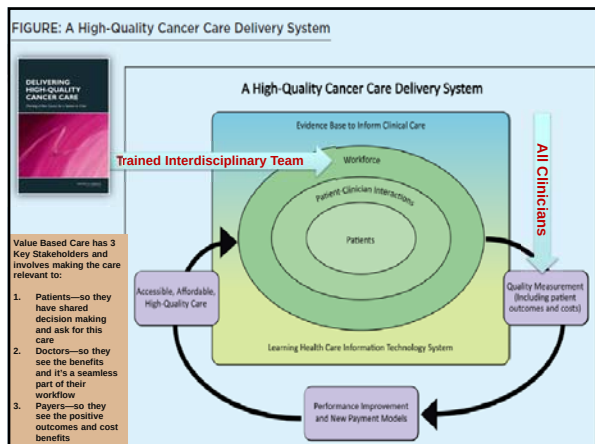
RESULTS: Time since surgery was inversely associated with the impairment items score ($\beta = -20$; 95% confidence interval [CI], -49 to -9) and positively associated with the activity limitation items score ($\beta = 59$; 95% CI, 29-88). The impact of upper limb disability preoperatively on the items involving both the activity limitation and participation restriction scores was positive ($\beta = 2.89$; 95% CI, 1.6-5.0) after adjusting for demographic, treatment type, and socioeconomic factors.

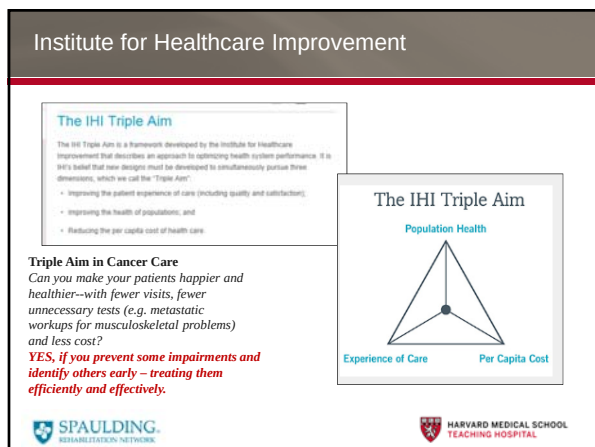
CONCLUSIONS: Our study revealed that upper limb impairment recovered with time after breast cancer surgery; however, upper limb function-related activity and participation were reduced through 2 years after surgery.

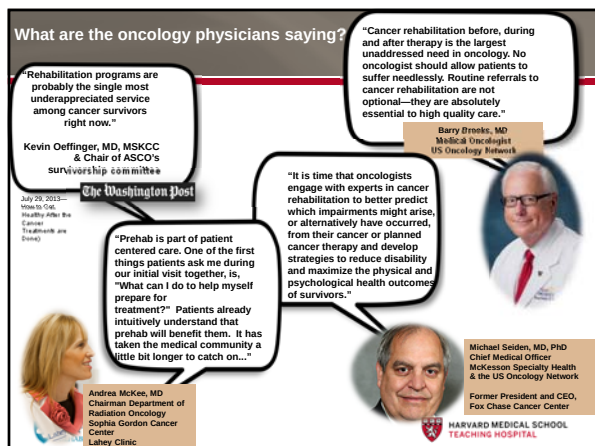
DASH increased at 3 & 12 months after surgery and then decreased (but were still above baseline) at 2 years. However, although the impairments improved, activity and participation restriction scores (functional limitations) didn't. Why do you think this is so?











Impairment driven cancer rehabilitation is the next frontier in survivorship care.



Next on the Horizon

1. More and better studies on cancer rehab
2. More sophisticated understanding by oncology healthcare professionals of the difference between general exercise vs therapeutic exercise to treat impairments
3. Huge increases in survivors demanding cancer rehab
4. Huge increases in oncologists wanting rehab care of their patients (high-quality cancer care)
5. Hospitals and cancer centers being held accountable for cancer rehab care—including demonstrating appropriate screening, tracking of referrals to rehab (what is the gap in care compared to new cancer cases), and physical/psychological outcomes
6. More inclusion of primary care providers, nurse navigators, mental health professionals & others
7. Better reimbursement
8. Cancer rehab is part of bundles
9. Rehab is not optional—it's a standard part of high-quality cancer care



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REHABILITATION MEDICINE

Save the Date - Cancer Rehabilitation Conference

This conference is being hosted by the Rehabilitation Department of the NIH Clinical Center and is co-sponsored by the National Cancer Institute and the National Center for medical Rehabilitation Research.

When: Monday, June 8 to Tuesday, June 9, 2015

Where: Natcher Auditorium
National Institutes of Health

Who Should Attend: Representatives from cancer advocacy interest in cancer and rehabilitation, health care policy leaders with researchers and organizations that use survivorship, patients and other public and medical health care entities concerned

The National Institutes of Health is excited to announce a roundtable discussion with other nationally recognized experts regarding cancer rehabilitation practice models. The conference will present current practice models in cancer rehabilitation, identify screening and usage models and clinical measurement tools and discuss clinical integration of rehabilitation services into the oncology

Email:
julie_silver@hms.harvard.edu



A Cancer Journal for Clinicians

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ARTICLE TITLE: Impairment-Driven Cancer Rehabilitation: An Essential Component of Quality Care and Survivorship

CME CNE

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EDUCATIONAL OBJECTIVES:

After reading the article "Impairment-Driven Cancer Rehabilitation: An Essential Component of Quality Care and Survivorship," the learner should be able to:

1. Describe the most common physical impairments that occur as a result of cancer and/or its treatment.
2. Review evidence regarding the outcomes of rehabilitation interventions for cancer survivors before, during, and after treatment.

ACTIVITY DISCLOSURES

No commercial support has been accepted related to the development or publication of this activity.

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AUTHOR DISCLOSURES

Julie K. Silver, MD, is the cofounder of Oncology Rehab Partners, LLC, which developed the STAR Program (Survivorship Training and Rehabilitation).

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Impairment-Driven Cancer Rehabilitation: An Essential Component of Quality Care and Survivorship

Julie K. Silver, MD¹; Jennifer Baima, MD²; R. Samuel Mayer, MD³

Adult cancer survivors suffer an extremely diverse and complex set of impairments, affecting virtually every organ system. Both physical and psychological impairments may contribute to a decreased health-related quality of life and should be identified throughout the care continuum. Recent evidence suggests that more cancer survivors have a reduced health-related quality of life as a result of physical impairments than due to psychological ones. Research has also demonstrated that the majority of cancer survivors will have significant impairments and that these often go undetected and/or untreated, and consequently may result in disability. Furthermore, physical disability is a leading cause of distress in this population. The scientific literature has shown that rehabilitation improves pain, function, and quality of life in cancer survivors. In fact, rehabilitation efforts can ameliorate physical (including cognitive) impairments at every stage along the course of treatment. This includes prehabilitation before cancer treatment commences and multimodal interdisciplinary rehabilitation during and after acute cancer treatment. Rehabilitation appears to be cost-effective and may reduce both direct and indirect health care costs, thereby reducing the enormous financial burden of cancer. Therefore, it is critical that survivors are screened for both psychological and physical impairments and then referred appropriately to trained rehabilitation health care professionals. This review suggests an impairment-driven cancer rehabilitation model that includes screening and treating impairments all along the care continuum in order to minimize disability and maximize quality of life. *CA Cancer J Clin* 2013;63:295-317. ©2013 American Cancer Society.

Keywords: cancer rehabilitation, prehabilitation, physiatry, physical therapy, occupational therapy, speech therapy, survivorship, disability, impairment, impairment-driven, long-term effects, side effects



CME

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Introduction

Cancer is one of the most prevalent, disabling, and costly health care conditions affecting people living in the United States and other developed countries. More than 40% of those born today will develop some type of cancer during their lifetime.¹ Due to advances in diagnosis, treatment, and supportive care for cancer, the 5-year relative survival rate for all cancers diagnosed has increased from 49% (1975-1977) to 67% (2001-2007).² The majority (64%) of cancer survivors were diagnosed five or more years ago. Siegel et al projected the number of cancer survivors in the United States will increase from 13.6 million to 18 million by 2022.³ However, the survival rates alone do not reflect the significant burden of treatment toxicity. Oncologists have

the dual concern of increasing survival rates while simultaneously trying to decrease treatment toxicity. Therefore, identifying and addressing treatment-induced physical impairments that can lead to considerable disability is an important part of cancer care.

The cost of cancer is enormous. In 2011, Mariotto et al reported that health care costs for approximately 13.8 million cancer survivors was estimated to be \$124.57 billion and, based on current growing incidence and improved survival rates, the number of cancer survivors in the United States will increase by 2020 to at least 18.1 million, generating an annual cost of \$157.77 billion that year.⁴ It is difficult to quantify the indirect costs of cancer survivorship in the United States (eg, lost wages, caregiver burdens,

¹Associate Professor, Department of Physical Medicine and Rehabilitation, Harvard Medical School, Boston, MA; ²Clinical Instructor, Harvard Medical School, Staff Physiatrist, Brigham and Women's Hospital, Chestnut Hill, MA; ³Associate Professor and Vice Chair for Education, Department of Physical Medicine and Rehabilitation, Johns Hopkins University School of Medicine, Baltimore, MD.

Corresponding author: Julie K. Silver, MD, Department of Physical Medicine and Rehabilitation, Harvard Medical School, Harvard Health Publications, Countway Library, 2nd Fl, 10 Shattuck St, Boston, MA 02115; julie_silver@hms.harvard.edu

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DISCLOSURES: Dr. Silver is the cofounder of Oncology Rehab Partners, LLC, which developed the STAR Program (Survivorship Training and Rehabilitation).

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transportation, and adaptive equipment), although they are obviously enormous. Other countries, however, have attempted to quantify these costs. Polish health economists have estimated that work loss due to cancer accounts for 0.8% of its gross domestic product.⁵ If the United States had a similar work loss due to cancer (with a gross domestic product of approximately \$15 trillion), the equivalent cost would be \$120 billion. Although it is challenging to estimate the profound direct and indirect health care costs of cancer and its sequelae, 2 recent systematic reviews suggested that cancer rehabilitation is cost-effective.^{6,7} In addition, a 2013 Scandinavian study reported that of the approximately 1100 participants who were consecutively recruited an average of 11 months after diagnosis and assessed at the beginning and end of rehabilitation, 76% returned to work within a mean of 6 weeks.⁸

An important study published in 2012 compared the health-related quality of life (HRQOL) in cancer survivors with that of others.⁹ Cancer survivors reported a much worse HRQOL for both physical and emotional health compared with population norms. Weaver et al⁹ assessed HRQOL in 1822 adults with a history of cancer and 24,804 individuals who had never been diagnosed with cancer. Poor physical health was reported by 24.5% of cancer survivors but by only 10.2% of those without a history of cancer. Poor mental health was reported by 10.1% of cancer survivors compared with 5.9% of adults without a cancer diagnosis. When extrapolated, this study suggests that 3.3 million cancer survivors in the United States may have poor physical health and 1.4 million may have poor mental health.

This study demonstrated that cancer survivors' HRQOL is more often influenced by physical issues than emotional problems. Approximately 1 of 4 cancer survivors reported poor physical health whereas only 1 of 10 reported poor mental health. Although the physical and emotional components were reported distinctly in this study, in reality there is considerable overlap and influence of one upon the other.

Evidence suggests that patients, in fact, have many unmet needs.¹⁰ For example, Cheville et al found that in 163 women with metastatic breast cancer, 92% had at least one physical impairment, with a total of 530 impairments identified overall; 484 of these impairments (91%) required a physical rehabilitation intervention and 469 (88%) required physical and/or occupational therapy.¹¹ Despite more than 90% of the participants needing cancer rehabilitation services, fewer than 30% received this care. With the exception of lymphedema, less than 2% of the impairments that were not detected during hospitalization and required physical or occupational therapy received treatment. Thorsen et al evaluated 1325 survivors of the 10 most prevalent cancers and found that 63% reported the need for at least one rehabilitation service, with physical therapy being the most frequently reported need (43%).¹²

They also reported that patients were often not referred for services; 40% of the participants reported unmet rehabilitation needs. A study by Schmitz et al found that at least 60% of breast cancer survivors had one or more treatment-related impairments at each checkpoint over a 6-year follow-up period.¹³ Cheville et al evaluated the detection and treatment of functional problems in cancer survivors and concluded that "Functional problems are prevalent among outpatients with cancer and are rarely documented by oncology clinicians."¹⁴

A leading cause or perhaps even *the* leading cause of emotional distress in cancer survivors is physical disability. Banks et al investigated distress in cancer survivors and found that the major cause was disability.¹⁵ They concluded, "The risk of psychological distress in individuals with cancer relates much more strongly to their level of disability than it does to the cancer diagnosis itself."¹⁵ Ponto et al observed that, in women living with ovarian cancer, a predictor of distress was poor performance status.¹⁶ A study of 112 Jordanian patients receiving chemotherapy found that lower scores in emotional and physical functioning were associated with higher reports of distress.¹⁷ In fact, the link between physical and psychological function is becoming so important that, in a recent study of screening in an inpatient setting, researchers advised, "...routinely screening for psychological and physical distress should become a first step in the assessment of the biopsychosocial needs of people receiving inpatient treatment for cancer."¹⁸

There is a need to better understand and clarify the field of cancer rehabilitation, including the selection of appropriate screening for impairments and subsequent disability as well as the identification of health care professionals who are qualified to treat patients for their rehabilitation needs. Rehabilitation health care professionals should be focused on functional outcomes that include activities of daily living (eg, dressing or bathing). However, effectively completing activities of daily living indicates a very low level of function and most cancer survivors accomplish them without any problems. Other functional outcomes that include instrumental activities of daily living, such as performing household chores or going to the grocery store to get food, should also be evaluated. However, even focusing on instrumental activities of daily living is not enough as functional problems may be subtle, but cause significant disability and reduced QOL. For example, rehabilitation professionals who treat patients with head and neck cancer know that subtle swallowing impairments may lead to significant functional problems and subsequent disability for many individuals.¹⁹ Consider the head and neck cancer survivor who continues to have subtle swallowing issues and wants to return to work but has no privacy during lunch to eat without being observed. He may elect to stay on disability rather than risk embarrassment or, even worse, choking or aspirating when rushing through lunch even though his

TABLE 1. Examples of Functional Assessment Tools^a**General performance**

Functional Independence Measure (FIM)

Short-Form 36 (SF-36)

Karnofsky Performance Status Scale

Eastern Cooperative Oncology Group (ECOG)

National Institutes of Health Rehabilitation Medicine Department
Performance Scale (NIH-RMDPS)**Mobility/balance**

Timed Up and Go (TUG) Test

6-Minute Walk Test

Tinetti Balance and Gait Assessment Tools

Pain

Visual analog scales

Brief Pain Inventory

Fatigue

Visual analog scales

Piper Fatigue Scale

Functional Assessment of Chronic Illness Therapy-Fatigue Scale (FACIT-F)

Distress

Distress Thermometer

Hospital Anxiety and Depression Scale

^aThis is not intended to be a complete list.

family needs his former income and he can perform all functions of his job.

It is important to: 1) focus on screening for physical impairments (from mild to severe) as they need to be identified and treated to improve survivors' physical and psychological outcomes (Table 1); and 2) refer cancer survivors who have problems amenable to rehabilitation interventions to the appropriate health care professionals who have the expertise to evaluate and treat their physical impairments and maximize functional status (Fig. 1). It takes years of training in rehabilitation medicine to appropriately evaluate and treat this diverse and medically complicated patient population; therefore, rehabilitation interventions to treat physical impairments should be performed only by health care professionals who are trained in rehabilitation. Physiatrists should ideally be part of the cancer care team and would be instrumental in diagnostic evaluations as well as provide unique expertise in prescribing pain medications to treat nonmalignant conditions that are a result of cancer treatments, perform injections, and prescribe appropriate splints and other devices. A physiatrist, a specialist in the nonoperative treatment of musculoskeletal problems, might serve as the attending physician on the inpatient rehabilitation unit.

Fitness professionals are an important part of the rehabilitation team as well; however, as they are not trained to treat physical impairments, their scope of practice is limited to providing general exercise recommendations. Patients should only be triaged for general exercise instruction after they have been screened and treated for impairments by trained rehabilitation professionals. Safety is a significant concern in this medically complex population, and lack of appropriate screening or treatment may result in further injury or other medical complications.²⁰⁻²²

The following 3 examples highlight the value of screening for and treating physical impairments in a best practices cancer rehabilitation model of care as well as demonstrate the relationship between cancer treatment-related impairments and disability. Because driving is a critical factor in many cancer survivors' lives, enabling them to be independent and functional in the community and at work and avoid significant disability, driving will be the impairment of focus in each example.^{23,24} This functional outcome (ie, driving) will remain static while the diagnosis, impairment, and disability vary depending on the case.

The first case is a young man with an osteosarcoma and a right-sided below-the-knee amputation who was unable to drive. Interdisciplinary rehabilitation interventions included medications (physiatrist), a prosthesis (prosthetist), gait training and therapeutic exercise (physical therapist), and a driving evaluation with adaptive equipment recommendations including a left accelerator pedal (occupational therapist). While this patient's impairment was unchanged (amputation), his level of disability significantly improved. The second case is a middle-aged man who had head and neck cancer and had stopped driving during treatment. Discontinuation of driving during treatment is a relatively common occurrence in this population.^{25,26} Loss of cervical range of motion, an impairment, made driving unsafe. Care included physiatry (medications to decrease pain and muscle spasms), physical therapy (soft-tissue mobilization and therapeutic exercise), and occupational therapy (adaptive equipment including larger mirrors and sensors that were activated when backing up or changing lanes). This patient's impairment improved but never returned to his premorbid baseline; however, his driving disability resolved. A third case involves a middle-aged woman treated for breast cancer who subsequently developed lymphedema and pain with paresthesias in her hand on the affected side while driving for more than a few minutes. Rehabilitation interventions included physiatry (nerve conduction studies indicated median nerve compression at the wrist for which surgical decompression was recommended), physical therapy (reduction of lymphatic congestion both preoperatively and postoperatively), and occupational therapy (custom hand splint and adaptive equipment including voice-activated computer software that would allow her to send emails without using the keyboard

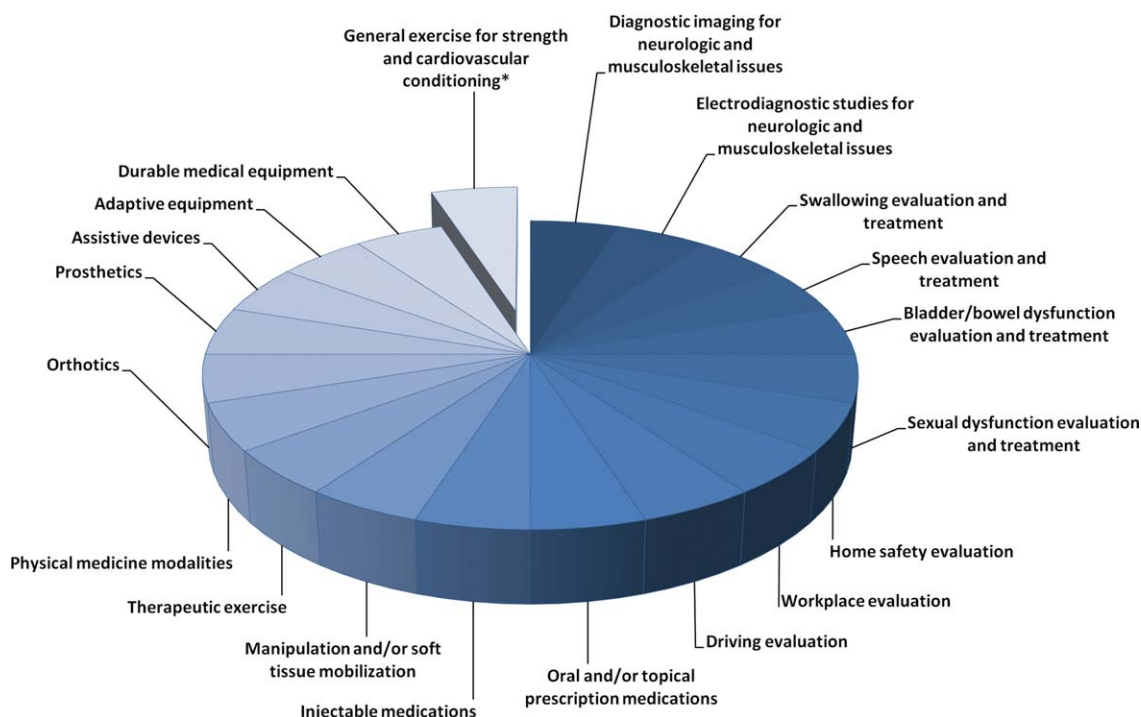


FIGURE 1. Rehabilitation Interventions Focused on Improving Physical Health and Decreasing Disability. Psychosocial, nutrition, and integrative therapies were not included. *This is the only intervention that is not typically reimbursable by third party payors in the United States.

while healing). Her driving disability was completely resolved, and she was able to return to work.

