

ORIGINAL RESEARCH

Imaging and Clinical Characteristics Predict Near-Term Disablement From Bone Metastases: Implications for Rehabilitation



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Abstract

Objective: To distinguish which patients with bone metastases are at risk for near-term disablement in order to assist clinicians in assessing the appropriateness of referrals for rehabilitation services.

Design: Prospective cohort study.

Setting: National Cancer Institute–designated comprehensive cancer center imbedded in a tertiary medical center.

Participants: Data were collected from members (n=78) of a patient cohort (N=311) with stage IIIB or IV non–small-cell lung cancer or extensive-stage small-cell lung cancer who developed new or progressive imaging-confirmed bone metastases during the 2-year course of the study.

Interventions: Not applicable.

Main Outcome Measures: Functional capabilities were assessed at 3- to 4-week intervals over the study’s 2-year duration with the Activity Measure for Post-Acute Care Computer Adaptive Testing.

Results: Seventy-eight participants developed new or progressive bone metastases during the study. Most were men, and 83% had non–small-cell lung cancer. Metastases were most frequently located in the ribs (n=62), pelvis (n=49), or the thoracic (n=60) and lumbar spine (n=44). While neither the number of bone metastases nor their specific location was associated with near-term changes in patient mobility, their association with pain or a focal neurologic deficit was strongly associated with large declines in mobility. Similarly, patients whose imaging studies revealed new metastases and the expansion of established metastases were more likely to lose mobility.

Conclusions: The total burden, specific locations, and overall distribution of bone metastases did not predict disablement. Patients with lung cancer–associated bone metastases are at markedly increased risk for declining mobility when their metastases are expanding in size and increasing in number, or are associated with pain or with new neurologic deficits.

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Although the need for a better understanding of the impact of advanced cancer on patients’ functioning is well recognized,¹ much remains to be learned.² Bone metastases provide a case in point as they are known to engender severe disablement and increase health care utilization, yet some patients with extensive osseous metastases experience few, if any, adverse sequelae.³ Extensive efforts have been invested in the development of pathologic fracture risk prediction rules⁴⁻⁶; however, similar

efforts to develop an improved understanding of patient- and metastasis-level characteristics that predict the likelihood and magnitude of impending functional loss remain lacking.⁷ This is not a trivial issue because functional preservation is a key aim of cancer care delivered with palliative intent. Further, clinical decision-making regarding the cost-to-benefit ratio of surgical, radiation, and antineoplastic treatments often hinges on the likelihood that a patient’s performance status will remain stable or improve. Lung cancer (LC) offers an opportunity to better understand the factors that produce cancer-related disablement, as it avidly metastasizes to bone and is known to produce physical impairment.^{8,9}

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It has been widely accepted that bone metastases contribute significantly to patients' functional losses.³ Initial work by our group that studied a large cohort of patients with late-stage LC confirms this impression and provides an estimate of the magnitude of these losses, in that patients with new or progressive bone metastases experienced abrupt functional declines that exceeded twice our assessment tool's minimal clinically important difference in LC.¹⁰ However, the variance was also large and suggested that, even when symptomatic, some bone metastases have minimal impact on patients' ability to function while others are devastating.

The ability to distinguish the patients with bone metastases whose function is most likely to precipitously decline could inform management by aiding clinicians in assessing the appropriateness of different treatment options (eg, surgery, radiopharmaceuticals, rehabilitation). This study was designed to test our hypothesis that specific patient- and imaging-level characteristics predict near-term declines in the functionality of patients with advanced-stage LC and bone metastases. Because patients with advanced cancer inconsistently receive validated rehabilitation services,^{2,11,12} a related aim was to provide the medical, radiologic, and surgical oncologists who manage patients with guidance as to whether and when to refer their patients for rehabilitation services.