Impairments and disability are related, but not the same. Mild impairments may cause significant disability and, conversely, rather severe impairments may only cause minor disability. Therefore, in order to alleviate disability, it is important to screen for impairments and then determine how they are related to current function. The prospective surveillance model has been suggested for breast cancer survivors and is focused on the early identification and treatment of physical impairments in this population.²⁷ Unfortunately, a significant barrier that contributes to patients not being triaged appropriately for rehabilitation medicine services is a lack of understanding about and/or implementation of screening questions, tools, and procedures that help to identify physical impairments in survivors. Psychological screening (distress screening) is an important part of cancer care as well. In fact, every facility that provides cancer care should be implementing screening procedures for both physical and psychological impairments. While this review is primarily focused on screening for and treating physical impairments, both are of paramount importance and influence each other for better or worse. Therefore, a recommended rehabilitation approach is to focus on impairment-driven cancer rehabilitation, which should include screening for and treating psychological and physical impairments simultaneously. Table 2 highlights some of the different strategies included in this approach that might be deployed by an interdisciplinary rehabilitation team.

The prospective surveillance model, recently described for a female breast cancer population in a supplement to the journal *Cancer*, has much to offer in the early identification of impairments and is complementary to impairment-driven cancer rehabilitation care.²⁸ In the prospective surveillance model, the focus is on surveillance at various junctures throughout the care continuum and into long-term survivorship with the goal of the early identification of impairments followed by appropriate referrals to rehabilitation professionals. In this model, there is the theoretical risk of overdiagnosing impairments in cancer survivors that may not affect their ability to function or QOL. While this is a concern, the practical reality today is one of underdiagnosis and an all-too-common scenario in which cancer survivors are left to their own devices to either “accept a new normal” or to self-identify impairments that are causing them considerable pain, functional loss, disability, and reduced QOL to their health care providers. Diagnosing malignancies often follows a similar pattern in that screening tests may detect cancers at an earlier stage than when patients present with a self-identified “lump” or other symptom. Impairments that may be relatively easily addressed by rehabilitation interventions if detected early can become very difficult to treat if they have progressed over weeks, months, or years. If both the diagnosis of the initial malignancy and the subsequent treatment-related impairments are allowed to progress to the point where the patient self-identifies the condition, the diagnosis is likely to be at a more advanced stage and may require more

TABLE 2. Common Interdisciplinary Rehabilitation Team Strategies

SERVICE	PURPOSE	EXAMPLES
Diagnostic imaging	Diagnose etiology of impairment	MRI for diagnosis of adhesive capsulitis or “frozen shoulder” in a patient with breast cancer
Electrodiagnosis	Diagnosis of neuropathy or myopathy	Diagnose long thoracic nerve palsy or “winging scapula” in a patient with lung cancer
Cardiovascular conditioning	Mitigate fatigue	Treat postchemotherapy fatigue
Therapeutic exercise	Address specific muscle imbalances	Address shoulder dysfunction in a patient with head and neck cancer
Manipulation and soft-tissue mobilization	Improve range of motion	Address sequelae associated with radiation fibrosis syndrome
Thermal and electrical modalities	Control pain	TENS for neuropathic pain
Oral and topical analgesics	Control pain	Lidocaine patch for postthoracotomy pain
Injections and implantable pumps	Control pain	Phenol injection of splanchnic nerve for pancreatic cancer pain
Swallowing evaluation	Identify and improve swallowing impairments and avoid or reduce aspiration	Recommend dietary modifications in a patient with laryngeal cancer
Speech evaluation	Identify and improve speech and language impairments	Improve speech in a patient with brain metastasis in the left hemisphere
Assistive devices	Enhance function	Prescribe a reacher for a patient with loss of lumbar motion from metastasis
Orthotics	Compensate for weakness or limited range of motion to improve ambulation and avoid falls	Prescribe an ankle-foot orthosis for a patient with foot drop from neuropathy
Prosthetics	Replace amputated limb	Prescribe prosthesis for a patient with osteosarcoma of the radius
Home evaluation	Assess and improve safety of home environment	Assess functional mobility in the home, including stairs, for a patient with fixation after metastasis to femur
Work evaluation	Evaluate and improve ability to perform essential job functions	Facilitate return to work after resection for a brain tumor
Driving evaluation	Assess and improve safe driving	Recommend adaptive equipment such as larger mirrors and sensors for a patient with head and neck cancer with limited cervical range of motion
Mental health counseling	Evaluate and improve psychological well-being	Recommend specific coping strategies for decreasing anxiety around returning to work
Neuropsychological testing	Evaluate cognitive deficits in “chemo brain”	Recommend rehabilitation interventions that focus on adaptive strategies to improve memory and concentration as well as functional organization in daily life

MRI indicates magnetic resonance imaging; TENS, transcutaneous electrical nerve stimulation.

medical services with perhaps a worse outcome. Notably, the anticipated outcome with impairments that were not addressed early would likely be increased morbidity, whereas the anticipated outcome with cancer that is not addressed early may be increased morbidity and/or mortality. While a recent review of studies on the cost-effectiveness of cancer rehabilitation was positive, there is a lack of data to date on the financial benefits of the prospective surveillance model.⁶

While rehabilitation in its totality encompasses much more than physical impairments, without a clear and concise focus on identifying and treating physical impairments (including cognitive dysfunction) in cancer survivors, there is little hope of improving their care. The contention,

supported in the literature cited previously,¹⁴ is that if health care professionals focused on routinely screening patients with cancer for physical impairments, in addition to distress and other issues, and then referred appropriately to trained rehabilitation professionals, significant improvement in function, reduced disability, lower direct and indirect healthcare costs, and increased physical and psychological HRQOL would result (Table 1) (Fig. 1).²⁹ Therefore, this review is written from the standpoint of impairment-driven cancer rehabilitation. Admittedly, the rehabilitation literature often does not make the distinction between physical and psychological health outcomes clear, but where distinction does exist, attempts were made to highlight it.

Identifying Physical Impairments in Patients With Cancer

Table 3 lists the myriad impairments that may occur in patients with cancer, impacting virtually every organ system, and Table 1 lists some examples of validated tools that may be used to identify physical impairments in this population. These impairments can be due to tumor compression, treatment side effects, or paraneoplastic phenomena. While they can be sudden, catastrophic events such as spinal cord compression, Cheville et al noted that in patients with metastatic breast cancer, disablement is more frequently “driven by the accrual of multiple physical impairments, adverse symptoms, and their interactions rather than by discrete and functionally catastrophic impairments.”³⁰ In order to limit the scope of this review, several common impairments will be presented as examples. This article focuses on rehabilitation interventions; the reader should refer to specific treatment guidelines for the medical and surgical management of these conditions.

Pain

Most cancer patients experience pain during the course of their illness, often debilitating pain.³¹ Pain is also one of the most common issues that cancer rehabilitation health care professionals routinely address. It is estimated that 30% to 50% of patients undergoing acute cancer treatment will experience pain and up to 70% of those with metastatic disease will have pain.³²

Chronic pain in cancer survivors is relatively common as well. Postmastectomy, postamputation, and postthoracotomy pain syndromes have all been described previously. The prevalence of chronic postmastectomy and postthoracotomy pain may be as high as 50%.³³⁻³⁵ In another recent study, researchers found that approximately 2 of 3 women undergoing surgery for breast cancer developed pain.³⁶ Other studies of chronic pain in patients undergoing limb amputation and thoracotomy report incidences of up to 70% to 80%.³⁷ Head and neck cancer survivors have a reported incidence of chronic pain of approximately 50%.³⁸⁻⁴⁰

In a Danish study, researchers evaluated more than 3000 female breast cancer survivors who were on average just over 2 years after surgery.³³ This study found that approximately 50% of the women reported pain. Of the women who complained of pain, 20% had contacted a physician within the past 3 months for reports of pain in the surgical area, despite having had the surgery on average more than 2 years earlier. Interestingly, in this study, women were more likely to report persistent pain if they were younger (aged younger than 40 years), had received radiation treatment, had undergone an axillary lymph node dissection rather than a sentinel lymph node biopsy, or had experienced pain in other parts of their body as well.

Barriers to managing pain have been described in the literature, and chronic pain is such a significant issue in

cancer survivors that physicians at The University of Texas M. D. Anderson Cancer Center in Houston suggested, “Promotion of wellness behaviors and the use of physical therapy and physical medicine techniques early in cancer recovery may help to diminish the intensity and incidence of chronic pain in long-term survivors. For example, perhaps all mastectomy or radical neck dissection patients should be put through a course of physical therapy as a part of routine care.”^{37,41}

Pain affects QOL in cancer survivors and may be due to the malignancy itself, side effects or aftereffects of the treatment, or other unrelated comorbidities.⁴² Fear of pain may be the cause of functional limitations rather than the pain itself, and in a study comparing patients with advanced cancer with those with chronic noncancer pain, the fear of pain predicted limitations in function only in those patients with advanced cancer.⁴³ Pain severity correlates closely with function, and in a study of Chinese patients with cancer, those with more severe pain had poorer function while those with mild, well-controlled pain functioned similarly to individuals without pain.⁴⁴ Thus, it is critical to identify the pain generator(s) as specific interventions can frequently ameliorate pain, sometimes without medications. It is also important to note that pain often occurs in “clusters,” with other symptoms such as sleep or mood disturbance.⁴⁵ Table 4 lists some common examples and associated characteristics of cancer treatment-related pain.

Fatigue

Cancer-related fatigue (CRF) is defined as an “overwhelming and sustained exhaustion and decreased capacity for physical and mental work...not relieved by rest.”⁴⁶ In addition, fatigue has been shown to impact negatively one’s economic, social, and emotional status.^{47,48} Furthermore, CRF is correlated with treatment intensity and can last well past the completion of treatment.⁴⁹ As many as 75% of patients with cancer have CRF and the likelihood of developing fatigue is increased with any cancer-related treatment and is also more likely to occur with comorbidities (eg, hepatic, cardiac, renal, and pulmonary) and other conditions (eg, insomnia, inactivity, chronic pain, and mood disorders).^{50,51} Fatigue often persists beyond the treatment period.⁵²

It has been shown that improving quality of sleep is helpful, but increasing the amount of “rest” is not effective in reducing the symptoms of CRF.⁵³ Careful attention to comorbidities and their treatment will reduce CRF. Treatment of depression and chronic pain has also been shown to improve symptoms.⁵⁴ Exercise has been shown to mitigate fatigue and this is even true while patients are receiving active treatment of their cancer.⁵⁵⁻⁵⁷

Neurologic Impairments

A wide variety of impairments of nervous system function may result from cancer, either by direct effect at the primary

TABLE 3. Common Impairments in Cancer Patients^a

IMPAIRMENT CATEGORY	REASON TO REFER TO REHABILITATION	CANCER DIAGNOSIS											
		LUNG	BREAST	PROSTATE	COLORECTAL	CNS	HEAD/NECK	MELANOMA	LYMPHOMA	OSTEOSARCOMA	OVARIAN	TESTICULAR	ADVANCED
General physical	Difficulty returning to premonibid activities	■	■	■	■	■	■	■	■	■	■	■	■
	Fatigue	■	■	■	■	■	■	■	■	■	■	■	■
	Joint pain, diffuse (eg, arthralgias)	■	■	■	■	■	■	■	■	■	■	■	■
	Musculoskeletal pain (eg, myalgias, myofascial pain)	■	■	■	■	■	■	■	■	■	■	■	■
	Neuropathic pain	■	■	■	■	■	■	■	■	■	■	■	■
	Somatic pain	■	■	■	■	■	■	■	■	■	■	■	■
	Visceral pain	■	■	■	■	■	■	■	■	■	■	■	■
	Weakness	■	■	■	■	■	■	■	■	■	■	■	■
	Deconditioning ^b	■	■	■	■	■	■	■	■	■	■	■	■
	Autonomic dysfunction	■	■	■	■	■	■	■	■	■	■	■	■
Specific physical	Back pain	■	■	■	■	■	■	■	■	■	■	■	■
	Balance dysfunction	■	■	■	■	■	■	■	■	■	■	■	■
	Bowel dysfunction	■	■	■	■	■	■	■	■	■	■	■	■
	Cervical range-of-motion limitations	■	■	■	■	■	■	■	■	■	■	■	■
	Chemotherapy-induced peripheral neuropathy	■	■	■	■	■	■	■	■	■	■	■	■
	Chest/thoracic pain	■	■	■	■	■	■	■	■	■	■	■	■
	Cognitive impairment	■	■	■	■	■	■	■	■	■	■	■	■
	Compression neuropathy	■	■	■	■	■	■	■	■	■	■	■	■
	Dystonia	■	■	■	■	■	■	■	■	■	■	■	■
	Gait dysfunction	■	■	■	■	■	■	■	■	■	■	■	■
	Graft-versus-host disease	■	■	■	■	■	■	■	■	■	■	■	■
	Headaches	■	■	■	■	■	■	■	■	■	■	■	■
	History of falls	■	■	■	■	■	■	■	■	■	■	■	■
	Jaw excursion, limited	■	■	■	■	■	■	■	■	■	■	■	■
	Joint pain, localized	■	■	■	■	■	■	■	■	■	■	■	■
	Joint range-of-motion limitations	■	■	■	■	■	■	■	■	■	■	■	■

TABLE 3. (Continued)

IMPAIRMENT CATEGORY	REASON TO REFER TO REHABILITATION	CANCER DIAGNOSIS											
		LUNG	BREAST	PROSTATE	COLORECTAL	CNS	HEAD/NECK	MELANOMA	LYMPHOMA	OSTEOSARCOMA	OVARIAN	TESTICULAR	ADVANCED
	Lumbosacral plexopathy			■	■			■	■		■	■	■
	Lymphedema		■	■	■		■	■	■		■	■	■
	Muscular asymmetry	■	■	■	■	■	■	■	■	■	■	■	■
	Neck pain		■				■						■
	Osteopenia/osteoporosis	■	■	■	■	■	■	■	■	■	■	■	■
	Paralysis					■							■
	Plexopathy		■				■	■	■				■
	Radiation fibrosis syndrome	■	■	■	■	■	■	■	■	■	■	■	■
	Radiculopathy						■		■				■
	Scapular winging		■			■	■		■				■
	Scar adhesions	■	■	■	■	■	■	■	■	■	■	■	■
	Sensory deficits	■	■	■	■	■	■	■	■	■	■	■	■
	Sexual dysfunction	■	■	■	■	■	■	■	■	■	■	■	■
	Shoulder pain		■			■	■		■		■		■
	Speech impairment					■	■						■
	Swallowing impairment					■	■						■
	Trismus						■						■
	Urinary dysfunction			■	■	■			■		■	■	■
	Visuospatial and/or proprioception dysfunction	■	■	■	■	■	■	■	■	■	■	■	■
Psychosocial Functional	Psychosocial dysfunction	■	■	■	■	■	■	■	■	■	■	■	■
	Difficulty with ADLs (dressing/ bathing, etc)	■	■	■	■	■	■	■	■	■	■	■	■
	Difficulty with IADLs (chores/ shopping, etc)	■	■	■	■	■	■	■	■	■	■	■	■
	Orthotics					■							■
	Prosthetics									■			■
	Assistive devices (cane, reacher, etc)	■	■	■	■	■	■	■	■	■	■	■	■

TABLE 3. (Continued)

IMPAIRMENT CATEGORY	REASON TO REFER TO REHABILITATION	CANCER DIAGNOSIS											
		LUNG	BREAST	PROSTATE	COLORECTAL	CNS	HEAD/NECK	MELANOMA	LYMPHOMA	OSTEOSARCOMA	OVARIAN	TESTICULAR	ADVANCED
	Adaptive equipment needs	■	■	■	■	■	■	■	■	■	■	■	■
	Durable medical equipment needs	■	■	■	■	■	■	■	■	■	■	■	■
	Home safety evaluation	■	■	■	■	■	■	■	■	■	■	■	■
	Workplace evaluation	■	■	■	■	■	■	■	■	■	■	■	■
	Driving evaluation	■	■	■	■	■	■	■	■	■	■	■	■

ADLs indicates activities of daily living; CNS, central nervous system; IADLs, instrumental activities of daily living.

^aThis is not meant to be a comprehensive list of cancer diagnoses or impairments.

^bIn need of instruction about a safe and therapeutic exercise program.

Modified from the “When to Refer to Rehab” template with permission from Oncology Rehab Partners, LLC, Northborough, Massachusetts.

or metastatic tumor site or secondarily as a consequence of surgery, chemotherapy, or radiation treatments. Neurologic impairments, regardless of whether they are due to the malignancy or the cancer treatment, may significantly impact the individual's physical, social, vocational, and emotional capabilities. Rehabilitation strategies need to factor in progressive, sometimes rapid, functional decline; the toxic effects of cancer treatments; tumor recurrence; CRF; medical fragility; and the psychological and family issues associated with an often terminal disease. The interdisciplinary rehabilitation team is best equipped to handle the complexities of restorative care in these situations, and meet the patient's and family's goals of maximizing functional recovery and preserving QOL.

Chemotherapy-induced peripheral neuropathy, a possible side effect of some chemotherapy drugs, is the most prevalent neurologic complication of cancer.⁵⁸ It is estimated that peripheral neuropathy may develop in 50% to 60% of patients treated with taxanes and can result from paraneoplastic phenomena as well.^{59,60} Neuropathy symptoms may be subtle and functional losses in sensation, proprioception, and motor function can accrue almost imperceptibly over time. For example, Wampler et al screened patients with breast cancer after treatment with taxanes and found significant postural instability.⁶¹ Interventions include balance training, an emphasis on using visual compensation for proprioception, and orthotics. Patients need education about foot care and environmental hazards such as throw rugs.

The term "chemo brain" refers to a patient's report of mild cognitive impairment (MCI) during or following chemotherapy. Although this term is widely used by patients, it is somewhat controversial in the medical literature as not all experts agree on the use of the term, the etiology of the symptoms, and/or whether this is a legitimate diagnosis.^{62,63} Many chemotherapeutic drugs cause neurotoxicity, and the brain may be affected. There are numerous proposed mechanisms behind chemotherapy-induced MCI^{64,65} and subsequent impairments, although subtle, may cause significantly decreased function and disability in cancer survivors.^{63,66,67} Neurocognitive interventions to improve function are an important part of rehabilitation care and often involve psychiatry and occupational and speech therapy consultations. Although the pathophysiology of MCI in cancer survivors is different than in patients with traumatic brain injury, the rehabilitation interventions used are often similar and focus on strategies that improve memory, attention, and organizational skills. In fact, it is not uncommon for patients with mild traumatic brain injuries (concussions), such as military personnel exposed to blasts,⁶⁸ to have impairments and functional problems that are similar to those in patients who have undergone chemotherapy. Neuropsychological testing may be performed prior to consultations to identify specific deficits.

TABLE 4. Examples of Nonmalignant Pain Due to Cancer Treatment

PRIMARY CANCER	SYMPTOM	PAIN GENERATOR	TREATMENTS
Lung cancer	Chest wall pain	Postthoracotomy pain	TENS, lidocaine patch, intercostal block
Breast cancer	Hand pain	Carpal tunnel syndrome from lymphedema	Lymphedema therapy, splinting, injection, surgical release
Laryngeal cancer	Shoulder pain	Scapular winging from accessory nerve palsy	Taping, manual mobilization, scapular stabilization exercises

TENS indicates transcutaneous electrical nerve stimulation.

Brain tumors often cause neurologic sequelae. Despite increases in the survival rates of patients with primary brain tumors and advances in treatment, survival is limited for many individuals and this feature needs to be factored into the timing, duration, and types of rehabilitation interventions offered. Nevertheless, rehabilitation after brain tumor resection has been shown to result in better outcomes, including gains in functional status and discharge to home.⁶⁹ In fact, patients with brain tumors have been found in some studies to have shorter lengths of stay on acute rehabilitation units compared with those with other noncancerous brain disorders, possibly as a result of higher initial levels of functional independence on admission, fewer behavioral issues, better social support, and expedited discharge planning due to cancer-related prognostic factors.⁷⁰

Most patients with brain tumors have multiple impairments depending on tumor location and size and, in those who have undergone surgery, the volume of tissue excised. In a study of patients with brain tumors undergoing acute rehabilitation, the most common neurologic deficits included impaired cognition (80%), weakness (78%), and visual-perceptual dysfunction (53%).⁷¹ In a more recent study of 106 patients, the most common impairments reported were pain (56%; which included a 42% incidence of headaches), ataxia (44%), seizures (43%), paresis (37%), cognitive dysfunction (36%), and visual impairment (35%).⁷²

Specific rehabilitation measures for patients with brain tumor-related disability emphasize early attention to mobilization, including bed mobility, transfer training, and ambulation or wheelchair skills. Those patients presenting with unilateral leg weakness will benefit from a physical therapist assisting with progressive gait and balance training and, when necessary, using an assistive device appropriate for the degree of stability required (single-point cane, 4-pronged cane, or walker). Provision of an ankle-foot orthosis to control weakness and/or spasticity of the ankle musculature is often needed. The risk of limb contracture, especially in ankle plantar flexion, wrist and finger flexion, and shoulder adduction and internal rotation is increased in patients with weakness, particularly spastic hemiplegia. Early and regular stretching programs, along with appropriate limb positioning and supportive devices such as Multi Podus boots, are critical. Glenohumeral support and position in bed

and wheelchair, the latter involving a lap table or arm trough, is key to preventing hemiparetic shoulder pain. A flaccid or significantly subluxed glenohumeral joint may require a humeral cuff or sling-type arm support that is used judiciously so as to not promote a contracture in internal rotation and adduction. For individuals limited by unilateral arm weakness, an occupational therapist can provide adaptive equipment such as reachers, sock donners, or elastic shoelaces.

Injuries to the spinal cord may be secondary to either traumatic or nontraumatic causes. Cancer-related spinal cord injury (SCI) incidence may actually exceed that from trauma and represents the most frequent type of nontraumatic SCI.⁷³ Symptoms consistent with SCI occur as a result of metastasis in up to 5% of all patients with cancer.⁷⁴ Weakness is present in 74% to 76% of patients, autonomic dysfunction in 52% to 57% of patients, and sensory loss in 51% to 53% of patients.⁷⁵ Pain alone may persist for a month or more (average, 6 weeks) before significant neurological changes develop. The acute onset of back or neck pain in a patient with cancer should be considered to be spinal metastasis until proven otherwise. It is critical, therefore, to rule out metastasis prior to sending the patient for an exercise program as spinal metastases may result in pathologic fracture and even cord compression if proper precautions are not instituted.

Positive results have been demonstrated following rehabilitation in individuals with disability from spinal cord tumors, with significant functional gains measured after inpatient rehabilitation.⁷⁶ For patients with incomplete injury, those with the greatest number of neurological deficits were found to benefit the most from inpatient rehabilitation. Factors that have been identified as better prognostic indicators of survival after inpatient rehabilitation include lymphoma, multiple myeloma, breast and kidney cancer types; SCI as the presenting symptom; slow progression rate of neurologic symptoms; combined surgical and radiation treatments; partial bowel control; and partial independence with transfers from bed to chair on admission to the rehabilitation unit.⁷⁷ In a more recent retrospective study from Australia, patients with primary spinal cord tumors and those without pain had significantly better functional outcomes than those with

metastatic disease and those with pain. However, all groups made substantial progress on average.⁷⁸

Medical complications associated with recent SCI are common, potentially life-threatening, and require a vigilant and knowledgeable hospital staff. Comprehensive care for SCI includes the management of pain, autonomic dysreflexia, pulmonary and urinary tract infections, thromboembolic disease, bowel and bladder dysfunction, decubitus ulcers, limb contractures, and spasticity as well as attention to ventilatory ability in those with high spinal levels of injury. Certain measures instituted immediately after the onset of spinal cord dysfunction remain standards of acute care in this patient population. Prophylaxis for lower extremity venous thromboses with low-molecular-weight heparin should be initiated immediately unless otherwise medically contraindicated and continued for at least the duration of the rehabilitation phase (eg, for a total of 3 months in cases of plegia or severe paresis). Other areas of management that should be instituted early in patients with loss of thoracic musculature include incentive spirometry and chest physiotherapy. The initiation of intermittent bladder catheterization every 4 to 6 hours when daily bladder volumes are less than 2 liters should be routine treatment, as well as the institution of a bowel program with daily or every-other-day suppository or digital stimulation. Other key measures in early spinal cord care include the prevention of skin breakdown in body areas commonly at risk (occiput, sacrum, greater trochanter, heels, and ischial tuberosities) by the patient turning in bed every 2 hours, as well as the use of a specialized pressure relief bed and wheelchair mattresses, and heel protectors. In addition, at least daily limb range of motion should be initiated immediately after the onset of the SCI. Of note, as a result of vasoconstriction from splanchnic sympathetic nerve stimulation by noxious stimuli below the level of the spinal lesion, patients with severe spinal cord dysfunction above the T6 level are prone to developing autonomic dysreflexia, which includes a significant increase in blood pressure above baseline. If blood pressure remains significantly elevated, pharmacological measures and intensive monitoring may be needed.⁷⁹

Bony Metastases

The vast majority of cases of skeletal cancer are of metastatic origin. Bone metastases are a frequent source of cancer-related physical impairment that require the active involvement of the rehabilitation team. Challenges for the treating team arise when metastatic bone lesions produce severe pain that limits function or increases the risk of fracture during therapeutic exercise or mobility. Rehabilitation for this patient population focuses on decreasing the stress or immobilizing compromised bone through the provision of assistive devices and orthoses, strength and balance training, and modification of the patient's environment. Whenever possible, bed rest should be avoided as it adds

to general debility and further functional loss, as well as increases the risks of hypercalcemia and thromboembolic disease. Depending on the severity and location of the lesion, mobility restrictions can range from non-weight-bearing to weight-bearing as tolerated. For complete non-weight-bearing restrictions, assistive devices in the form of walkers or bilateral crutches are typically necessary. If the condition is bilateral, wheelchair mobility may become the safest option. Single-point canes are used for patients with minimal balance deficits and smaller lesion size, but patients with larger, more symptomatic lesions should be advanced to a forearm-type crutch, which permits a greater degree of weight support.

It is critical to first rule out the coexistence of upper extremity lytic lesions before prescribing assistive devices that require weight support through the arms. Bracing may reduce the risk or symptoms of a pathologic fracture involving the upper extremities and can facilitate use of the arms in functional activities. Those individuals with upper limb lesions should be taught to minimize torsion and weight-loading and may benefit from an arm sling or humeral cuff support. In the spine, use of a Jewett brace to prevent spinal flexion or a custom-molded clamshell design to give stability in all directions can be prescribed. When more rigid bracing is not tolerated secondary to poor skin tolerance or discomfort, a thoracolumbar corset provides limited support and pain relief. Spinal bracing needs to extend several segments above and below the involved area of the spine.

Cancer patients with pathological fractures and associated functional deficits have been shown to make significant gains when admitted to an inpatient rehabilitation hospital unit.⁸⁰ It should be recognized that the rehabilitation of patients with skeletal metastases has multiple inherent risks, and strategies to exercise these patients remain largely theoretical due to a lack of empiric data. However, the alternative to rehabilitation therapies is often bed rest, which carries its own set of potential complications, including muscle contractures, weakness and atrophy, osteoporosis, orthostatic hypotension, pressure sores, pulmonary infection, and an increased risk of thromboembolic disease.

Soft-Tissue Impairments Associated With Cancer Diagnoses

Cancer and/or its treatments can cause significant soft-tissue abnormalities. One of the most frequently observed is lymphedema, which is extremity swelling resulting from disruption of the lymphatics following axillary or groin lymph node dissection. The prevalence of lymphedema in patients with breast cancer has been generally reported to be between 15% and 30%.⁸¹ Complete decongestive therapy, which includes the use of manual lymph drainage and compression garments, is effective in controlling edema. When applied early in the course of treatment, before the development of a significant volume increase (eg, a greater

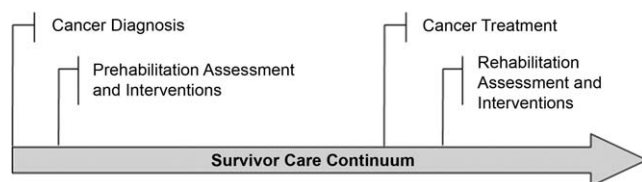


FIGURE 2. Timeline of Prehabilitation and Rehabilitation Assessments and Interventions.

than 250-cc increase in the arm), lymphedema can almost be reversed.^{82,83} Weight lifting, traditionally believed to be contraindicated in patients with lymphedema, has subsequently been shown to be beneficial.⁸⁴

Another frequently seen soft-tissue complication of cancer treatment is radiation fibrosis. Long-term sequelae include contracture and loss of muscle mass. Conservative management with manual release techniques, stretching exercises, and corticosteroid injections to the shoulder (used judiciously) may help to improve range of motion. The use of antifibrotic agents, such as pentoxifylline, in the treatment of this problem has shown promise.⁸⁵ Botulinum toxin injections have also been used successfully.⁸⁶

Cancer Rehabilitation and the Care Continuum

Opportunities to screen for and treat impairments in cancer survivors may begin shortly after diagnosis and continue even years after the completion of cancer treatment (Fig. 2). The care continuum includes prehabilitation (interventions designed to increase one's function in anticipation of an upcoming stressor),^{87,88} rehabilitation during acute cancer care, rehabilitation after acute cancer care, and rehabilitation of patients with cancer as a chronic condition (that may or may not ultimately be the cause of their mortality). Prehabilitation is a process on the cancer continuum of care that occurs between the time of cancer diagnosis and the beginning of acute treatment and includes physical and psychological assessments that establish a baseline functional level, identify impairments, and provide interventions that promote physical and psychological health to reduce the incidence and/or severity of future impairments. Rehabilitation professionals who treat physical impairments, including cognitive dysfunction, typically include but are not limited to physiatrists, physical therapists, occupational therapists, speech-language pathologists, and rehabilitation nurses.

Prehabilitation

Prehabilitation is the precursor to rehabilitation and may involve a single or multiple interventions in anticipation of upcoming cancer treatment; interventions may be considered prior to virtually any type of cancer treatment.⁸⁹ A prehabilitation program usually begins with an initial assessment to identify any postdiagnosis, but pretreatment, impairments. If these exist, then appropriate triage

TABLE 5. Improving the Oncology-Rehabilitation Interface

- Include trained rehabilitation professionals in the formal cancer care programming, including survivorship programming.
- Educate all staff involved in the care of oncology patients about impairment-driven cancer rehabilitation care.
- Establish a multidisciplinary cancer rehabilitation program/service line or, alternately, create a referral process for rehabilitation services within the geographic area.
- Use screening tools to identify impairments.
- Identify screening opportunities and integrate with appropriate on-site and/or local referral resources.
- Map patient flow through the organization.
- Require documentation of the navigation process, including cancer rehabilitation referrals.
- Track patient functional outcomes across the continuum of care beginning with a baseline assessment.
- Include reassessments to identify new or ongoing rehabilitation needs.
- Include the patient as a partner in his/her rehabilitation care.
- Use patient education materials to complement rehabilitation care.

measures should be considered, which may include referrals to physiatrists and/or physical, occupational, or speech therapists (Table 5). If impairments are not identified, then the goal is to prevent or limit future impairments, especially focusing on those that may occur with upcoming cancer treatment (Table 6). Courneya and Friedenreich described the Physical Exercise Across the Cancer Experience (PEACE) Framework that recommended “buffering” prior to cancer treatment, which is one type of prehabilitation intervention (exercise).⁸⁸ Patients awaiting resection can be offered supervised preoperative strength and endurance exercises to buffer the potentially detrimental effects of postsurgical immobility. Multimodal prehabilitation, or the use of more than one intervention at a time (such as concurrent physical therapy and nutrition counseling), may be more successful than unimodal treatment. Interval reassessments are, of course, necessary to maximize the efficacy of interventions and coordinate with upcoming cancer treatment(s).

Preoperative physical therapy is effective in reducing the length of hospital stay and postoperative complication rates in patients undergoing surgery. Examples include lung, colorectal, and esophageal cancer.^{87,90-97} Morano et al formulated a 4-week prehabilitation program that did not delay the “usual workup” for lung cancer and subsequent resection surgery.⁹⁷ This trial of 24 patients randomized to pulmonary prehabilitation or breathing exercises only demonstrated that patients in the pulmonary prehabilitation subset had a shorter hospital stay and a shorter duration of chest tube necessity.

TABLE 6. Examples of Prehabilitation Goals

- Improve cardiovascular, pulmonary, and/or musculoskeletal function.
- Improve balance and reduce the risk of falls.
- Reduce anxiety and improve coping with specific cognitive behavioral strategies.
- Improve quality of sleep with sleep hygiene education.
- Optimize surgical outcomes with smoking cessation interventions.
- Optimize diet with nutrition counseling.
- Begin preoperative pelvic floor muscle strengthening to improve continence outcomes.
- Begin pretreatment swallowing exercises to improve swallowing outcomes.
- Implement home safety strategies to avoid falls.
- Facilitate return to work with adaptive equipment.

An Italian study demonstrated improved function in patients with stage I or II non-small cell lung cancer and chronic obstructive pulmonary disease who underwent an extensive prehabilitation program, including supervised aerobic exercises and strength training.⁹⁰ Eleven patients underwent a 4-week physical therapy program prior to lobectomy, with medical evaluation occurring prior to and on completion of the program. Later, Divisi et al observed 27 patients in a 4-week to 6-week prehabilitation program of physical therapist-supervised breathing exercises, cycle ergometry with telemetry monitoring, smoking cessation, and nutrition optimization.⁹¹ All patients achieved functional improvement as measured by peak oxygen consumption and pulmonary function tests.

A Japanese study used historical controls to avoid depriving any of their patients of the benefits of prehabilitation.⁹² Twenty-two patients with lung cancer and chronic obstructive pulmonary disease underwent supervised hospital-based respiratory therapy and an independent walking program for 2 weeks prior to undergoing lobectomy. These patients were compared with 60 patients with lung cancer who received care at the same institution before the prehabilitation program. Despite greater impairments in lung function being noted in the prehabilitation group, the prehabilitation patients had fewer postoperative complications and a shorter hospital stay.

Timing and availability of potentially curative treatment are important considerations when designing a prehabilitation program. Benzo et al followed 9 control patients and 10 study patients to demonstrate the efficacy of physical therapy prior to lung resection surgery in a randomized controlled trial (RCT).⁹³ The study patients required a chest tube for a shorter duration of time, had lower postoperative respiratory morbidity, and needed fewer days in the hospital after surgery.

Of note, in a prior study, the same authors tried to randomize patients to 4 weeks of prehabilitation or usual care before lung resection, but neither providers nor patients were willing to wait the 4 weeks before the potentially curative surgery. As such, Benzo et al recommended the shorter-duration prehabilitation program, tailored to meet the surgery date.⁹³ Although the timing of cancer treatments remains of utmost importance, even short-duration prehabilitation may provide significant benefit. Rehabilitation can potentially affect mortality, as functional capacity may predict survival in patients with non-small cell lung cancer.⁹⁸

Kim et al and Carli et al experimented with different options in order to determine best practices for prehabilitation in patients prior to colorectal surgery. The pilot study by Kim et al randomized 21 patients scheduled to undergo bowel resection to physical therapy or control groups.⁹⁴ The physical therapy group underwent 2 to 5 weeks of aerobic exercise of increasing intensity. Although the distance walked improved in both the study group and the control group, heart rate and oxygen uptake during submaximal exercise as well as peak power output were found to be improved in the study group only.

In their following study, Carli et al randomized 112 patients to an intervention group of participants who took part in a structured cycling and strengthening program with interval supervision or to a control group.⁹⁵ Remarkably, there were no significant differences in outcomes noted between the groups. As such, the authors tried to address nutritional, psychological, and exercise compliance issues in the design of a subsequent study.^{87,99} The patients who underwent trimodal prehabilitation with optimization of nutrition, anxiety reduction, and moderate aerobic exercise combined with resistance training had a better postoperative walking capacity at 4 weeks and 8 weeks after surgery as compared with historical controls. As noted in a Canadian study, resistance training is particularly important in this population as only 25% of colorectal cancer survivors may be meeting strength exercise guidelines.¹⁰⁰

A Japanese retrospective cohort study reviewed the outcomes of prehabilitation in 100 patients with esophageal cancer who underwent esophagectomy.⁹⁶ The prehabilitation group received preoperative respiratory rehabilitation for greater than 7 days prior to surgery while a control group received insufficient or no breathing training. The prehabilitation group had fewer postoperative pulmonary complications than controls.

Prehabilitation also plays a role in other operable cancers, such as prostate cancer. Perioperative unimodal rehabilitation provides a significant benefit in patients with prostate cancer.¹⁰¹ Goode reviewed studies evaluating the role of

pelvic floor therapy on continence after prostatectomy.¹⁰¹ Of the studies that included preoperative pelvic floor muscle training with a physical therapist, 2 showed a clinically significant benefit and one did not. Taken in the context of the 5 of 6 studies that showed a benefit of unimodal rehabilitation in patients with prostate cancer at different times on the care continuum, prehabilitation appears to be helpful for these patients overall. Physical therapists are particularly important in treating this population.

Speech-language pathologists may also offer targeted unimodal exercise interventions that improve outcomes prior to the treatment of head and neck cancer. Patients with head and neck cancer often experience physical and psychological impairments due to the potential for changes in their speaking and swallowing abilities.¹⁰² The current Johns Hopkins protocol for the treatment of patients with head and neck cancer includes prehabilitation with a speech-language pathologist for education, baseline assessment of swallowing, nutrition, and prophylactic oral motor exercises.¹⁰³ In this protocol, Tippet and Webster advocate for pretreatment intervention before surgery, chemotherapy, or radiation to achieve the best outcomes in patients with head and neck cancer.¹⁰³

Further evidence for prehabilitation is provided by a RCT of the initiation of swallowing exercises prior to and during chemoradiation treatment for patients with head and neck cancer.¹⁰⁴ Patients who underwent the swallowing therapy intervention had better function at 3 and 6 months after treatment of their cancer than controls. Of note, nearly 70% of patients assigned to the swallowing therapy intervention stopped doing their home program by the fifth week of radiation treatment. Remarkably, they still had improvement 3 to 6 months later, although no significant difference was noted subsequently.

The studies cited herein demonstrate the efficacy of some prehabilitation interventions in the treatment of patients with cancer. Further research is needed to better understand the role of prehabilitation in the treatment of newly diagnosed patients.

Rehabilitation During Acute Cancer Care

Historically, preoperative and postoperative care were provided by surgeons. However, research suggests that a multidisciplinary approach may result in better outcomes. A variety of terms have been used to describe these approaches, such as “fast-track rehabilitation” or “enhanced recovery” or “accelerated rehabilitation,” and they have been studied in different cancer populations including, but not limited to, patients with colorectal,¹⁰⁵ ovarian,¹⁰⁶ gastric,¹⁰⁷ pancreatic,¹⁰⁸ and lung cancer.¹⁰⁹ In a 2013 retrospective study on patients undergoing an esophagectomy with a fast-track rehabilitation that included early mobilization, epidural analgesia control, fluid infusion volume

control, and enteral nutrition for early discharge (compared with a group receiving conventional care), Cao et al found that the intervention group had fewer complications, less postoperative pain, a reduction in the length of their hospital stay, and a faster return to work and normal activities.¹¹⁰ In a 2013 review of fast-track rehabilitation articles published between 1966 and 2012, Adamina et al concluded, “Multidisciplinary management of perioperative patient care has improved outcomes.”¹¹¹

During active cancer treatment, rehabilitation interventions may be helpful in preventing the predicted decline in QOL related to the disease and treatment side effects; however, lifestyle factors and comorbid diagnoses cannot be ignored. Brown et al observed that patients did not experience reduced fatigue during radiation treatment despite a multimodal rehabilitation program.¹¹² Participants in the failed intervention suggested that addressing alcohol and tobacco abuse, mood disorders, sleep disorders, and sleep hygiene in any subsequent group sessions might reduce fatigue.¹¹³ They also recommended that caregivers be included, but not for every session. According to these survey data, it appears that patients prefer a multimodal program that includes counseling services.

Although reported separately, a study of the same group of patients with cancer undergoing radiation treatment at the Mayo Clinic found that their QOL was maintained in the multimodal rehabilitation intervention group at one month of follow-up, but declined significantly in the control group of patients who were receiving the usual radiation oncology care without rehabilitation.¹¹⁴ At 6 months, intervention patients maintained their QOL, while controls gradually returned to baseline. Of note, the strength training was well-tolerated.¹¹⁵ In addition, aerobic activities were not included in the sessions, which may be one explanation for the lack of improvement in fatigue. Regardless, the higher QOL in the intervention group demonstrated a significant benefit of multimodal rehabilitation.

A subsequent study by Clark et al did show that a shorter, 6-session, multimodal rehabilitation program could also maintain QOL during the intense period of radiation treatment.¹¹³ A total of 131 patients with cancer undergoing radiation were randomized to a multimodal rehabilitation program or to standard medical care without rehabilitation. The multimodal team included a physical therapist, psychologist/psychiatrist, advanced practice nurse, clinical social worker, and certified hospital chaplain. At one month of follow-up, the QOL was significantly better in the intervention group than the control group. There was no significant difference at 6 months, despite a follow-up telephone intervention.

Another study demonstrated improved QOL after a unimodal rehabilitation intervention specific to patients with prostate cancer undergoing radiation treatment.¹¹⁶ Monga et al randomized 30 patients with prostate cancer to a physical therapy intervention or to radiation treatment without aerobic exercise. The intervention patients demonstrated improved QOL and less fatigue.¹¹⁶ A recent review by McNeely and Courneya endorsed both aerobic and resistance training as effective evidence-based treatment for CRF, but cautioned that training may be more effective during the survivorship phase of care.¹¹⁷ Further study will be helpful in determining the best way to prevent and treat fatigue during radiation, but it seems reasonable to consider that supervised aerobic conditioning plays an important role.

Multimodal rehabilitation has also been studied in patients with cancer during chemotherapy. Adamsen et al randomized 269 patients to an intervention set or a control set.¹¹⁸ Of note, patients had 21 different types of cancer diagnoses, including solid tumors and hematologic malignancies. Patients in the intervention set received high-intensity and low-intensity supervised physical training, relaxation techniques, and manipulation. Supervision was performed by a physical therapist or trained nurse specialist. Those in the control set received standard medical care and were permitted to perform unsupervised physical activity as tolerated. After 6 weeks, patients in the intervention set demonstrated less fatigue, improved aerobic capacity, greater strength, improved vitality, and better emotional well-being.¹¹⁸ The intervention resulted in a significant improvement in depression, but not in anxiety.¹¹⁹

A more recent study by Andersen et al evaluated 213 patients with cancer undergoing chemotherapy who were randomized to their multimodal intervention of high-intensity and low-intensity supervised physical training, relaxation techniques, and manipulation for 6 weeks or a wait-list control group.¹²⁰ The control group could participate in the intervention after their first 6 weeks of standard medical care and observation only. CRF was significantly reduced in the intervention group, but there was no statistically significant effect on QOL. Of note, this study did include aerobic exercise, which may be the key physical rehabilitative tool for fatigue treatment.