Methods

Participants and enrollment

The data used in this study were collected from the 78 members of a previously described 311-member late-stage LC patient cohort¹⁰ who developed new or progressive imaging-confirmed bone metastases during the 2-year course of the study. All participants in the cohort had stage IIIB or IV non-small-cell lung cancer or extensive-stage small-cell lung cancer at the time of enrollment. All cohort members' imaging studies and reports were reviewed as part of the study, and all had their functional capabilities assessed by the Activity Measure for Post-Acute Care (AM-PAC) Computer Adaptive Testing (CAT) at 3- to 4-week intervals. This study was approved by the Mayo Clinic Institutional Review Board.

Data collection

Data were collected from 3 sources: (1) verbally from patients (AM-PAC CAT and symptom numeric rating scale [NRS] scores); (2) Mayo Clinic electronic medical records and outside reports; and (3) neuroradiologic imaging review. AM-PAC CAT and NRS scores were telephonically collected over a 2-year interval by research assistants at enrollment and every 3 to 4 weeks thereafter until study completion, dropout, or death. Efforts to contact participants began 3 weeks after their last telephonic contact and continued until a patient either withdrew from the study or died.

List of abbreviations:

AM-PAC	Activity Measure for Post-Acute Care
CAT	Computer Adaptive Testing
CT	computed tomography
LC	lung cancer
MRI	magnetic resonance imaging
NRS	numeric rating scale
PET	positron emission tomography

Information abstracted from the electronic medical record and outside records included type and stage of LC, Charlson Index,¹³ patient demographics and clinical characteristics, any treatments administered for bone metastases, the clinical indication for obtaining the imaging that revealed new/progressive metastases, and whether the patient was symptomatic at the time of imaging. The reasons for imaging were classified as follows: (1) pain; (2) neurologic deficit; (3) routine screening; (4) initial staging; (5) nonpain symptom; and (6) other. Treatments for bone metastases were characterized as follows: (1) palliative radiation; (2) interventional pain procedure; (3) surgery; (4) initiation/change of chemotherapy; and (5) other. For purposes of the analyses described below, imaging indication and treatments were treated as binary indicator variables and linked to the scan that precipitated either a change or the consideration of a change in management. All medical records were abstracted separately by 3 cancer rehabilitation physicians (A.C., K.T., T.P.P.), with disagreements resolved through an in-person consensus process involving all 3 physicians.

All imaging studies obtained within 8 weeks of an AM-PAC CAT data collection point were reviewed by experienced, board-certified, and fellowship-trained musculoskeletal radiologists (N.S.M., M.D.R.). Information recorded for each scan included the following: (1) type of scan (chest computed tomography [CT], abdominal CT, pelvic CT, whole-body positron emission tomography [PET]/CT, whole-body bone scan, pelvic magnetic resonance imaging [MRI], cervical spine MRI, thoracic spine MRI, lumbar spine MRI); (2) location of bone metastases (coded as binary); (3) presence of bilateral or unilateral metastases for ribs, sacrum, pelvis, humeri, and femurs; and (4) whether the scan led to a patient's initial diagnosis with bone metastases or revealed new metastases, progressive metastases, or both.

Patient-reported outcomes

Activity Measure for Post-Acute Care Computer Adaptive Testing

The AM-PAC is an item response theory-based functional assessment tool. Although the AM-PAC comprises 3 domains—mobility, daily activities, and applied cognition^{14,15}—only the 132-item mobility item bank^{16,17} was used in this study.^{11,12} Each item queries respondents regarding the amount of difficulty they experience performing a specific activity. Response options include “none,” “a little,” “a lot,” and “unable.” The AM-PAC mobility item bank demonstrates validity, reliability, and responsiveness when administered via the CAT platform.^{10,14-16,18-21}

Symptom numeric rating scale

The 11-point pain NRS has been extensively validated as a means to assess symptom intensity among patients with cancer.^{17,18} The scale ranges from 0 (none) to 10 (as bad as it can be).^{18-20,22,23} Participants were asked to rate their worst pain, fatigue, and dyspnea over the past 7 days preceding each assessment point.

Statistical analyses

The telephonic collection of AM-PAC CAT scores was not temporally linked to any aspect of participants' clinical care (eg, oncology clinic visits, imaging tests, chemotherapy/radiation treatment). Since the primary outcome and unit of analysis was

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