Inpatient rehabilitation is an important option for patients undergoing acute treatment but who are unable to leave the hospital. A review of the efficacy of inpatient rehabilitation found that patients with cancer who undergo this care may have a higher rate of transfer back to acute care and a shorter life expectancy overall than patients with other diagnoses (such as stroke, traumatic brain injury, or SCI).¹²¹ Functional gains after rehabilitation were not only significant, but similar to the gains made by noncancer patients. These authors did recommend that life expectancy

be considered in determining the length of stay in acute inpatient rehabilitation, but the presence of metastatic disease did not adversely affect functional gains.

Many of the studies discussed demonstrate the efficacy of physical therapy. However, in many cases, isolated physical therapy may not be enough to overcome an impairment. A multidisciplinary team approach may reasonably be recommended, especially for patients with neuromuscular impairments.¹²² One example of this type of impairment is a gait or balance abnormality from chemotherapy-induced peripheral neuropathy. Patients can be screened for potential risk factors for peripheral neuropathy during the prehabilitation phase and offered rehabilitation services at any point during the care continuum if they develop significant impairment.

Another example of a multidisciplinary approach to acute care rehabilitation involves patients with trismus as a complication of head and neck cancer. These patients may not be able to open their mouths fully due to pain and physical limitations despite aggressive speech and/or physical therapy. The adjunct use of botulinum toxin injections, pain medications, and a dynamic jaw-opening device has been shown to improve trismus in a pilot study.¹²³ Botulinum toxin injections have been successfully used by physiatrists to treat spasticity and dystonia in patients with many different types of cancer, even while the patient is undergoing chemotherapy.¹²⁴ There may be a role for similar injections in the treatment of dystonia, neuralgia, or migraine associated with radiation fibrosis syndrome.⁸⁶

Patient-centered care involves encouraging survivors to continue to implement the strategies and techniques that they learned from their rehabilitation caregivers. They will hopefully continue to perform therapeutic exercises and other physical activity on their own. A large study that addressed self-rated health in older patients with cancer found that 46% of those studied who were older than 65 years of age and 41% of participants who were older than 80 years of age reported engaging in physical activity independently during cancer treatment.¹²⁵ In this study, patients older than 65 years of age who exercised during treatment experienced less shortness of breath during treatment and better self-rated health both during and after treatment. The oldest patients (those older than 80 years of age) who were physically active during treatment reported better self-rated health and less memory loss during treatment and better self-rated health and less fatigue after treatment. Overall, cancer patients receiving acute care, even elderly patients, exhibit a favorable risk-to-benefit profile for rehabilitative training, and some experience a significant improvement in outcomes.

A 2013 meta-analysis focused on the psychological impact of exercise interventions delivered during adjuvant treatment of breast cancer in an attempt to assess the “optimal dose.”¹²⁶ Seventeen studies were included and revealed improvements for all outcomes including fatigue, depression, and QOL. Interestingly, relatively low doses of exercise (fewer than 12 metabolic equivalent for task [MET] hours/week) consisting of approximately 90 minutes to 120 minutes of weekly moderate exercise were more efficacious in improving fatigue and QOL than higher doses. This study serves as an important reminder that there are many factors to consider when prescribing exercise in order to optimize a cancer survivor’s health, including the current health status of the patient, comorbidities, and past and current cancer treatment, as well as the exercise mode, frequency, duration, and intensity.

Rehabilitation After Cancer Care in Survivors

The rehabilitation of survivors after acute cancer treatment is a broad topic and one that has been studied in some cancer populations (eg, individuals with breast and lung cancer) more than others (eg, those with hematologic¹²⁷ or bladder¹²⁸ malignancies). It is beyond the scope of this article to review all interventions in all cancer diagnoses or populations (such as adult survivors of childhood cancers)¹²⁹; therefore, key studies will be highlighted as examples.

A recent Cochrane Database Review of exercise interventions that were initiated after the completion of active cancer treatment included 40 trials with 3694 participants (1927 participants in an exercise group and 1764 in a comparison group).⁵⁶ This review concluded that exercise may have beneficial effects on HRQOL and certain HRQOL domains for cancer-specific concerns such as body image and self-esteem, fatigue, and anxiety in survivors of breast cancer. The authors noted that the results must be interpreted cautiously due to several factors, including the heterogeneity of exercise programs, cancer types, and cancer treatments. In another 2012 meta-analysis on physical activity in cancer survivors after the completion of “main treatment,” Fong et al reviewed 34 RCTs (22 or 65% of which were breast cancer studies),¹³⁰ and concluded that in breast cancer survivors who had finished acute treatments, physical activity had positive effects on physiology, body composition, physical functions, psychological outcomes, and QOL. When patients with other types of cancers were also included, exercise was associated with reduced body mass index and body weight, increased peak oxygen consumption and peak power output, and improved QOL.

In survivors of prostate cancer, a recent review found that incontinence, fitness, fatigue, body constitution, and QOL can be improved by “clinical exercise” during and after acute cancer treatments.¹³¹ Of note in this systematic

review, the authors concluded that “supervised exercise” is more effective than “nonsupervised exercise.”

CRF is a common impairment even after treatment is completed. A German study randomized 63 patients with cancer who were participating in a multimodal rehabilitation program including physical therapy, patient education, group exercise, and psychooncologic counseling to either an intervention group that received additional structured strength training and aerobic exercises or to a control group that received the standard rehabilitation program.¹³² After rehabilitation, both groups showed improvement in muscle strength, QOL, physical well-being, and functionality. At 3 months after rehabilitation, only the intervention group demonstrated persistent improvements in QOL and function. Furthermore, the intervention group demonstrated a significant improvement in CRF that was not seen in the control group.

A smaller RCT of patients who had been successfully treated for gynecologic cancer demonstrated improvement in CRF after 12 weeks of supervised aerobic and strength training exercises.¹³³ The intervention group demonstrated improvement immediately after the intervention as well as 6 months later. The persistence of improvement in fatigue may be related to the enrollment of patients who were sedentary prior to the study. These patients likely made the successful transition from supervised to unsupervised training, which is beneficial to nearly all aspects of health in previously sedentary patients. A meta-analysis published in 2012 found that exercise reduced fatigue in patients with cancer both during and after acute treatments.¹³⁴ Of note is that the authors of this review concluded that the effect was palliative during treatment and recuperative after treatment.

Therapeutic exercise directed at specific impairments may reduce musculoskeletal pain and improve function. For example, survivors of head and neck cancer may experience pain and weakness in the shoulder, related to spinal accessory nerve damage or irritation. McNeely et al randomized 52 survivors of head and neck cancer to a control group that received a standard, supervised, therapeutic exercise program or to an intervention group that received a supervised progressive resistance program that was tailored to treat their individual needs associated with cancer-related impairment of the shoulder.¹³⁵ Outcomes were measured at baseline and at the end of the 12-week intervention. The patients who underwent the progressive resistance exercise that was tailored to their needs demonstrated reduced pain and improved upper extremity muscular strength and endurance compared with the control subset. A 2012 review led by Carvalho et al found 3 trials, including the study by McNeely et al,¹³⁵ involving 104 participants that evaluated therapeutic exercise interventions for shoulder dysfunction in individuals treated for head and neck cancer.¹³⁶ In this review, 2 RCTs demonstrated that progressive resistance training combined with range-of-motion exercises and stretching was more

effective than “standard physiotherapy.” Of note is that other exercise regimens were not shown to be effective compared with postoperative physical therapy.

Patients who undergo stem cell transplantation as part of their treatment often experience impairments in strength and endurance. Knols et al evaluated the efficacy of a 12-week supervised aerobic and strength training program on physical functioning in patients within 6 months of stem cell transplantation.¹³⁷ Sixty-seven patients in the control group did not receive any formal rehabilitation, but did receive usual medical care as needed. Sixty-four participants in the intervention group demonstrated improved physical performance both immediately after the intervention and at the 3-month follow-up.

Supervised exercise in patients with lymphoma appears particularly motivating for long-term exercise (up to 6 months).¹³⁸ However, it would be helpful to know if rehabilitation makes a difference after a year or more. A trial to investigate long-term return-to-work in cancer survivors followed cancer patients for 3 years after diagnosis.¹³⁹ Seventy-two patients in the intervention group underwent a high-intensity physical rehabilitation program. Thirty-eight age-matched controls received usual medical care for cancer survivors. All subjects were evaluated by telephone at 3 years. Of note, all subjects had been working at the time of their cancer diagnosis. Approximately 78% of the patients in the intervention group returned to working the same number of hours as they did prior to their cancer diagnosis, compared with 66% of patients from the control group. The authors concluded that strength and interval training is useful in maximizing return-to-work in cancer survivors.

A 2011 study published by Korstjens et al evaluated the effects of cancer rehabilitation on psychological functioning and compared a usual-care comparison group, a group that received physical training, and a group that underwent both physical training and cognitive behavioral problem-solving training.¹⁴⁰ The researchers expected that the group that underwent both physical training and cognitive behavioral problem-solving training would outperform the other groups; however, they found that the 2 intervention groups performed similarly and only had additional benefits over the usual-care comparison group with regard to anxiety. The authors concluded that physical training was “feasible and sufficient” to reduce cancer survivors’ anxiety. A recent meta-analysis that included 56 studies evaluated the effectiveness of physical exercise on psychosocial functioning and HRQOL in breast cancer survivors and found that both physical exercise and behavioral techniques improve psychosocial functioning and HRQOL; however, more research is needed to understand the combined effect of these interventions.¹⁴¹

Rehabilitation of Patients With Cancer as a Chronic Condition

An early review of rehabilitation interventions for patients with advanced cancer was reported by Cheville in 2001.¹⁴² Since then, Cheville et al have contributed much to the literature on the evidence-based needs, often unmet, of patients with advanced cancer. For example, as noted in the introduction to this review, Cheville et al found that of 163 women with metastatic breast cancer, 92% had at least one physical impairment, with 530 impairments identified overall, and that fewer than 30% of the participants received the appropriate care.¹¹ In 2011, Cheville et al reviewed the causes of underuse of rehabilitation services for individuals with advanced cancer.³⁰ In this review, the authors suggested that much of the disability associated with advanced cancer may be avoided and stated that this is “an important public health issue.”³⁰ One of the central questions in this review was, “Why does functional loss in patients with cancer fail to trigger rehabilitation referrals?”³⁰ Cheville et al explored several reasons, including that cancer-related disability is often insidious and that cancer care delivery systems are not conducive to the early detection of functional problems. In this particularly fragile population, the authors encouraged health care professionals to avoid underestimating the functional loss that may occur with minor impairments and stated, “Even seemingly benign impairments warrant attention, given their capacity to erode diminishing functional reserve.”³⁰ International studies have demonstrated the need for rehabilitation and its underuse as well.¹⁴³⁻¹⁴⁶ Indeed, the burden of impairments directly related to cancer and/or cancer treatments can be profound when considered as a whole rather than the sum of each part.

Although palliative care may be offered at any stage of cancer, some of the published literature regarding rehabilitation in patients with advanced cancer has focused on palliative care populations. For example, in an editorial addressing this issue, Eyigor wrote, “In palliative care, improvement of physical function is more than control of symptoms. Despite this, most palliative care and hospice programs disregard physical performance while evaluating quality of life (QOL).”¹⁴⁷ Eyigor suggested several possible reasons for this deficit, including a lack of knowledge or education about the benefits of rehabilitation in this population, a limited supply of physiatrists familiar with patients with advanced cancer, and oncologists not directing patients to rehabilitation. Eyigor recommended, “Including physiatrists in the overall plan for palliative care is likely to increase the success of general treatment in addition to patient-family satisfaction.”¹⁴⁷ In a survey study by Spill et al evaluating oncologists’ and physiatrists’ attitudes regarding rehabilitation for patients with advanced cancer, the researchers mailed out 820 surveys and received responses from 395 physicians (response rate

of 48%).¹⁴⁸ Both groups had similar attitudes about care in many respects, but one area where they differed was with regard to rehabilitation services for patients with advanced cancer regardless of prognosis. When it came to the physicians' willingness to refer/accept a patient with advanced cancer regardless of estimated prognosis, only 8.4% of the oncologists were willing to refer in contrast to 15.1% of the physiatrists reported as 35% willing to accept the referral. The authors concluded that oncologists view prognosis as a more significant barrier to rehabilitation services than do physiatrists.

Certainly, the rehabilitation of patients with cancer as a serious chronic condition involves careful assessment of the individual's goals and life expectancy. If there is an anticipated short life expectancy, rehabilitation goals should take this into account and focus on improving function and QOL for the patient as well as reducing the burden of care. All interventions, including but not limited to physiatry and physical, occupational, and speech therapies, should be tailored to meet the goals of the patient and modified in the case of declining health. One of the more robust areas of rehabilitation research in patients with advanced cancer has focused on physical activity, and there is increasing evidence that therapeutic exercise may be beneficial in individuals living with cancer as a chronic condition, even when the disease has progressed considerably. For example, studies in individuals with cachexia have demonstrated that even with advanced disease, skeletal muscles have the capacity to respond to exercise training.¹⁴⁹

Albrecht and Taylor reviewed 16 articles published between 1994 and 2010 to determine the effect of physical activity in patients with advanced-stage cancer.¹⁵⁰ They found that even patients with advanced-stage cancer can benefit from rehabilitation in terms of improvements in mood, pain, fatigue, shortness of breath, constipation, and insomnia. Preference for the location of their aerobic and strength training program varied greatly; consequently, the ideal location (home vs hospital) could not be determined. Of note, most participants in the studies were willing and able to complete physical activity despite having an advanced stage of disease.

Authors of a subsequent pilot study of 24 patients with terminal cancer randomized the patients to a control group with a sham therapy intervention (local touch to the area of pain) or a physical therapy intervention for 2 weeks.¹⁵¹ The physical therapy intervention included massage as well as formal rehabilitative exercises. They found results similar to those of Albrecht and Taylor,¹⁵⁰ namely that the patients who received legitimate physical therapy demonstrated improved mood and decreased pain compared with the patients who received the sham touch intervention.

A prospective, single-arm intervention study of patients with stage III or IV inoperable lung cancer evaluated the effect of a hospital-based strength training and aerobic

exercise program.¹⁵² Twenty-three patients completed the training during chemotherapy. There was significant improvement in physiologic and emotional HRQOL at the 6-week follow-up. The authors concluded that exercise training is appropriate for patients with inoperable lung cancer, even while they are undergoing treatment.

A RCT of 36 patients in the United Kingdom with advanced breast or hematologic cancer evaluated the unmet needs of these patients using the Supportive Care Needs Survey.¹⁵³ The intervention group received personalized multimodal rehabilitation care in a hospice daycare unit that could include any or all of the following services: physiotherapy, complementary therapy (ie, acupuncture, Reiki, etc), and counseling or social services. The control group received usual care with access to the medical team, but no specific multidisciplinary intervention. The intervention group demonstrated significantly fewer unmet needs, and meeting these needs appeared to be cost-effective.

Cheville et al randomized 66 adult patients with stage IV lung or colorectal cancer to a home-based walking and strengthening program or usual care.¹⁵⁴ Unlike the previously described studies, patients currently in hospice care were excluded. At 8 weeks, the intervention group reported improved mobility, fatigue, and sleep quality compared with the usual-care group.

A larger RCT of patients with advanced cancer in Norway that was published in 2011 evaluated fatigue and physical performance in these patients.¹⁵⁵ A total of 121 patients were randomized to the physical exercise group and 110 patients were randomized to the usual-care group. Patients in the physical exercise group performed circuit training, incorporating both aerobic and strength training exercises with postexercise stretching. After 8 weeks of physical exercise, fatigue was not reduced, but physical performance was significantly improved in the exercise group. The authors theorized that fatigue was not improved because many of these patients with incurable disease experienced disease progression over the 8-week intervention period. Of note, since patients were recruited from daycare palliative care units, hospice patients were not excluded. The inclusion of patients with a greater illness burden may be part of the reason that these findings differ from those of other smaller studies that demonstrated improvements in fatigue with 8 weeks of exercise.

Physical activity has been an important area of research in patients with advanced cancer, but there are many other issues that need to be addressed in this population including, but not limited to, voice and speech outcomes in survivors of advanced head and neck cancer that may improve with speech-language pathologist consultations,¹⁵⁶ breathlessness in patients with advanced lung cancer who may benefit from nursing interventions,¹⁵⁷ and the rehabilitation of survivors with metastatic bone disease.¹⁵⁸ The scope of this article

precludes an exhaustive discussion of impairments and rehabilitation interventions, but before leaving this topic in patients with advanced cancer, it is essential to consider the cognitive issues that may significantly compromise the QOL of these individuals and the considerable strain that this may place on caregivers and the health care system. For example, cognitive impairments in individuals with brain tumors are typically more severe as the disease progresses, and more research to identify the efficacy of specific rehabilitation interventions is needed.¹⁵⁹ Patients with advanced cancer may also experience delirium, and in a 2013 narrative review, Kang et al noted that approximately one-half of these cases may be reversed with a comprehensive approach to management.¹⁶⁰

Conclusions

Delivering quality, patient-centered care requires that all cancer patients and survivors be screened for psychological and physical impairments throughout the care continuum in order to preserve and/or improve their functioning and QOL. Impairments, from subtle to profound, should be identified and treated by trained health care professionals. Because many survivors present with multiple impairments,

treatment often requires an interdisciplinary team approach that can offer multimodal interventions. General exercise referrals, whether they involve advice in the office setting or referrals to skilled fitness professionals, while an important component of the rehabilitation care continuum, should be offered to survivors only after their impairments have been identified, treated optimally by rehabilitation health care professionals, and safety precautions and contraindications identified and documented. Although all oncology health care professionals should be knowledgeable about impairment-driven cancer rehabilitation in order to make appropriate and timely referrals to rehabilitation professionals, it is particularly important that oncologists, nurse practitioners, physician assistants, patient navigators, and mental health professionals be able to quickly identify impairments and refer patients for their rehabilitation needs. Primary care physicians also play an important role in facilitating referrals. As impairment-driven cancer rehabilitation can significantly improve physical and psychological health outcomes in survivors as well as reduce direct and indirect health care costs, future research efforts should be focused on building on the current evidence in order to provide quality integration of this care into oncology clinical practice. ■

References

1. Surveillance, Epidemiology, and End Results [SEER] Stat Fact Sheets: All Sites. Bethesda, MD: National Cancer Institute; 2011. seer.cancer.gov/statfacts/html/all.html. Accessed April 7, 2013.
2. American Cancer Society. Cancer Facts & Figures 2012. Atlanta, GA: American Cancer Society; 2012.
3. Siegel R, DeSantis C, Virgo K, et al. Cancer treatment and survivorship statistics, 2012. *CA Cancer J Clin*. 2012;62:220-241.
4. Mariotto AB, Yabroff KR, Shao Y, Feuer EJ, Brown ML. Projections of the cost of cancer care in the United States: 2010-2020. *J Natl Cancer Inst*. 2011;103:117-128.
5. Macioch T, Hermanowski T. The indirect costs of cancer-related absenteeism in the workplace in Poland. *J Occup Environ Med*. 2011;53:1472-1477.
6. Mewes JC, Steuten LM, Ijzerman MJ, van Harten WH. Effectiveness of multidimensional cancer survivor rehabilitation and cost-effectiveness of cancer rehabilitation in general: a systematic review. *Oncologist*. 2012;17:1581-1593.
7. Heitland W, Schadlich PK, Chen X, Remy V, Moro L. Annual cost of hospitalization, inpatient rehabilitation and sick leave of anal cancer in Germany. *J Med Econ*. 2013;16:364-371.
8. Mehnert A, Koch U. Predictors of employment among cancer survivors after medical rehabilitation—a prospective study. *Scand J Work Environ Health*. 2013;39:76-87.
9. Weaver KE, Forsythe LP, Reeve BB, et al. Mental and physical health-related quality of life among U.S. cancer survivors: population estimates from the 2010 National Health Interview Survey. *Cancer Epidemiol Biomarkers Prev*. 2012;21:2108-2117.
10. Ugolini D, Neri M, Cesario A, et al. Scientific production in cancer rehabilitation grows higher: a bibliometric analysis. *Support Care Cancer*. 2012;20:1629-1638.
11. Cheville AL, Troxel AB, Basford JR, Kornblith AB. Prevalence and treatment patterns of physical impairments in patients with metastatic breast cancer. *J Clin Oncol*. 2008;26:2621-2629.
12. Thorsen L, Gjerset GM, Loge JH, et al. Cancer patients' needs for rehabilitation services. *Acta Oncol*. 2011;50:212-222.
13. Schmitz KH, Speck RM, Rye SA, DiSipio T, Hayes SC. Prevalence of breast cancer treatment sequelae over 6 years of follow-up: the Pulling Through Study. *Cancer*. 2012;118(suppl 8):2217-2225.
14. Cheville AL, Beck LA, Petersen TL, Marks RS, Gamble GL. The detection and treatment of cancer-related functional problems in an outpatient setting. *Support Care Cancer*. 2009;17:61-67.
15. Banks E, Byles JE, Gibson RE, et al. Is psychological distress in people living with cancer related to the fact of diagnosis, current treatment or level of disability? Findings from a large Australian study. *Med J Aust*. 2010;193(suppl 5):S62-S67.
16. Ponto JA, Ellington L, Mellon S, Beck SL. Predictors of adjustment and growth in women with recurrent ovarian cancer. *Oncol Nurs Forum*. 2010;37:357-364.
17. Omran S, Saeed AM, Simpson J. Symptom distress of Jordanian patients with cancer receiving chemotherapy. *Int J Nurs Pract*. 2012;18:125-132.
18. Clark PG, Rochon E, Brethwaite D, Edmiston KK. Screening for psychological and physical distress in a cancer inpatient treatment setting: a pilot study. *Psychooncology*. 2011;20:664-668.
19. Cousins N, Macaulay F, Lang H, Macgillivray S, Wells M. A systematic review of interventions for eating and drinking problems following treatment for head and neck cancer suggests a need to look beyond swallowing and trismus [published online ahead of print January 4, 2013]. *Oral Oncol*. pii: S1368-8375(12)00371-5. doi: 10.1016/j.oraloncology.2012.12.002.
20. Cristian A, Tran A, Patel K. Patient safety in cancer rehabilitation. *Phys Med Rehabil Clin N Am*. 2012;23:441-456.
21. Brown JC, Troxel AB, Schmitz KH. Safety of weightlifting among women with or at risk for breast cancer-related lymphedema: musculoskeletal injuries and health care use in a weightlifting rehabilitation trial. *Oncologist*. 2012;17:1120-1128.
22. Stigt JA, Uil SM, van Riesen SJ, et al. A randomized controlled trial of postthoracotomy pulmonary rehabilitation in patients with resectable lung cancer. *J Thorac Oncol*. 2013;8:214-221.
23. Collins LG, Nash R, Round T, Newman B. Perceptions of upper-body problems during recovery from breast cancer treatment. *Support Care Cancer*. 2004;12:106-113.

24. Yadav R. Rehabilitation of surgical cancer patients at University of Texas M. D. Anderson Cancer Center. *J Surg Oncol*. 2007;95:361-369.
25. Yuen HK, Gillespie MB, Day TA, Morgan L, Burik JK. Driving behaviors in patients with head and neck cancer during and after cancer treatment: a preliminary report. *Head Neck*. 2007;29:675-681.
26. Silver JK, Gilchrist LS. Cancer rehabilitation with a focus on evidence-based outpatient physical and occupational therapy interventions. *Am J Phys Med Rehabil*. 2011;90(5 suppl 1):S5-S15.
27. Stout NL, Binkley JM, Schmitz KH, et al. A prospective surveillance model for rehabilitation for women with breast cancer. *Cancer*. 2012;118(suppl 8):2191-2200.
28. Schmitz KH, Stout NL, Andrews K, Binkley JM, Smith RA. Prospective evaluation of physical rehabilitation needs in breast cancer survivors: a call to action. *Cancer*. 2012;118(suppl 8):2187-2190.
29. Hansen DG, Larsen PV, Holm LV, Rottmann N, Bergholdt SH, Sondergaard J. Association between unmet needs and quality of life of cancer patients: a population-based study. *Acta Oncol*. 2013;52:391-399.
30. Cheville AL, Kornblith AB, Basford JR. An examination of the causes for the underutilization of rehabilitation services among people with advanced cancer. *Am J Phys Med Rehabil*. 2011;90(5 suppl 1):S27-S37.
31. Cherny NI, Portenoy RK. The management of cancer pain. *CA Cancer J Clin*. 1994;44:263-303.
32. Goudas LC, Bloch R, Gialeli-Goudas M, Lau J, Carr DB. The epidemiology of cancer pain. *Cancer Invest*. 2005;23:182-190.
33. Gartner R, Jensen MB, Nielsen J, Ewertz M, Kroman N, Kehlet H. Prevalence of and factors associated with persistent pain following breast cancer surgery. *JAMA*. 2009;302:1985-1992.
34. Tasmuth T, von Smitten K, Hietanen P, Kataja M, Kalso E. Pain and other symptoms after different treatment modalities of breast cancer. *Ann Oncol*. 1995;6:453-459.
35. Rogers ML, Duffy JP. Surgical aspects of chronic post-thoracotomy pain. *Eur J Cardiothorac Surg*. 2000;18:711-716.
36. Miaskowski C, Cooper B, Paul SM, et al. Identification of patient subgroups and risk factors for persistent breast pain following breast cancer surgery. *J Pain*. 2012;13:1172-1187.
37. Burton AW, Fanciullo GJ, Beasley RD, Fisch MJ. Chronic pain in the cancer survivor: a new frontier. *Pain Med*. 2007;8:189-198.
38. Taylor JC, Terrell JE, Ronis DL, et al; University of Michigan Head and Neck Cancer Team. Disability in patients with head and neck cancer. *Arch Otolaryngol Head Neck Surg*. 2004;130:764-769.
39. van Wilgen CP, Dijkstra PU, van der Laan BF, Plukker JT, Roodenburg JL. Morbidity of the neck after head and neck cancer therapy. *Head Neck*. 2004;26:785-791.
40. Evensen JF, Bjordal K, Knutsen BH, Olsen DR, Store G, Tausjo JE. Side effects and quality of life after inadvertent radiation overdosage in brachytherapy of head-and-neck cancer. *Int J Radiat Oncol Biol Phys*. 2002;52:944-952.
41. Silver J, Mayer RS. Barriers to pain management in the rehabilitation of the surgical oncology patient. *J Surg Oncol*. 2007;95:427-435.
42. Mantyh PW. Cancer pain and its impact on diagnosis, survival and quality of life. *Nat Rev Neurosci*. 2006;7:797-809.
43. Lemay K, Wilson KG, Buenger U, et al. Fear of pain in patients with advanced cancer or in patients with chronic non-cancer pain. *Clin J Pain*. 2011;27:116-124.
44. Wang XS, Cleeland CS, Mendoza TR, et al. The effects of pain severity on health-related quality of life: a study of Chinese cancer patients. *Cancer*. 1999;86:1848-1855.
45. Golan-Vered Y, Pud D. Chemotherapy-induced neuropathic pain and its relation to cluster symptoms in breast cancer patients treated with paclitaxel. *Pain Pract*. 2013;13:46-52.
46. Cella D, Peterman A, Passik S, Jacobsen P, Breitbart W. Progress toward guidelines for the management of fatigue. *Oncology (Williston Park)*. 1998;12:369-377.
47. Pickard-Holley S. Fatigue in cancer patients. A descriptive study. *Cancer Nurs*. 1991;14:13-19.
48. Curt GA, Breitbart W, Cella D, et al. Impact of cancer-related fatigue on the lives of patients: new findings from the Fatigue Coalition. *Oncologist*. 2000;5:353-360.
49. Jacobsen PB. Assessment of fatigue in cancer patients. *J Natl Cancer Inst Monogr*. 2004(32):93-97.
50. Vogelzang NJ, Breitbart W, Cella D, et al. Patient, caregiver, and oncologist perceptions of cancer-related fatigue: results of a tripart assessment survey. The Fatigue Coalition. *Semin Hematol*. 1997;34(3 suppl 2):4-12.
51. Portenoy RK. Cancer-related fatigue: an immense problem. *Oncologist*. 2000;5:350-352.
52. Servaes P, Gielissen MF, Verhagen S, Bleijenberg G. The course of severe fatigue in disease-free breast cancer patients: a longitudinal study. *Psychooncology*. 2007;16:787-795.
53. Morrow GR, Shelke AR, Roscoe JA, Hickok JT, Mustian K. Management of cancer-related fatigue. *Cancer Invest*. 2005;23:229-239.
54. Blesch KS, Paice JA, Wickham R, et al. Correlates of fatigue in people with breast or lung cancer. *Oncol Nurs Forum*. 1991;18:81-87.
55. Mock V, Frangakis C, Davidson NE, et al. Exercise manages fatigue during breast cancer treatment: a randomized controlled trial. *Psychooncology*. 2005;14:464-477.
56. Mishra SI, Scherer RW, Geigle PM, et al. Exercise interventions on health-related quality of life for cancer survivors. *Cochrane Database Syst Rev*. 2012;8:CD007566.
57. Mishra SI, Scherer RW, Snyder C, Geigle PM, Berlanstein DR, Topaloglu O. Exercise interventions on health-related quality of life for people with cancer during active treatment. *Cochrane Database Syst Rev*. 2012;8:CD008465.
58. Kannarkat G, Lasher EE, Schiff D. Neurologic complications of chemotherapy agents. *Curr Opin Neurol*. 2007;20:719-725.
59. Taxol [package insert]. Princeton, NJ: Bristol-Myers Squibb Company; 2003, updated 2011.
60. Hilken PH, Verweij J, Stoter G, Vecht CJ, van Putten WL, van den Bent MJ. Peripheral neurotoxicity induced by docetaxel. *Neurology*. 1996;46:104-108.
61. Wampler MA, Topp KS, Miaskowski C, Byl NN, Rugo HS, Hamel K. Quantitative and clinical description of postural instability in women with breast cancer treated with taxane chemotherapy. *Arch Phys Med Rehabil*. 2007;88:1002-1008.
62. Reid-Arndt SA, Cox CR. Stress, coping and cognitive deficits in women after surgery for breast cancer. *J Clin Psychol Med Settings*. 2012;19:127-137.
63. Castellon S, Ganz PA. Neuropsychological studies in breast cancer: in search of chemobrain. *Breast Cancer Res Treat*. 2009;116:125-127.
64. Nelson CJ, Nandy N, Roth AJ. Chemotherapy and cognitive deficits: mechanisms, findings, and potential interventions. *Palliat Support Care*. 2007;5:273-280.
65. Dutta V. Chemotherapy, neurotoxicity, and cognitive changes in breast cancer. *J Cancer Res Ther*. 2011;7:264-269.
66. Marin AP, Sanchez AR, Arranz EE, Aunon PZ, Baron MG. Adjuvant chemotherapy for breast cancer and cognitive impairment. *South Med J*. 2009;102:929-934.
67. Chang G, Meadows ME, Orav EJ, Antin JH. Mental status changes after hematopoietic stem cell transplantation. *Cancer*. 2009;115:4625-4635.
68. Rigg JL, Mooney SR. Concussions and the military: issues specific to service members. *PM R*. 2011;3(10 suppl 2):S380-S386.
69. Bartolo M, Zucchella C, Pace A, et al. Early rehabilitation after surgery improves functional outcome in inpatients with brain tumours. *J Neurooncol*. 2012;107:537-544.
70. Kirshblum S, O'Dell MW, Ho C, Barr K. Rehabilitation of persons with central nervous system tumors. *Cancer*. 2001;92(suppl 4):1029-1038.
71. O'Dell MW, Barr K, Spanier D, Warnick RE. Functional outcome of inpatient rehabilitation in persons with brain tumors. *Arch Phys Med Rehabil*. 1998;79:1530-1534.
72. Khan F, Amatya B. Factors associated with long-term functional outcomes, psychological sequelae and quality of life in persons after primary brain tumour. *J Neurooncol*. 2013;111:355-366.
73. van den Berg ME, Castellote JM, Mahillo-Fernandez I, de Pedro-Cuesta J. Incidence of nontraumatic spinal cord injury: a Spanish cohort study (1972-2008). *Arch Phys Med Rehabil*. 2012;93:325-331.
74. Parsch D, Mikut R, Abel R. Postacute management of patients with spinal cord injury due to metastatic tumour disease: survival and efficacy of rehabilitation. *Spinal Cord*. 2003;41:205-210.
75. Gilbert RW, Kim JH, Posner JB. Epidural spinal cord compression from metastatic tumor: diagnosis and treatment. *Ann Neurol*. 1978;3:40-51.

76. Eriks IE, Angenot EL, Lankhorst GJ. Epidural metastatic spinal cord compression: functional outcome and survival after inpatient rehabilitation. *Spinal Cord*. 2004; 42:235-239.
77. Hacking HG, Van As HH, Lankhorst GJ. Factors related to the outcome of inpatient rehabilitation in patients with neoplastic epidural spinal cord compression. *Paraplegia*. 1993;31:367-374.
78. Tan M, New PW. Retrospective study of rehabilitation outcomes following spinal cord injury due to tumour. *Spinal Cord*. 2012;50:127-131.
79. Krassioukov A, Warburton DE, Teasell R, Eng JJ, Spinal Cord Injury Rehabilitation Evidence Research Team. A systematic review of the management of autonomic dysreflexia after spinal cord injury. *Arch Phys Med Rehabil*. 2009;90:682-695.
80. Bunting RW, Shea B. Bone metastasis and rehabilitation. *Cancer*. 2001;92(suppl 4): 1020-1028.
81. Kwan W, Jackson J, Weir LM, Dingee C, McGregor G, Olivetto IA. Chronic arm morbidity after curative breast cancer treatment: prevalence and impact on quality of life. *J Clin Oncol*. 2002;20:4242-4248.
82. Ramos SM, O'Donnell LS, Knight G. Edema volume, not timing, is the key to success in lymphedema treatment. *Am J Surg*. 1999;178:311-315.
83. Bar Ad V, Cheville A, Solin LJ, Dutta P, Both S, Harris EE. Time course of mild arm lymphedema after breast conservation treatment for early-stage breast cancer. *Int J Radiat Oncol Biol Phys*. 2010;76:85-90.
84. Schmitz KH, Ahmed RL, Troxel A, et al. Weight lifting in women with breast-cancer-related lymphedema. *N Engl J Med*. 2009;361:664-673.
85. Okunieff P, Augustine E, Hicks JE, et al. Pentoxifylline in the treatment of radiation-induced fibrosis. *J Clin Oncol*. 2004;22:2207-2213.
86. Stubblefield MD, Levine A, Custodio CM, Fitzpatrick T. The role of botulinum toxin type A in the radiation fibrosis syndrome: a preliminary report. *Arch Phys Med Rehabil*. 2008;89:417-421.
87. Mayo NE, Feldman L, Scott S, et al. Impact of preoperative change in physical function on postoperative recovery: argument supporting prehabilitation for colorectal surgery. *Surgery*. 2011;150:505-514.
88. Courneya KS, Friedenreich CM. Framework PEACE: an organizational model for examining physical exercise across the cancer experience. *Ann Behav Med*. 2001; 23:263-272.
89. Silver JK, Baima J. Cancer prehabilitation: an opportunity to decrease treatment-related morbidity, increase cancer treatment options and improve physical and psychological health outcomes. *Am J Phys Med Rehabil*. In press.
90. Bobbio A, Chetta A, Ampollini L, et al. Preoperative pulmonary rehabilitation in patients undergoing lung resection for non-small cell lung cancer. *Eur J Cardiothorac Surg*. 2008;33:95-98.
91. Divisi D, Di Francesco C, Di Leonardo G, Crisci R. Preoperative pulmonary rehabilitation in patients with lung cancer and chronic obstructive pulmonary disease. *Eur J Cardiothorac Surg*. 2013;43:293-296.
92. Sekine Y, Chiyo M, Iwata T, et al. Perioperative rehabilitation and physiotherapy for lung cancer patients with chronic obstructive pulmonary disease. *Jpn J Thorac Cardiovasc Surg*. 2005;53:237-243.
93. Benzo R, Wigle D, Novotny P, et al. Preoperative pulmonary rehabilitation before lung cancer resection: results from two randomized studies. *Lung Cancer*. 2011; 74:441-445.
94. Kim do J, Mayo NE, Carli F, Montgomery DL, Zavorsky GS. Responsive measures to prehabilitation in patients undergoing bowel resection surgery. *Tohoku J Exp Med*. 2009;217:109-115.
95. Carli F, Charlebois P, Stein B, et al. Randomized clinical trial of prehabilitation in colorectal surgery. *Br J Surg*. 2010;97:1187-1197.
96. Inoue J, Ono R, Makiura D, et al. Prevention of postoperative pulmonary complications through intensive preoperative respiratory rehabilitation in patients with esophageal cancer. *Dis Esophagus*. 2013; 26:68-74.
97. Morano MT, Araujo AS, Nascimento FB, et al. Preoperative pulmonary rehabilitation versus chest physical therapy in patients undergoing lung cancer resection: a pilot randomized controlled trial. *Arch Phys Med Rehabil*. 2013;94:53-58.
98. Jones LW, Hornsby WE, Goetzinger A, et al. Prognostic significance of functional capacity and exercise behavior in patients with metastatic non-small cell lung cancer. *Lung Cancer*. 2012;76:248-252.
99. Li C, Carli F, Lee L, et al. Impact of a trimodal prehabilitation program on functional recovery after colorectal cancer surgery: a pilot study. *Surg Endosc*. 2013; 27:1072-1082.
100. Speed-Andrews AE, McGowan EL, Rhodes RE, et al. Correlates of strength exercise in colorectal cancer survivors. *Am J Health Behav*. 2013;37:162-170.
101. Goode PS. Efficacy of an assisted low-intensity programme of perioperative pelvic floor muscle training in improving the recovery of continence after radical prostatectomy: a randomized controlled trial. *BJU Int*. 2012;110:1010-1011.
102. de Leeuw J, van den Berg MG, van Achterberg T, Merckx MA. Supportive care in early rehabilitation for advanced-stage radiated head and neck cancer patients. *Otolaryngol Head Neck Surg*. 2013;148: 625-632.
103. Tippet DC, Webster KT. Rehabilitation needs of patients with oropharyngeal cancer. *Otolaryngol Clin North Am*. 2012; 45:863-878.
104. Kotz T, Federman AD, Kao J, et al. Prophylactic swallowing exercises in patients with head and neck cancer undergoing chemoradiation: a randomized trial. *Arch Otolaryngol Head Neck Surg*. 2012;138: 376-382.
105. Aarts MA, Okrainec A, Glicksman A, Pearsall E, Victor JC, McLeod RS. Adoption of enhanced recovery after surgery (ERAS) strategies for colorectal surgery at academic teaching hospitals and impact on total length of hospital stay. *Surg Endosc*. 2012;26:442-450.
106. Jakobsen DH, Hogdall C, Kehlet H. Perioperative care of patients with stage IIIC ovarian cancer [in Danish]. *Ugeskr Laeger*. 2010;172:2688-2691.
107. Wang D, Kong Y, Zhong B, Zhou X, Zhou Y. Fast-track surgery improves postoperative recovery in patients with gastric cancer: a randomized comparison with conventional postoperative care. *J Gastrointest Surg*. 2010;14:620-627.
108. Ypsilantis E, Praseedom RK. Current status of fast-track recovery pathways in pancreatic surgery. *JOP*. 2009;10:646-650.
109. Das-Neves-Pereira JC, Bagan P, Coimbra-Israel AP, et al. Fast-track rehabilitation for lung cancer lobectomy: a five-year experience. *Eur J Cardiothorac Surg*. 2009;36:383-391; discussion 391-392.
110. Cao S, Zhao G, Cui J, et al. Fast-track rehabilitation program and conventional care after esophagectomy: a retrospective controlled cohort study. *Support Care Cancer*. 2013;21:707-714.
111. Adamina M, Gie O, Demartines N, Ris F. Contemporary perioperative care strategies. *Br J Surg*. 2013;100:38-54.
112. Brown P, Clark MM, Atherton P, et al. Will improvement in quality of life (QOL) impact fatigue in patients receiving radiation therapy for advanced cancer? *Am J Clin Oncol*. 2006;29:52-58.
113. Clark MM, Rummans TA, Atherton PJ, et al. Randomized controlled trial of maintaining quality of life during radiotherapy for advanced cancer. *Cancer*. 2013;119: 880-887.
114. Rummans TA, Clark MM, Sloan JA, et al. Impacting quality of life for patients with advanced cancer with a structured multidisciplinary intervention: a randomized controlled trial. *J Clin Oncol*. 2006;24:635-642.
115. Cheville AL, Girardi J, Clark MM, et al. Therapeutic exercise during outpatient radiation therapy for advanced cancer: feasibility and impact on physical well-being. *Am J Phys Med Rehabil*. 2010; 89:611-619.
116. Monga U, Garber SL, Thornby J, et al. Exercise prevents fatigue and improves quality of life in prostate cancer patients undergoing radiotherapy. *Arch Phys Med Rehabil*. 2007;88:1416-1422.
117. McNeely ML, Courneya KS. Exercise programs for cancer-related fatigue: evidence and clinical guidelines. *J Natl Compr Canc Netw*. 2010;8:945-953.
118. Adamsen L, Quist M, Andersen C, et al. Effect of a multimodal high intensity exercise intervention in cancer patients undergoing chemotherapy: randomised controlled trial. *BMJ*. 2009;339:b3410.
119. Midtgaard J, Stage M, Moller T, et al. Exercise may reduce depression but not anxiety in self-referred cancer patients undergoing chemotherapy. Post-hoc analysis of data from the 'Body & Cancer' trial. *Acta Oncol*. 2011;50:660-669.
120. Andersen C, Rorth M, Ejlersten B, et al. The effects of a six-week supervised multimodal exercise intervention during chemotherapy on cancer-related fatigue [published online ahead of print October

- 16, 2012]. *Eur J Oncol Nurs*. pii: S1462-3889(12)00089-0. doi:10.1016/j.ejon.2012.09.003.
121. Huang ME, Sliwa JA. Inpatient rehabilitation of patients with cancer: efficacy and treatment considerations. *PM R*. 2011;3:746-757.
122. Stubblefield MD, McNeely ML, Alfano CM, Mayer DK. A prospective surveillance model for physical rehabilitation of women with breast cancer: chemotherapy-induced peripheral neuropathy. *Cancer*. 2012;118(suppl 8):2250-2260.
123. Stubblefield MD, Manfield L, Riedel ER. A preliminary report on the efficacy of a dynamic jaw opening device (dynamaplast trismus system) as part of the multimodal treatment of trismus in patients with head and neck cancer. *Arch Phys Med Rehabil*. 2010;91:1278-1282.
124. Fu J, Gutierrez C, Bruera E, Guo Y, Palla S. Use of injectable spasticity management agents in a cancer center [published online ahead of print November 11, 2012]. *Support Care Cancer*.
125. Sprod LK, Mohile SG, Demark-Wahnefried W, et al. Exercise and cancer treatment symptoms in 408 newly diagnosed older cancer patients. *J Geriatr Oncol*. 2012;3:90-97.
126. Carayol M, Bernard P, Boiche J, et al. Psychological effect of exercise in women with breast cancer receiving adjuvant therapy: what is the optimal dose needed? *Ann Oncol*. 2013;24:291-300.
127. Paul KL. Rehabilitation and exercise considerations in hematologic malignancies. *Am J Phys Med Rehabil*. 2011;90(5 suppl 1):S88-S94.
128. Djurasic L, Crnomarkovic D, Pejic T, et al. The importance of physical therapy in the postoperative period after total cystectomy of bladder carcinoma. *Acta Chir Iugosl*. 2011;58:103-105.
129. Ness KK, Hudson MM, Ginsberg JP, et al. Physical performance limitations in the Childhood Cancer Survivor Study cohort. *J Clin Oncol*. 2009;27:2382-2389.
130. Fong DY, Ho JW, Hui BP, et al. Physical activity for cancer survivors: meta-analysis of randomised controlled trials. *BMJ*. 2012;344:e70.
131. Baumann FT, Zopf EM, Bloch W. Clinical exercise interventions in prostate cancer patients—a systematic review of randomized controlled trials. *Support Care Cancer*. 2012;20:221-233.
132. Heim ME, v d Malsburg ML, Niklas A. Randomized controlled trial of a structured training program in breast cancer patients with tumor-related chronic fatigue. *Onkologie*. 2007;30:429-434.
133. Donnelly CM, Blaney JM, Lowe-Strong A, et al. A randomised controlled trial testing the feasibility and efficacy of a physical activity behavioural change intervention in managing fatigue with gynaecological cancer survivors. *Gynecol Oncol*. 2011;122:618-624.
134. Puetz TW, Herring MP. Differential effects of exercise on cancer-related fatigue during and following treatment: a meta-analysis. *Am J Prev Med*. 2012;43:e1-e24.
135. McNeely ML, Parliament MB, Seikaly H, et al. Effect of exercise on upper extremity pain and dysfunction in head and neck cancer survivors: a randomized controlled trial. *Cancer*. 2008;113:214-222.
136. Carvalho AP, Vital FM, Soares BG. Exercise interventions for shoulder dysfunction in patients treated for head and neck cancer. *Cochrane Database Syst Rev*. 2012;4:CD008693.
137. Knols RH, de Bruin ED, Uebelhart D, et al. Effects of an outpatient physical exercise program on hematopoietic stem-cell transplantation recipients: a randomized clinical trial. *Bone Marrow Transplant*. 2011;46:1245-1255.
138. Courneya KS, Stevinson C, McNeely ML, et al. Effects of supervised exercise on motivational outcomes and longer-term behavior. *Med Sci Sports Exerc*. 2012;44:542-549.
139. Thijs KM, de Boer AG, Vreugdenhil G, van de Wouw AJ, Houterman S, Schep G. Rehabilitation using high-intensity physical training and long-term return-to-work in cancer survivors. *J Occup Rehabil*. 2012;22:220-229.
140. Korstjens I, Mesters I, May AM, et al. Effects of cancer rehabilitation on problem-solving, anxiety and depression: a RCT comparing physical and cognitive-behavioural training versus physical training. *Psychol Health*. 2011;26(suppl 1):63-82.
141. Duijts SF, Faber MM, Oldenburg HS, van Beurden M, Aaronson NK. Effectiveness of behavioral techniques and physical exercise on psychosocial functioning and health-related quality of life in breast cancer patients and survivors—a meta-analysis. *Psychooncology*. 2011;20:115-126.
142. Cheville A. Rehabilitation of patients with advanced cancer. *Cancer*. 2001;92(suppl 4):1039-1048.
143. Kumar SP, Jim A. Physical therapy in palliative care: from symptom control to quality of life: a critical review. *Indian J Palliat Care*. 2010;16:138-146.
144. Halkett GK, Ciccarelli M, Keesing S, Aoun S. Occupational therapy in palliative care: is it under-utilised in Western Australia? *Aust Occup Ther J*. 2010;57:301-309.
145. Lin YH, Pan PJ. The use of rehabilitation among patients with breast cancer: a retrospective longitudinal cohort study. *BMC Health Serv Res*. 2012;12:282.
146. Okamura H. Importance of rehabilitation in cancer treatment and palliative medicine. *Jpn J Clin Oncol*. 2011;41:733-738.
147. Eyigor S. Physical activity and rehabilitation programs should be recommended on palliative care for patients with cancer. *J Palliat Med*. 2010;13:1183-1184.
148. Spill GR, Hlubocky FJ, Daugherty CK. Oncologists' and physiatrists' attitudes regarding rehabilitation for patients with advanced cancer. *PM R*. 2012;4:96-108.
149. Maddocks M, Murton AJ, Wilcock A. Therapeutic exercise in cancer cachexia. *Crit Rev Oncog*. 2012;17:285-292.
150. Albrecht TA, Taylor AG. Physical activity in patients with advanced-stage cancer: a systematic review of the literature. *Clin J Oncol Nurs*. 2012;16:293-300.
151. Lopez-Sendin N, Albuquerque-Sendin F, Cleland JA, Fernandez-de-las-Penas C. Effects of physical therapy on pain and mood in patients with terminal cancer: a pilot randomized clinical trial. *J Altern Complement Med*. 2012;18:480-486.
152. Quist M, Rorth M, Langer S, et al. Safety and feasibility of a combined exercise intervention for inoperable lung cancer patients undergoing chemotherapy: a pilot study. *Lung Cancer*. 2012; 75:203-208.
153. Jones L, Fitzgerald G, Leurent B, et al. Rehabilitation in advanced, progressive, recurrent cancer: a randomized controlled trial [published online ahead of print November 20, 2012]. *J Pain Symptom Manage*. pii: S0885-3924(12)00498-8. doi:10.1016/j.jpainsymman.2012.08.017.
154. Cheville AL, Kollasch J, Vandenberg J, et al. A home-based exercise program to improve function, fatigue, and sleep quality in patients with stage IV lung and colorectal cancer: a randomized controlled trial [published online ahead of print September 24, 2012]. *J Pain Symptom Manage*. pii: S0885-3924(12)00328-4. doi:10.1016/j.jpainsymman.2012.05.006.
155. Oldervoll LM, Loge JH, Lydersen S, et al. Physical exercise for cancer patients with advanced disease: a randomized controlled trial. *Oncologist*. 2011;16:1649-1657.
156. Jacobi I, van der Molen L, Huiskens H, van Rossum MA, Hilgers FJ. Voice and speech outcomes of chemoradiation for advanced head and neck cancer: a systematic review. *Eur Arch Otorhinolaryngol*. 2010;267:1495-1505.
157. Rueda JR, Sola I, Pascual A, Subirana Casacuberta M. Non-invasive interventions for improving well-being and quality of life in patients with lung cancer. *Cochrane Database Syst Rev*. 2011(9):CD004282.
158. Sciubba DM, Petteys RJ, Dekutoski MB, et al. Diagnosis and management of metastatic spine disease. *J Neurosurg Spine*. 2010;13:94-108.
159. Giovagnoli AR. Investigation of cognitive impairments in people with brain tumors. *J Neurooncol*. 2012;108:277-283.
160. Kang JH, Shin SH, Bruera E. Comprehensive approaches to managing delirium in patients with advanced cancer. *Cancer Treat Rev*. 2013;39:105-112.

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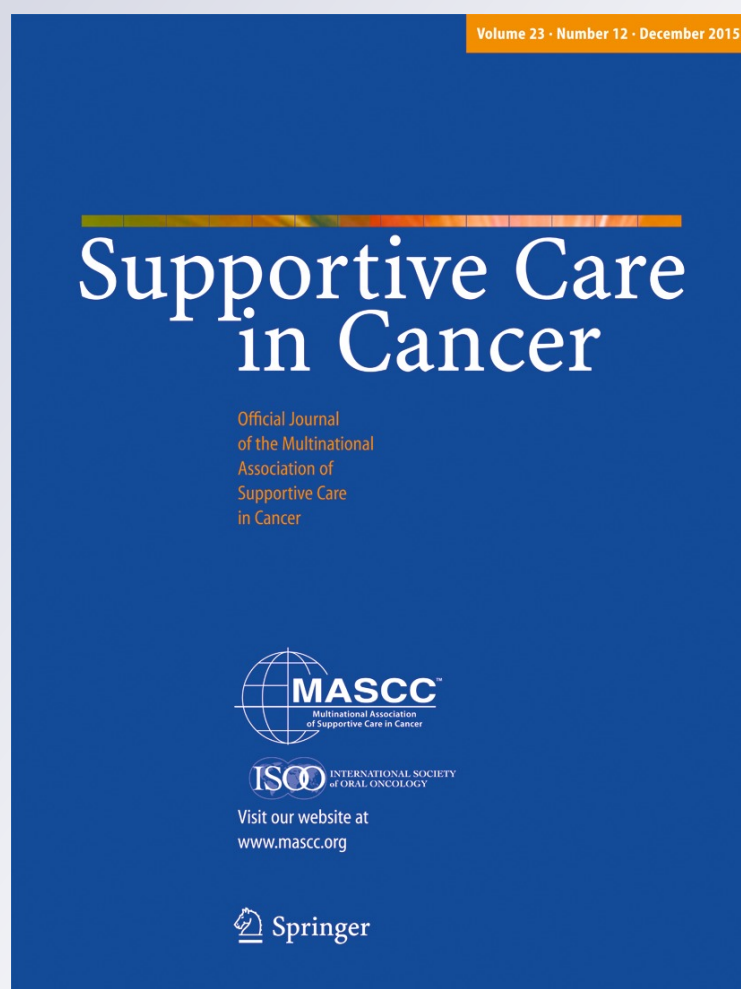
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Julie K. Silver¹ · Vishwa S. Raj² · Jack B. Fu³ · Eric M. Wisotzky⁴ · Sean Robinson Smith⁵ · Rebecca A. Kirch⁶

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Abstract Palliative care and rehabilitation practitioners are important collaborative referral sources for each other who can work together to improve the lives of cancer patients, survivors, and caregivers by improving both quality of care and quality of life. Cancer rehabilitation and palliative care involve the delivery of important but underutilized medical services to oncology patients by interdisciplinary teams. These subspecialties are similar in many respects, including their focus on improving cancer-related symptoms or cancer treatment-related side effects, improving health-related quality of life, lessening caregiver burden, and valuing patient-centered care and shared decision-making. They also aim to improve healthcare efficiencies and minimize costs by means such as reducing hospital lengths of stay and unanticipated readmissions. Although their goals are often aligned, different specialized skills and approaches are used in the delivery of care. For example, while each specialty prioritizes goal-concordant care through identification of patient and family

preferences and values, palliative care teams typically focus extensively on using patient and family communication to determine their goals of care, while also tending to comfort issues such as symptom management and spiritual concerns. Rehabilitation clinicians may tend to focus more specifically on functional issues such as identifying and treating deficits in physical, psychological, or cognitive impairments and any resulting disability and negative impact on quality of life. Additionally, although palliative care and rehabilitation practitioners are trained to diagnose and treat medically complex patients, rehabilitation clinicians also treat many patients with a single impairment and a low symptom burden. In these cases, the goal is often cure of the underlying neurologic or musculoskeletal condition. This report defines and describes cancer rehabilitation and palliative care, delineates their respective roles in comprehensive oncology care, and highlights how these services can contribute complementary components of essential quality care. An understanding of how

✉ Julie K. Silver
julie_silver@hms.harvard.edu
Vishwa S. Raj
vishwa.raj@carolinashealthcare.org
Jack B. Fu
jfu@mdanderson.org
Eric M. Wisotzky
eric.m.wisotzky@medstar.net
Sean Robinson Smith
srsz@med.umich.edu
Rebecca A. Kirch
rkirch@cancer.org

¹ Department of Physical Medicine and Rehabilitation, Harvard Medical School, Spaulding Rehabilitation Hospital, 300 First Avenue, Charlestown, MA 02129, USA

² Department of Physical Medicine and Rehabilitation, Carolinas Rehabilitation, 1100 Blythe Boulevard, Charlotte, NC 28203, USA

³ Department of Palliative, Rehabilitation, and Integrative Medicine, MD Anderson Cancer Center, University of Texas, 1515 Holcombe Blvd. Unit 1414, Houston, TX 77030, USA

⁴ MedStar National Rehabilitation Network, 102 Irving St, NW, Washington, DC 20010, USA

⁵ Department of Physical Medicine and Rehabilitation, University of Michigan, 325 E Eisenhower Pkwy, Ste 100, Ann Arbor, MI 48108, USA

⁶ American Cancer Society, 555 11th Street NW, Suite 300, Washington, DC 20004, USA

cancer rehabilitation and palliative care are aligned in goal setting, but distinct in approach may help facilitate earlier integration of both into the oncology care continuum—supporting efforts to improve physical, psychological, cognitive, functional, and quality of life outcomes in patients and survivors.

Keywords Cancer rehabilitation · Prehabilitation · Palliative care · Supportive oncology · Survivorship · Quality of life

Introduction

Although the majority of cancer patients and survivors would benefit from integration of cancer rehabilitation services during and after treatment, the underutilization of this care is well documented [1–3]. Palliative care, another important component of high-quality oncology care, is also underutilized [4]. The reason for underutilization of these critical services is multifactorial, and one important step that the medical community can take to improve access to quality care is to encourage healthcare professionals to better understand and recommend these services to colleagues, patients, and families early in the course of oncology care. This report defines and describes cancer rehabilitation and palliative care and highlights how they are aligned with and differ from each other.

On the surface, the roles of palliative care (i.e., symptom management and supportive care) and rehabilitation medicine (i.e., improving function and reducing disability) may seem divergent as they apply to cancer care for patients and survivors. Palliative care focuses specifically on addressing immediate quality of life (QOL) needs and concerns related to physical, psychological, and social distress; often in the setting of serious and complex life-threatening illness [5]. In contrast, rehabilitation medicine and physiatry emphasize short- and long-term solutions for restoration of or improvement in functioning and care management through patient empowerment and coordination of multispecialty care [6]. Palliative care and rehabilitation practitioners are trained to diagnose and treat medically complex patients. However, while palliative care consultations are often (though not always) triggered by a high symptom burden or metastatic disease, rehabilitation clinicians may treat many patients with a single impairment and low symptom burden. In these cases, the aim is often a cure of the underlying neurologic or musculoskeletal condition.

Parallels become evident, however, after considering the clinical philosophy underlying each specialty. Both use an interdisciplinary model to identify goals of care; improve function; develop treatment plans that are patient and family centric; and take into account medical, physical, social, and psychological components while employing a symptom-oriented approach [7]. They mutually focus on improving cancer-related symptoms or cancer treatment-related side

effects, improving patient health-related QOL, lessening caregiver burden, and valuing patient-centered care and shared decision-making. Each aims to improve health care efficiencies and reduce healthcare costs by means such as reducing hospital lengths of stay and unanticipated readmissions. They value psycho-oncology and the diagnostic and treatment services provided by trained behavioral health professionals. Thus, palliative care [8] and cancer rehabilitation [9] goals are aligned in helping to improve and restore QOL for patients and families. In recognition of the importance of cancer rehabilitation and palliative care services, the American College of Surgeons' Commission on Cancer (CoC) requires that patients have access to both [10]. Furthermore, the CoC now requires that patients receive a survivorship care plan that documents their past treatment as well as future needs, including cancer rehabilitation and palliative care services [11].

Cancer rehabilitation and palliative care services support delivery of patient-centered care, which, as defined by the Institute of Medicine (IOM), involves “providing care that is respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions” [12]. The IOM goes on to identify patient-centered care as one of six interrelated factors constituting high-quality healthcare. While cancer rehabilitation and palliative care are congruent with patient-centered care initiatives, their approaches involve application of different specialized expertise and focus to achieve improved QOL and functional outcomes. For example, palliative care professionals offer patient-centered, family oriented care by using communication strategies to help determine and align treatments with patient preferences and values across the care continuum and throughout the lifespan. In contrast, cancer rehabilitation professionals focus more on developing treatment plans with individualized goals designed to promote optimal patient function at home, work, and in the community.

Studies have demonstrated the benefits of palliative care in terms of QOL, economic, and medical outcomes [13–15], and an increasing recognition of the benefits of palliative care has led to a tripling in the number of palliative care programs in American hospitals since 2000 [16]. Cancer rehabilitation improves physical and functional outcomes [1], may be cost-effective [17], and may ameliorate some of the costs associated with lost work productivity and early retirement [18–20]. Not surprisingly, and like palliative care, cancer rehabilitation has been shown to improve QOL, even in patients with late-stage cancers [21].

These specialties utilize an interdisciplinary team approach to total patient care and work closely with interdisciplinary healthcare professionals such as dietitians and mental health professionals. For example, dietitians can provide interventions that address the nutritional demands associated with premorbid or comorbid malnutrition; increased levels of activity with physical therapy (energetics); and common side

effects of cancer-related treatment (anorexia, nausea, vomiting, and diarrhea). As a cancer diagnosis can also be associated with significant levels of distress anywhere along the continuum of care, mental health professionals are critical to the process of maintaining and, more importantly, improving patient well-being and QOL.

Cancer rehabilitation and palliative care may also utilize integrative medicine approaches such as massage or acupuncture, although they may be prescribed in a different manner. For example, in palliative care, generalized massage may be prescribed to reduce stress and muscle tension. In rehabilitation medicine, however, the approach might be focused on alleviating a specific impairment such as improving shoulder range of motion in someone with a rotator cuff impingement through a physical therapist's use of myofascial release techniques. In addition, as rehabilitation professionals tend to focus on identifying musculoskeletal or neurologic impairments that can be improved with specific interventions, physiatrists may prescribe opiate medications or rely on non-opiate oral medications or perform procedures including, but not limited to, trigger point, botulinum toxin, and joint injections. Incorporation of therapeutic exercise, physical modalities, and neurocognitive therapy interventions into the treatment plan through use of physical, occupational, and speech therapy may provide further benefit.

Both specialties may provide effective intervention in the case of cognitive deficits. For example, neuro-stimulants are frequently used to improve fatigue, attention, and memory [22–24]. However, rehabilitation and palliative care approaches to cognitive problems may differ depending upon a host of factors including professional training, familiarity with the patient population, and scientific evidence base [25–28]. For instance, physiatrists have expertise in managing brain injuries in non-oncological populations and are typically very familiar with the research in traumatic brain injury, stroke, and other neurological conditions that affect cognition. They bring this scientific knowledge and clinical expertise forward when managing cancer patients with various forms of cognitive impairment including agitation, delirium, and impaired arousal.

During the evaluation and treatment phase, the specialties often utilize similar approaches such as incorporating neuropsychological testing and other mental health services, but there may be differences as well. For instance, rehabilitation professionals might tend to focus on function and emphasize goals for patient safety, especially mobility to avoid falls, by addressing ambulation and transfers (e.g., from the bed to a chair or on/off the toilet seat), home accommodations (e.g., ramp to enter the home), adaptive equipment (e.g., shower seat/grab bars or Hoyer lift for transfers) and assistive devices (e.g., cane or walker). They may also spend considerable time on patient and family training to encourage functional independence in the cancer survivor in an effort to preserve everyone's QOL and reduce the physical and emotional burden of

care on others in the home. Palliative care professionals may approach the services with a bit of a different lens and spend more time on psychosocial issues such as management of cognition-related patient and caregiver distress and symptoms such as nausea and vomiting. It is easy to see that specialists in rehabilitation medicine and palliative care, working in cooperation with each other, are likely to be mutually beneficial to patients and family members.

It is well documented that there is a growing population of adult and childhood cancer survivors who are living long-term with disease-related effects, treatment-related side effects, and/or late effects of earlier treatment [4]. These survivors often endure multiple chronic conditions that can be disabling, life-threatening, and medically complex. Especially in these cases, together, cancer rehabilitation and palliative care have the potential to positively affect a multitude of issues. The most commonly cited symptoms seen in advanced cancer patients include fatigue, pain, weakness, dyspnea, delirium, nausea, vomiting, anxiety, and depression [29]. While oncology teams may consult with palliative care specialists to help manage these more complex or refractory symptoms, concern has been raised about neglecting to address physical function in advanced cancer patients [30]. Indeed, in a systematic review of rehabilitation in advanced-stage cancer, the authors demonstrated that including physical rehabilitation in a palliative care program can have positive effects on many cancer-related symptoms [31]. Furthermore, in a recent systematic review of 13 studies of the effects of cancer rehabilitation in patients with advanced cancer who were also receiving palliative care, Salakari et al. found significant improvements in general well-being and QOL as well as positive effects on fatigue, general condition, mood, and coping with cancer [32]. Therefore, it may be reasonable to consider utilizing these services in cancer patients regardless of their age, stage, or prognosis.

Fostering a better understanding of cancer rehabilitation

Although palliative care and rehabilitation can play important roles in improving QOL and survivorship, both services are often misunderstood by health professionals and the public as well. Confusion about the scope and focus of these subspecialties may exist even within oncology care. For example, rehabilitation is often confused with exercise or fitness programs, and many “rehabilitation” research studies and clinical interventions are described as “exercise only” and do not address the range of impairments that patients and survivors encounter. This misunderstanding has led to a concerning trend among some professionals—encouraging the adoption of the cardiac rehabilitation model of care [33] in oncology, without taking into account the medical complexities and

disabilities experienced by many in the cancer population. As evidence, consider that an exercise-only based model of cancer rehabilitation does not support the diagnosis or treatment of speech, swallowing, and cognitive impairments that may develop in patients with head and neck or primary or metastatic brain cancer.

It is important to note that within cardiac rehabilitation, the cardiologist usually manages a single impairment or set of impairments that are localized to the cardiovascular system. In contrast, cancer patients and survivors often experience many concurrent impairments which may occur in any organ system in the body—with the complexity of their presentation being more similar to that of a patient after a stroke than to that of a patient with cardiac disease. This profile can be overwhelming for oncologists and other members of the oncology team who are not generally equipped to diagnose and treat the many rehabilitation issues and subsequent disability that can significantly reduce function and QOL in this population. Furthermore, functional impairment(s) may preclude a patient's participation in the exercise recommended under the cardiac rehabilitation model. Therefore, a conventional and well-tested interdisciplinary model for rehabilitation care—such as that used for stroke and other serious illnesses and injuries in which physiatrists; rehabilitation nurses; and physical, occupational, and speech therapists play a critical role—is likely a more reasonable approach to addressing the impairments and disabilities exhibited by the medically complex cancer patient. Importantly, while fitness is a key component of the conventional rehabilitation model, it does not represent the totality of the services provided.

Over the years, numerous attempts have been made to define the term “cancer rehabilitation.” Cromes, in 1978, wrote that “cancer rehabilitation aims to allow the patient to achieve optimal physical, social, physiological and vocational functioning within the limits imposed by the disease and its treatment” [34]. Later, J. Herbert Dietz, MD, an attending surgeon at Memorial-Sloan Kettering Cancer Center and author of one of the first cancer rehabilitation textbooks, defined cancer rehabilitation according to four distinct phases [35]:

1. Preventative: Interventions that will lessen the effect of expected disabilities
2. Restorative: Interventions that attempt to return patients to previous levels of physical, psychological, social, and vocational functioning
3. Supportive: Interventions designed to teach patients to accommodate to their disabilities and to minimize debilitating changes from ongoing disease
4. Palliative: Interventions focused on minimizing or eliminating complications and providing comfort and support

Of note, this classification system acknowledged the utility of integrating rehabilitation interventions into a palliative

phase long before a growing body of evidence was available to support this concept.

Dietz was similarly insightful in discussing the use of preventative cancer rehabilitation, now commonly described as *prehabilitation* [36]. Prehabilitation in the cancer population is a growing area of clinical interest and research. Silver and colleagues have specifically defined cancer prehabilitation as “a process on the continuum of care that occurs between the time of diagnosis and the beginning of acute treatment and includes physical and psychological assessments that establish a baseline functional level, identify impairments, and provide targeted interventions that promote physical and psychological health to reduce the incidence and/or severity of future impairments” [1]. The primary goal of prehabilitation then is to prevent or reduce the severity of existing and anticipated treatment-related impairments that may cause significant disability.

Following initiation of treatment, rehabilitation of the patient with cancer should operate within the framework of “impairment-driven cancer rehabilitation,” also introduced by Silver and colleagues [1]. This framework includes the screening of all cancer patients for specific psychological and physical impairments that should trigger referrals to appropriately and highly trained rehabilitation healthcare professionals. These professionals would include only those whose scope of practice includes the diagnosis and treatment of physical and psychological impairments and the resulting disabilities and functional issues associated with cancer and its treatment.

Because this report reviews and provides an opportunity to further clarify the scope of cancer rehabilitation care, we propose a new definition for cancer rehabilitation that addresses critical concepts used in the International Classification of Function (ICF), including changes in body structure/function, activity limitations, and participation restriction:

Cancer rehabilitation is medical care that should be integrated throughout the oncology care continuum and delivered by trained rehabilitation professionals who have it within their scope of practice to diagnose and treat patients' physical, psychological and cognitive impairments in an effort to maintain or restore function, reduce symptom burden, maximize independence and improve quality of life in this medically complex population.

Fostering better understanding of palliative care

Despite mounting evidence consistently demonstrating its benefits to QOL and even survival in patients with cancer or other serious illnesses [37], palliative care also is

misunderstood and often still wrongly considered applicable only at the end of life or when cancer treatment has “failed.” The World Health Organization has long defined *palliative care* as “an approach that improves the quality of life of patients and their families facing the problem associated with life-threatening illness, through the prevention and relief of suffering by means of early identification and impeccable assessment and treatment of pain and other problems, physical, psychosocial and spiritual” [38]. It is therefore important to note that palliative care is appropriate at any age and stage of disease, and should be provided together with therapeutic cancer treatment intended to cure or halt progression of the disease [37]. Indeed, a provisional clinical opinion of the American Society of Clinical Oncology calls for integrated palliative care as part of cancer treatment in all patients experiencing high symptom burden or metastatic disease [39].

Using consistent and clear messages to explain palliative care is essential to improving patient and family access to these services and their benefits. A national poll commissioned by the Center to Advance Palliative Care and the American Cancer Society revealed that 7 in 10 Americans are “not at all knowledgeable” about palliative care [40]. However, an overwhelming majority of respondents (92 %) indicated that they would want palliative care for themselves or their loved ones and believed that it should be accessible in hospitals when the following definition was included:

Palliative care is specialized medical care for people with serious illnesses. This type of care is focused on providing patients with relief from the symptoms, pain, and stress of a serious illness—whatever the diagnosis. The goal is to improve quality of life for both the patient and the family. Palliative care is provided by a team of doctors, nurses, and other specialists who work with a patient’s other doctors to provide an extra layer of support. Palliative care is appropriate at any age and at any stage in a serious illness, and can be provided together with curative treatment [40].

To ensure delivery of the best care possible, the language and approaches used in clinical care to introduce and describe palliative services to patients, families, and professional colleagues must evolve so that they align consistently with this definition and messaging proven to minimize confusion and promote better understanding, acceptance, and access. Although significant differences in practice patterns may exist depending upon the actual name of the service line available [41], palliative care in oncology settings often is considered synonymous with “supportive care” [42]. Contrary to recent evidence supporting integration of palliative care services early in the disease course, differentiation is still sometimes made according to each perceived level of care; with palliative care being reserved only for the end of life and supportive care

focusing on management of treatment and post-treatment issues [43]. Adding to the complexity, rehabilitation is often understood as an integral component of supportive care [44], but not necessarily understood as an essential part of palliative care. Clearly, the diversity in definition of scope is confusing, and may lead to underutilization of services as awareness of appropriate referral for specific impairments may be compromised within the medical community itself.

Advancing collaborative interdisciplinary care coordination

In order to advance the provision of high-quality oncology care, it is important to recognize barriers to care and implement strategies to overcome them. It is clear that cancer rehabilitation and palliative care play independent and important roles in the treatment of the complex cancer patient, but better collaboration between these two specialties is needed. However, barriers may include, but are not limited to, rehabilitation professionals’ real or perceived lack of experience with medically complex cancer patients who may have a high symptom burden that may include end of life situations [45, 46]. On the other hand, oncology professionals, including those in palliative care, may not understand the many different ways rehabilitation medicine can help these patients and/or they may not have experience in screening these patients for their rehabilitation needs [30]. In addition and as previously discussed, rehabilitation and palliative care clinicians each apply different skills and address different areas of emphasis. Importantly, both typically use interdisciplinary team approaches to care. It is this common approach to care that can form the foundation for an effective strategy aimed at overcoming some of the barriers to provision of high-quality oncology care: collaborative interdisciplinary care coordination between the oncology, rehabilitation, and palliative care teams working together within their own specialties to address cancer-related and treatment-related issues.

Interdisciplinary hospital-based palliative care teams often consist of a physician, nurse, and social worker, and may also include a chaplain or spiritual counselor, a pharmacist, and several others [5]. While outpatient and community-based service models are emerging with increasing frequency, hospital-based teams that provide consultation services remain the most prevalent model of palliative care delivery. These services usually involve specialty level palliative care for difficult-to-manage symptoms, complex family dynamics, and challenging care decisions that may involve the use of life-sustaining treatments [5]. Their efforts focus on getting distressing symptoms under control and coordinating communication in order to help align treatments with patient and family goals.

The interdisciplinary inpatient rehabilitation team usually is led by a physiatrist and includes a physical therapist (PT), occupational therapist (OT), and speech-language pathologist (SLP). Mental health professionals are also important members and may include a rehabilitation psychologist, social worker, case manager, and neuropsychologist. Recreational therapists, dietitians, orthotists, prosthetists, chaplains, and other types of professionals are either incorporated into the team automatically or may be available on a consultative basis when a need arises. Physiatry and physical/occupational/speech therapy services play prominent roles in maintaining, recovering, or improving patient function [47], and mental health services focus on cognitive and psychosocial issues including, but not limited to, distress associated with the cancer and treatment-related symptoms or impairments and resulting disability [1]. Physiatrists typically manage the rehabilitation team and provide additional expertise in diagnostic testing, performing injections and prescribing medications, adaptive equipment, prosthetics, and orthotics that compensate for a patient's disabilities.

Palliative care teams are often involved in end of life care and may have more experience with and perhaps rely more often on prescription of opioids and other medications for alleviation of physical symptoms associated with pain than rehabilitation teams who may utilize other interventions, even in cases of advanced cancer. The role that rehabilitation medicine and physical agents play in the treatment of cancer pain has been well documented [48] and complements conventional systemic analgesic therapy that is common among palliative care patients. In particular, physiatrists receive specialized training in the management of neurologic and musculoskeletal causes of impairment; receive specialized training to perform symptom relief procedures that include botulinum toxin, joint, and trigger point injections; and often earn additional board certifications including electrodiagnostic medicine and pain management. Consider then how the rehabilitation team may be helpful in supporting the palliative care team in the treatment of patients near the end of life with comorbid cognitive deficits. Use of injectable local treatments for pain could defer or forego the use of potentially sedating systemic medications [49, 50]. In these instances, physiatrists may be uniquely qualified to prescribe appropriate treatment supporting palliative care efforts without further compromising cognitive function. Moreover, Cheville and Basford described the use of physical medicine interventions in patients with pain due to cancer itself [48]. In many cases, adding an extra layer of support through use of specialized physiatry skills may be of significant benefit to palliative care teams trying to manage pain and other symptoms in their patients.

The rehabilitation team can also play a role in the treatment of fatigue. Fatigue is one of the most distressing and prevalent problems affecting patients with cancer, and it is a common reason for referral to cancer rehabilitation or palliative care

specialists [51]. Often, the physiatrist will be consulted because the fatigue has impacted the patient's function. Physical and occupational therapy may also be prescribed in order to facilitate appropriate therapeutic exercise. Prescription of energy conservation techniques such as energy conservation and activity management may be useful as well [52, 53].

Cancer patients and survivors are also at a higher risk for musculoskeletal injuries than noncancer patients [54, 55]. Common contributing issues are asthenia, cachexia, peripheral neuropathies, plexopathies, myopathies, radiation fibrosis, and medications such as aromatase inhibitors [56–58]. Physiatrists can be helpful in these cases because they are skilled in the diagnosis and treatment of musculoskeletal complications. Diagnostic work-up can include physical examination and analysis of imaging tests such as x-rays, magnetic resonance imaging, and computed tomography scans. Physiatrists may then perform musculoskeletal injections [59, 60] and/or prescribe oral medications as well as physical, occupational, and speech therapy.

Opportunities to improve the patient experience exist throughout all phases of cancer care, especially during times of disease recurrence and at the end of life. Use of rehabilitation may prevent a decline in or even improve function in patients with advanced cancer; "improving the quality of life by palliating function, mobility, activities of daily living, pain relief, endurance, and the psyche of a patient while helping to maintain as much independence as possible, leading to a decrease in burden on caregivers and family" [61]. Physical therapy and exercise have been shown to be a feasible modality for terminally ill patients [62], and patients who participated in a specific combination palliative rehabilitation program did show improvement in physical performance and symptom severity [63]. Rehabilitation services provided in a hospice day care unit for individuals with advanced, recurrent, or progressive breast or hematological malignancy also showed significant reduced need for health service resources along with corresponding improvement in QOL [64]. Furthermore, early integration of palliative care in the oncology care continuum may result in particularly meaningful healthcare cost reductions, as this approach improved both survival rates and QOL [65].

Because people often face complex physical and psychosocial needs near the end of life, the IOM advocated for improved care coordination and patient-caregiver communication in its 2014 report *Dying in America: Improving quality and honoring individual preferences near the end of life* [66]. As the disease process advances, people are faced with an increasing number of healthcare transitions, creating inefficiencies and leading to unrecognized and undertreated problems [67]. This finding was corroborated in a 2014 comprehensive analysis demonstrating that patients were dissatisfied with clinician recognition of symptoms and the lack of proper referrals when symptoms were identified [68]. The authors concluded that use of patient-centered outcome measures improved awareness of unmet needs, and improved patient

psychological QOL. It seems reasonable to suggest then that appropriate integration of oncology, rehabilitation, and palliative care that is focused on patient-centered outcomes may improve outcomes in domains such as patient health, function, QOL, and satisfaction with care.

Improving access to cancer rehabilitation and palliative care services

Appropriate and timely use of screening protocols and tools is one way to improve care coordination and access to services. Additionally, it is important that the evaluation processes address the constellation of symptoms that this patient population faces by screening for physical, cognitive, emotional, and other factors (Table 1) [20]. Screening can begin at the time of diagnosis and continue throughout treatment and survivorship, and ideal baseline and subsequent follow-up assessments will help facilitate appropriate referrals to rehabilitation and palliative care services. In fact, use of this type of protocol has been proposed in breast cancer survivors—the Prospective Surveillance Model [69]. This strategy helps capture symptoms as they arise, possibly reducing symptom burden and improving outcomes. Ultimately, assessments and recommendations for palliative care and rehabilitation services at the moment and in the future should be integrated into a patient's survivorship care plan [70].

Currently, there is no single universally recognized screening tool that will facilitate referrals to cancer rehabilitation and palliative care (Table 1). A consensus report from the Center to Advance Palliative Care outlined primary trigger criteria in order to help identify patients in need of a palliative care assessment in the hospital setting [71]. Guidelines set by the CoC endorsed distress screening as a standard of care in the USA. Dual screening—for both distress and physical impairments—has been proposed as well [1]. Screening for frailty, particularly in those with comorbidities, a long or complicated cancer history, and/or advanced age, is becoming increasingly important as the life expectancy and symptom burden of cancer survivors increases.

Since screening tools may collect a considerable amount of data, building space for assessment outcomes in an electronic medical record (EMR) can be useful. Indeed, one study of over 900 hospice programs found that the majority used EMR to track assessment of physical symptoms [72]. Many of those programs also used EMR to monitor psychosocial issues and coordination of interdisciplinary care. EMR systems can also use documentation to calculate assessment tool scores, indicate when a referral is necessary, and collect data related to quality improvement projects.

Improving interdisciplinary palliative and rehabilitation care demands a comprehensive strategy, and governmental and advocacy organizations have recently highlighted the

substantial need for more research [73]. Interdisciplinary collaboration on projects was specifically emphasized as necessary to the translation of data into improved clinical care. Subsequent outcome studies will be needed to measure the impact of any improvements in these services. Importantly, although both palliative care [74] and rehabilitation of patients with advanced cancer [75] have been shown to reduce overall costs, given recent health care reforms in the USA that emphasize Accountable Care Organizations [76] and bundled payment models [77], the economic impact of improvement in these services must be further studied.

The interdisciplinary nature of palliative care and rehabilitation also demands ongoing collaboration between national advocacy groups, government, professional organizations, clinicians, and patients in order to foster meaningful change in delivery of care models. The CoC has already mandated screening assessments, and the National Institute of Health's Cancer Rehabilitation Conference [78] and American Congress of Rehabilitation Medicine [79] are working to better integrate these services into healthcare systems. Advocacy initiatives like the Patient Quality of Life Coalition [80] that bring together a variety of stakeholders across diseases and disciplines provide a helpful coordinating infrastructure and framework to help advance these opportunities. In order to build upon this momentum, more involvement is needed from groups and individuals alike.

Finally, there is a lack of expertise in [81] and a number of providers for [82] this complex patient population and the IOM strongly advocates for improved education

Table 1 Examples of currently available rehabilitation and/or palliative care screening tools

Subject	Tool
Frailty	Vulnerable Elders Survey-13 Comprehensive Geriatric Assessment
Functional status	Barthel Index Functional Independence Measures Karnofsky Performance Status Scale
Gait/mobility	Timed Up and Go Test 6-Minute Walk Test
Cognition	Functional Assessment of Cancer Therapy (FACT)-Cog Mini-Cog
Quality of life	FACT-G Functional Living Index-Cancer
Distress	Distress Thermometer Hospital Anxiety and Depression Scale Edmonton Symptom Assessment System
Longitudinal research	PROMIS Cancer Rehabilitation Evaluation System

This is not intended to be a comprehensive list

of allied health providers, medical trainees, and even patients. For example, physicians and medical students have expressed deficiencies in palliative care training and communication skills and concerns also exist regarding the variable approach to training across medical schools [83]. Although cancer rehabilitation is considered an important part of physical medicine and rehabilitation (PM&R) residency education, research has demonstrated that the quality and quantity of experiences may be improved [45]. Furthermore, variability exists regarding perceived appropriateness of rehabilitation for individuals with advanced cancer by both medical oncologists and physiatrists [84]. Consideration of these issues may help explain why many oncologists feel inadequately prepared for supportive care tasks [85]. However, opportunities do exist to improve the delivery of supportive cancer care. In fact, studies have demonstrated that mid-level providers, after brief training, have been able to successfully screen patients for symptom burden and discuss end of life care [86], and should therefore be integrated into care programs. Trainees, including medical students, must have increased instruction in palliative and rehabilitation care. The IOM is currently recommending that clinicians across almost all specialties be trained in person-centered communication skills—a key foundation of palliative care—as well as “interprofessional collaboration, and symptom management” [66].

Perhaps equally concerning is that patients and families too lack understanding of palliative care services [45], and a concerted effort must be made to educate them about available resources and give them the words to use to get the care they need. Patients and survivors experience reduced health-related QOL as a result of impairments, and rehabilitation can improve physical, psychological, and cognitive impairments throughout the trajectory of cancer care [1]. In the USA, the court case *Jimmo v Sebelius* helped to clarify the “improvement standard” used by Medicare and resulted in an understanding that rehabilitation care should be focused on the individual need, and not solely on restorative potential, thus increasing access for patients in all phases of treatment [87]. Helping to understand the clinical implications of quality treatment and survivorship care may allow for new and exciting opportunities to integrate palliative care and cancer rehabilitation and significantly improve the quality of patient-centered programs.

Conclusion

Cancer rehabilitation and palliative care services are critical components of high-quality oncology care. Recognizing that cancer rehabilitation is medical care that goes far beyond exercise is essential. Clinicians and researchers alike should

differentiate general exercise and wellness initiatives from comprehensive cancer rehabilitation by qualified professionals that diagnose and treat patients’ and survivors’ impairments and improve their function and QOL. With the challenging goals of simultaneously lowering healthcare costs while improving patient outcomes and satisfaction with care, there is an urgent need to address the underutilization of both cancer rehabilitation and palliative care services as well as improve access.

The research in these fields continues to evolve and support better integration of these services into high-quality oncology care. For example, recent reports have suggested that palliative care services may decrease emergency department visits [88], prehabilitation may reduce costs and improve outcomes [89], and rehabilitation may prevent hospital-acquired disability [90]. As there is a need to continue to develop the evidence base with further integrated and collaborative research, both rehabilitation medicine and palliative care will be positioned to evolve in a complementary manner that improves oncology care outcomes.

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References

1. Silver JK, Baima J, Mayer RS (2013) Impairment-driven cancer rehabilitation: an essential component of quality care and survivorship. *CA Cancer J Clin* 63(5):295–317. doi:10.3322/caac.21186
2. Cheville AL, Troxel AB, Basford JR, Kornblith AB (2008) Prevalence and treatment patterns of physical impairments in patients with metastatic breast cancer. *J Clin Oncol* 26(16):2621–2629. doi:10.1200/JCO.2007.12.3075
3. Pergolotti M, Deal AM, Lavery J, Reeve BB, Muss HB (2015) The prevalence of potentially modifiable functional deficits and the subsequent use of occupational and physical therapy by older adults with cancer. *J Geriatr Oncol*. doi:10.1016/j.jgo.2015.01.004
4. Institute of Medicine (2013) Delivering high-quality cancer care: charting a new course for a system in crisis. National Academies Press, Washington, DC
5. Bruera E, Hui D (2012) Conceptual models for integrating palliative care at cancer centers. *J Palliat Med* 15(11):1261–1269. doi:10.1089/jpm.2012.0147
6. Mukai A (2011) The future of physiatry: with challenges come opportunities. *PM R* 3(3):189–192. doi:10.1016/j.pmrj.2011.02.002
7. Santiago-Palma J, Payne R (2001) Palliative care and rehabilitation. *Cancer* 92(4 Suppl):1049–1052
8. Rome RB, Luminais HH, Bourgeois DA, Blais CM (2011) The role of palliative care at the end of life. *Ochsner J* 11(4):348–352

9. Stubblefield MD, Hubbard G, Cheville A, Koch U, Schmitz KH, Dalton SO (2013) Current perspectives and emerging issues on cancer rehabilitation. *Cancer* 119(Suppl 11):2170–2178. doi:10.1002/cncr.28059
10. Commission on Cancer (2012) Cancer program standards 2012: ensuring patient-centered care. American College of Surgeons. <https://www.facs.org/~media/files/quality%20programs/cancer/coc/programstandards2012.ashx>. Accessed 2 Mar 2015
11. Institute of Medicine, National Research Council (2005) From cancer patient to cancer survivor: lost in transition. National Academies Press, Washington, DC
12. Institute of Medicine (2001) Crossing the quality chasm: a new health system for the 21st century. National Academy Press. <https://www.iom.edu/Reports/2001/Crossing-the-Quality-Chasm-A-New-Health-System-for-the-21st-Century.aspx>. Accessed 3 Mar 2015
13. Brumley R, Enguidanos S, Jamison P, Seitz R, Morgenstern N, Saito S, McIlwaine J, Hillary K, Gonzalez J (2007) Increased satisfaction with care and lower costs: results of a randomized trial of in-home palliative care. *J Am Geriatr Soc* 55(7):993–1000. doi:10.1111/j.1532-5415.2007.01234.x
14. Gade G, Venohr I, Conner D, McGrady K, Beane J, Richardson RH, Williams MP, Liberson M, Blum M, Della Penna R (2008) Impact of an inpatient palliative care team: a randomized control trial. *J Palliat Med* 11(2):180–190. doi:10.1089/jpm.2007.0055
15. Bakitas M, Lyons KD, Hegel MT, Balan S, Brokaw FC, Seville J, Hull JG, Li Z, Tosteson TD, Byock IR, Ahles TA (2009) Effects of a palliative care intervention on clinical outcomes in patients with advanced cancer: the project ENABLE II randomized controlled trial. *JAMA* 302(7):741–749. doi:10.1001/jama.2009.1198
16. Morrison RS, Augustin R, Souvanna P, Meier DE (2011) America's care of serious illness: a state-by-state report card on access to palliative care in our nation's hospitals. *J Palliat Med* 14(10):1094–1096. doi:10.1089/jpm.2011.9634
17. Mewes JC, Steuten LM, Ijzerman MJ, van Harten WH (2012) Effectiveness of multidimensional cancer survivor rehabilitation and cost-effectiveness of cancer rehabilitation in general: a systematic review. *Oncologist* 17(12):1581–1593. doi:10.1634/theoncologist.2012-0151
18. Pearce AM, Hanly P, Timmons A, Walsh PM, O'Neill C, O'Sullivan E, Gooberman-Hill R, Thomas AA, Gallagher P, Sharp L (2015) Productivity losses associated with head and neck cancer using the human capital and friction cost approaches. *Appl Health Econ Health Policy*. doi:10.1007/s40258-015-0155-8
19. Silver JK, Baima J, Newman R, Galantino ML, Shockney LD (2013) Cancer rehabilitation may improve function in survivors and decrease the economic burden of cancer to individuals and society. *Work* 46(4):455–472. doi:10.3233/WOR-131755
20. Silver JK (2014) Cancer rehabilitation and prehabilitation may reduce disability and early retirement. *Cancer* 120(14):2072–2076. doi:10.1002/cncr.28713
21. Quist M, Rorth M, Langer S, Jones LW, Laursen JH, Pappot H, Christensen KB, Adamsen L (2012) Safety and feasibility of a combined exercise intervention for inoperable lung cancer patients undergoing chemotherapy: a pilot study. *Lung Cancer* 75(2):203–208. doi:10.1016/j.lungcan.2011.07.006
22. Sami MB, Faruqi R (2015) The effectiveness of dopamine agonists for treatment of neuropsychiatric symptoms post brain injury and stroke. *Acta Neuropsychiatr* 1–11. doi:10.1017/neu.2015.17
23. Johansson B, Wentzel AP, Andrell P, Mannheimer C, Ronnback L (2015) Methylphenidate reduces mental fatigue and improves processing speed in persons suffered a traumatic brain injury. *Brain Inj* 1–8. doi:10.3109/02699052.2015.1004747
24. Escalante CP, Meyers C, Reuben JM, Wang X, Qiao W, Manzullo E, Alvarez RH, Morrow PK, Gonzalez-Angulo AM, Wang XS, Mendoza T, Liu W, Holmes H, Hwang J, Pisters K, Overman M, Cleeland C (2014) A randomized, double-blind, 2-period, placebo-controlled crossover trial of a sustained-release methylphenidate in the treatment of fatigue in cancer patients. *Cancer J* 20(1):8–14. doi:10.1097/PPO.000000000000018
25. Pillai A, Parikh V, Terry AV Jr, Mahadik SP (2007) Long-term antipsychotic treatments and crossover studies in rats: differential effects of typical and atypical agents on the expression of antioxidant enzymes and membrane lipid peroxidation in rat brain. *J Psychiatr Res* 41(5):372–386. doi:10.1016/j.jpsychires.2006.01.011
26. Wilson MS, Gibson CJ, Hamm RJ (2003) Haloperidol, but not olanzapine, impairs cognitive performance after traumatic brain injury in rats. *Am J Phys Med Rehabil* 82(11):871–879. doi:10.1097/01.PHM.0000091982.33232.CB
27. Elovic EP, Lansang R, Li Y, Ricker JH (2003) The use of atypical antipsychotics in traumatic brain injury. *J Head Trauma Rehabil* 18(2):177–195
28. Alici Y, Breitbart W (2015) Delirium. In: Bruera E, Higginson I, von Gunten CF, Morita T (eds) Textbook of palliative medicine and supportive care, 2nd edn. CRC Press, Boca Raton, pp 702–721
29. Donnelly S, Walsh D (1995) The symptoms of advanced cancer. *Semin Oncol* 22(2 Suppl 3):67–72
30. Eyigor S (2010) Physical activity and rehabilitation programs should be recommended on palliative care for patients with cancer. *J Palliat Med* 13(10):1183–1184. doi:10.1089/jpm.2010.0064
31. Albrecht TA, Taylor AG (2012) Physical activity in patients with advanced-stage cancer: a systematic review of the literature. *Clin J Oncol Nurs* 16(3):293–300. doi:10.1188/12.CJON.293-300
32. Salakari MR, Surakka T, Nurminen R, Pyllkanen L (2015) Effects of rehabilitation among patients with advanced cancer: a systematic review. *Acta Oncol* 54(5):618–628. doi:10.3109/0284186X.2014.996661
33. Dittus KL, Lakoski SG, Savage PD, Kokinda N, Toth M, Stevens D, Woods K, O'Brien P, Ades PA (2015) Exercise-based oncology rehabilitation: leveraging the cardiac rehabilitation model. *J Cardiopulm Rehabil Prev* 35(2):130–139. doi:10.1097/HCR.0000000000000091
34. Cromes GF Jr (1978) Implementation of interdisciplinary cancer rehabilitation. *Rehab Counsel Bull* 21(3):230–237
35. Dietz JH (1981) Rehabilitation oncology. John Wiley & Sons Inc, New York
36. Silver JK, Baima J (2013) Cancer prehabilitation: an opportunity to decrease treatment-related morbidity, increase cancer treatment options, and improve physical and psychological health outcomes. *Am J Phys Med Rehabil* 92(8):715–727. doi:10.1097/PHM.0b013e31829b4afe
37. Parikh RB, Kirch RA, Smith TJ, Temel JS (2013) Early specialty palliative care—translating data in oncology into practice. *N Engl J Med* 369(24):2347–2351. doi:10.1056/NEJMs1305469
38. Who definition of palliative care (2015) World Health Organization. <http://www.who.int/cancer/palliative/definition/en/>. Accessed 2 Mar 2015
39. Smith TJ, Temin S, Alesi ER, Abernethy AP, Balboni TA, Basch EM, Ferrell BR, Loscalzo M, Meier DE, Paice JA, Peppercorn JM, Somerfield M, Stovall E, Von Roenn JH (2012) American society of clinical oncology provisional clinical opinion: the integration of palliative care into standard oncology care. *J Clin Oncol* 30(8):880–887. doi:10.1200/JCO.2011.38.5161
40. Center to advance palliative care (2011) Public opinion research on palliative care. https://www.capc.org/media/filer_public/18/ab/18ab708c-f835-4380-921d-fbf729702e36/2011-public-opinion-research-on-palliative-care.pdf. Accessed 3 Mar 2015
41. Dalal S, Palla S, Hui D, Nguyen L, Chacko R, Li Z, Fadul N, Scott C, Thornton V, Coldman B, Amin Y, Bruera E (2011) Association between a name change from palliative to supportive care and the

- timing of patient referrals at a comprehensive cancer center. *Oncologist* 16(1):105–111. doi:10.1634/theoncologist.2010-0161
42. American Cancer Society (2014) A guide to palliative or supportive care: what is palliative care? <http://www.cancer.org/treatment/treatmentsandsideeffects/palliativecare/supportive-care>. Accessed 2 Mar 2015
43. Aapro MS (2012) Supportive care and palliative care: a time for unity in diversity. *Ann Oncol* 23(8):1932–1934. doi:10.1093/annonc/mds239
44. What is MASCC? (2015) Multinational association of supportive care in cancer. <http://www.mascc.org/about-mascc>. Accessed 2 Mar 2015
45. Raj VS, Balouch J, Norton JH (2014) Cancer rehabilitation education during physical medicine and rehabilitation residency: preliminary data regarding the quality and quantity of experiences. *Am J Phys Med Rehabil*. doi:10.1097/PHM.0000000000000060
46. Palacio A, Calmels P, Genty M, Le-Quang B, Beuret-Blanquart F (2009) Oncology and physical medicine and rehabilitation. *Ann Phys Rehabil Med* 52(7–8):568–578. doi:10.1016/j.rehab.2009.05.004
47. Shin KY, Guo Y, Konzen B, Fu J, Yadav R, Bruera E (2011) Inpatient cancer rehabilitation: the experience of a national comprehensive cancer center. *Am J Phys Med Rehabil* 90(5 Suppl 1):S63–68. doi:10.1097/PHM.0b013e31820be1a4
48. Cheville AL, Basford JR (2014) Role of rehabilitation medicine and physical agents in the treatment of cancer-associated pain. *J Clin Oncol* 32(16):1691–1702. doi:10.1200/JCO.2013.53.6680
49. Fu J, Ngo A, Shin K, Bruera E (2013) Botulinum toxin injection and phenol nerve block for reduction of end-of-life pain. *J Palliat Med* 16(12):1637–1640. doi:10.1089/jpm.2013.0182
50. Dhah S, Fu J (2015) Musculoskeletal disease management at the end of life: an opportunity for physiatrists to provide expert consultation. Poster presented at the Association of Academic Physiatrists, San Antonio, TX, March 10–14
51. Bower JE (2014) Cancer-related fatigue—mechanisms, risk factors, and treatments. *Nat Rev Clin Oncol* 11(10):597–609. doi:10.1038/nrclinonc.2014.127
52. Jacobsen PB, Donovan KA, Vadaparampil ST, Small BJ (2007) Systematic review and meta-analysis of psychological and activity-based interventions for cancer-related fatigue. *Health Psychol* 26(6):660–667. doi:10.1037/0278-6133.26.6.660
53. Barsevick AM, Whitmer K, Sweeney C, Nail LM (2002) A pilot study examining energy conservation for cancer treatment-related fatigue. *Cancer Nurs* 25(5):333–341
54. Soulen RL, Romero JA, Chuba PJ, Evelhoch JL, Simpson RE, Forman JD (1997) Musculoskeletal complications of neutron therapy for prostate cancer. *Radiat Oncol Investig* 5(2):81–91. doi:10.1002/(SICI)1520-6823(1997)5:2<81::AID-ROI6>3.0.CO;2-F
55. Olufade T, Gallicchio L, MacDonald R, Helzlsouer KJ (2015) Musculoskeletal pain and health-related quality of life among breast cancer patients treated with aromatase inhibitors. *Support Care Cancer* 23(2):447–455. doi:10.1007/s00520-014-2364-3
56. Crew KD, Greenlee H, Capodice J, Raptis G, Brafman L, Fuentes D, Sierra A, Hershman DL (2007) Prevalence of joint symptoms in postmenopausal women taking aromatase inhibitors for early-stage breast cancer. *J Clin Oncol* 25(25):3877–3883. doi:10.1200/JCO.2007.10.7573
57. Henry NL, Giles JT, Ang D, Mohan M, Dadabhoy D, Robarge J, Hayden J, Lemler S, Shahverdi K, Powers P, Li L, Flockhart D, Stearns V, Hayes DF, Storniolo AM, Clauw DJ (2008) Prospective characterization of musculoskeletal symptoms in early stage breast cancer patients treated with aromatase inhibitors. *Breast Cancer Res Treat* 111(2):365–372. doi:10.1007/s10549-007-9774-6
58. Niravath P (2013) Aromatase inhibitor-induced arthralgia: a review. *Ann Oncol* 24(6):1443–1449. doi:10.1093/annonc/mdt037
59. Ashraf MO, Devadoss VG (2014) Systematic review and meta-analysis on steroid injection therapy for De Quervain's tenosynovitis in adults. *Eur J Orthop Surg Traumatol* 24(2):149–157. doi:10.1007/s00590-012-1164-z
60. Ng YC, Lo NN, Yang KY, Chia SL, Chong HC, Yeo SJ (2011) Effects of periarticular steroid injection on knee function and the inflammatory response following unicondylar knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 19(1):60–65. doi:10.1007/s00167-010-1126-0
61. Barawid E, Covarrubias N, Tribuzio B, Liao S (2015) The benefits of rehabilitation for palliative care patients. *Am J Hosp Palliat Care* 32(1):34–43. doi:10.1177/1049909113514474
62. Jensen W, Bialy L, Ketels G, Baumann FT, Bokemeyer C, Oechsle K (2014) Physical exercise and therapy in terminally ill cancer patients: a retrospective feasibility analysis. *Support Care Cancer* 22(5):1261–1268. doi:10.1007/s00520-013-2080-4
63. Chasen MR, Feldstain A, Gravelle D, Macdonald N, Pereira J (2013) An interprofessional palliative care oncology rehabilitation program: effects on function and predictors of program completion. *Curr Oncol* 20(6):301–309. doi:10.3747/co.20.1607
64. Jones L, Fitzgerald G, Leurent B, Round J, Eades J, Davis S, Gishen F, Holman A, Hopkins K, Tookman A (2013) Rehabilitation in advanced, progressive, recurrent cancer: a randomized controlled trial. *J Pain Symp Manag* 46(3):315–325. doi:10.1016/j.jpainsymman.2012.08.017, e313
65. Temel JS, Greer JA, Muzikansky A, Gallagher ER, Admane S, Jackson VA, Dahlin CM, Blinderman CD, Jacobsen J, Pirl WF, Billings JA, Lynch TJ (2010) Early palliative care for patients with metastatic non-small-cell lung cancer. *N Engl J Med* 363(8):733–742. doi:10.1056/NEJMoa1000678
66. Institute of Medicine (2014) Dying in America: improving quality and honoring individual preferences near the end of life. The National Academies Press, Washington, DC
67. Teno JM, Gozalo PL, Bynum JP, Leland NE, Miller SC, Morden NE, Scupp T, Goodman DC, Mor V (2013) Change in end-of-life care for Medicare beneficiaries: site of death, place of care, and health care transitions in 2000, 2005, and 2009. *JAMA* 309(5):470–477. doi:10.1001/jama.2012.207624
68. Etkind SN, Daveson BA, Kwok W, Witt J, Bausewein C, Higginson IJ, Murtagh FE (2014) Capture, transfer, and feedback of patient-centered outcomes data in palliative care populations: does it make a difference? A systematic review. *J Pain Symp Manag*. doi:10.1016/j.jpainsymman.2014.07.010
69. Stout NL, Binkley JM, Schmitz KH, Andrews K, Hayes SC, Campbell KL, McNeely ML, Soballe PW, Berger AM, Cheville AL, Fabian C, Gerber LH, Harris SR, Johansson K, Pusic AL, Prosnitz RG, Smith RA (2012) A prospective surveillance model for rehabilitation for women with breast cancer. *Cancer* 118(8 Suppl):2191–2200. doi:10.1002/cncr.27476
70. Smith SR, Reish AG, Andrews C (2014) Cancer survivorship: a growing role for physiatric care. *PM R*. doi:10.1016/j.pmrj.2014.12.004
71. Weissman DE, Meier DE (2011) Identifying patients in need of a palliative care assessment in the hospital setting: a consensus report from the center to advance palliative care. *J Palliat Med* 14(1):17–23. doi:10.1089/jpm.2010.0347
72. Zheng NT, Rokoske FS, Kirk MA, Lyda-McDonald B, Bernard SL (2014) Hospices' use of electronic medical records for quality assessment and performance improvement programs. *J Pain Symp Manag* 48(4):582–589. doi:10.1016/j.jpainsymman.2013.11.010
73. Alfano CM, Smith T, de Moor JS, Glasgow RE, Khoury MJ, Hawkins NA, Stein KD, Rechis R, Parry C, Leach CR, Padgett L, Rowland JH (2014) An action plan for translating cancer survivorship research into care. *J Natl Cancer Inst* 106(11). doi:10.1093/jnci/dju287

74. Ciemins EL, Blum L, Nunley M, Lasher A, Newman JM (2007) The economic and clinical impact of an inpatient palliative care consultation service: a multifaceted approach. *J Palliat Med* 10(6): 1347–1355. doi:10.1089/jpm.2007.0065
75. Round J, Leurent B, Jones L (2014) A cost-utility analysis of a rehabilitation service for people living with and beyond cancer. *BMC Health Serv Res* 14(1):558. doi:10.1186/s12913-014-0558-5
76. O'Halloran K, Depalma A, Joseph V, Cobelli N, Sharan A (2012) The role of accountable care organizations in delivering value. *Curr Rev Musculoskelet Med* 5(4):283–289. doi:10.1007/s12178-012-9138-7
77. Greenapple R (2013) Rapid expansion of new oncology care delivery payment models: results from a payer survey. *Am Health Drug Benefit* 6(5):249–256
78. National Institutes of Health Clinical Center (2015) Save the date—cancer rehabilitation conference <http://www.cc.nih.gov/rmd/crc/index.html>. Accessed March 2 2015
79. Cancer rehabilitation networking group (2013) American congress of rehabilitation medicine. <http://www.acrm.org/acrm-communities/cancer/>. Accessed 2 Mar 2015
80. About PQLC (2015) Patient quality of life coalition. <http://patientqualityoflife.org/about-pqlc/>. Accessed 15 May 2015
81. Dickinson GE (2011) Thirty-five years of end-of-life issues in us medical schools. *Am J Hosp Palliat Care* 28(6):412–417. doi:10.1177/1049909110397608
82. Lupu D, American Academy of H, Palliative Medicine Workforce Task F (2010) Estimate of current hospice and palliative medicine physician workforce shortage. *J Pain Symp Manag* 40(6):899–911. doi:10.1016/j.jpainsymman.2010.07.004
83. Chiu N, Cheon P, Lutz S, Lao N, Pulenzas N, Chiu L, McDonald R, Rowbottom L, Chow E (2014) Inadequacy of palliative training in the medical school curriculum. *J Cancer Educ*. doi:10.1007/s13187-014-0762-3
84. Spill GR, Hlubocky FJ, Daugherty CK (2012) Oncologists' and physiatrists' attitudes regarding rehabilitation for patients with advanced cancer. *PM R* 4(2):96–108. doi:10.1016/j.pmrj.2011.08.539
85. Cherny NI, Catane R, European Society of Medical Oncology Taskforce on P, Supportive C (2003) Attitudes of medical oncologists toward palliative care for patients with advanced and incurable cancer: report on a survey by the European Society of Medical Oncology Taskforce on Palliative and Supportive Care. *Cancer* 98(11):2502–2510. doi:10.1002/cncr.11815
86. Lesperance M, Shannon R, Pumphrey PK, Dunbar E, Genther R, Coleman CL, Tabano M, Maurer J, Vazquez A, Capp E, McMillan J, Wilkerson K, Robbins G, Phillips DG, Howick P, Solaun C, Sloan J, Colon-Otero G (2014) Training mid-level providers on palliative care: bringing advanced directives and symptom assessment and management to community oncology practices. *Am J Hosp Palliat Care* 31(3):237–243. doi:10.1177/1049909113486335
87. Gladieux JE, Basile M (2014) Jimmo and the improvement standard: implementing medicare coverage through regulations, policy manuals and other guidance. *Am J Law Med* 40(1):7–25
88. Delgado-Guay MO, Kim YJ, Shin SH, Chisholm G, Williams J, Allo J, Bruera E (2015) Avoidable and unavoidable visits to the emergency department among patients with advanced cancer receiving outpatient palliative care. *J Pain Symp Manag* 49(3):497–504. doi:10.1016/j.jpainsymman.2014.07.007
89. Silver JK (2015) Cancer prehabilitation and its role in improving health outcomes and reducing health care costs. *Semin Oncol Nurs* 31(1):13–30. doi:10.1016/j.soncn.2014.11.003
90. Cheville AL, Basford JR (2014) Postacute care: reasons for its growth and a proposal for its control through the early detection, treatment, and prevention of hospital-acquired disability. *Arch Phys Med Rehabil* 95(11):1997–1999. doi:10.1016/j.apmr.2014.07.397