Rehabilitation in primary and metastatic brain tumours
Impact of functional outcomes on survival

Introduction
In the United States, an estimated 18,800 new cases of brain and other nervous system cancers were diagnosed and 12,800 deaths were predicted in 2006 [1]. Five-year survival rates for brain cancers have steadily increased from 22% to 33% over the past 3 decades [1]. However, despite improved treatments for brain tumours, they continue to have devastating effects with major disability and morbidity. Not only does the damage to the brain tissue from tumour growth result in neurological impairment, the treatments themselves can often produce significant side effects. Moreover, the diagnosis of a brain tumour can have a distressing psychological impact.

The disabilities from brain tumours are not unlike those found in patients who have had a stroke or trau-
mastic brain injury—two conditions in which rehabilitation has a well-established role. Although rehabilitation therapy in cancer patients has been gaining prominence over the last 3 decades [2–4], there are barriers to overcome in those with brain tumours: one survey found that half of American rehabilitation hospitals do not treat more than 10 patients annually with brain tumours [5]. It may be that neurosurgeons, neurologists and neuro-oncologists are either not aware of rehabilitation services or do not believe in the benefits of rehabilitation [6], although several studies have shown that patients with brain tumours do make significant functional gains following rehabilitation [7–14]. Another barrier to rehabilitation therapy in patients with brain tumours is that physiatrists (specialists in physical medicine and rehabilitation) may be uncomfortable providing such care for a progressive disease with poor prognosis since the life expectancy is a year or less for those with brain metastases [15–17] and glioblastoma multiforme (GBM) [18, 19].

Prognosis based on genetic markers [20], tumour grades [21], performance status [22] and types of treatments [23] has been investigated for primary brain tumours and several studies have examined functional outcome measures and survival for those with primary brain tumours [24, 25]. No studies have assessed prognostic factors for survival in patients with metastatic brain tumours using the Functional Independence Measure (FIM™) [26] (one of the main outcome measures in rehabilitation) nor have functional outcomes and survival been examined after rehabilitation.

The main objectives for this study were to (i) describe and compare demographics, clinical characteristics and outcomes in patients with GBM, brain metastases and other brain tumours; (ii) determine whether these patients achieve significant functional improvements through rehabilitation; (iii) explore predictive factors for high or low functional gains; and (iv) assess survival and determine predictors of survival.

Methods

This is a retrospective, descriptive study. Ethics approval was obtained from the Research Ethics Board of Hamilton Health Sciences to conduct this study.

Data collection

Clinical records were reviewed for consecutive admissions of people with a diagnosis of brain tumour, admitted to the Inpatient Neuro-Oncology Rehabilitation Ward at the Henderson General Hospital in Hamilton, Canada, from January 2003 to June 2006. Our rehabilitation ward is situated next to the regional cancer centre and attached to the acute care hospital allowing for close collaboration on the medical and oncological aspects of care. Some patients receive concurrent radiation or chemotherapy while undergoing inpatient rehabilitation. The referral population consists of patients recovering from surgery or from the acute medical oncology wards, either for first presentation or recurrence of brain tumour. The patients with brain tumours who come to the rehabilitation ward often have significant disability, but have the potential to benefit from an active rehabilitation program. Those who have better performance status tend to receive cancer treatments as outpatients, whereas those who are debilitated from moderate to severe cognitive impairment or from progressively and rapidly deteriorating conditions are referred to palliative care.

As one of our main objectives was to study the relationship between functional outcomes and survival after discharge from rehabilitation, we included patients who had a complete set of admission and discharge FIM™ scores. Patients with meningioma were not included in this study due to the “benign” nature of most tumours which can often be completely removed surgically with very good prognosis [13].

We reviewed computerized databases, paper charts and charts on microfiche, including consultation notes, progress notes, operative reports, brain MRI or CT, pathology reports, whole body bone scans for bone metastases, and abdominal, pelvic and chest imaging for organ metastases. Survival data were collected by searching the local obituaries and contacting family physicians and oncologists. We collected data for primary and metastatic brain tumour groups as follows:

(i) Demographic information, including gender, age on admission, length of stay on the rehabilitation ward and discharge destination.

(ii) Tumour characteristics, including the number and location of the lesions. Patients were categorized into 3 groups: GBM, metastatic brain tumours, and other brain tumours. They were grouped because of the difference in etiology between metastatic and primary brain tumours, and the more aggressive nature and poorer prognosis of GBM from most other primary brain tumours. For metastatic brain tumours, the primary histology, presence of organ metastases and presence of bone metastases were obtained. The primary histologies were grouped based on reported 5-year survival rates of ≤50% (lung, ovary, melanoma, unknown) and >50% (urinary bladder, breast, testis, colon, rectum, kidney) [1]. Karnofsky scores were not available for over half of the patients, and therefore could not be entered into data analysis.

(iii) Neurological symptoms on admission, including cognitive deficits, paresis, visual field deficits, sensory-perceptual deficits, bladder or bowel dysfunction, dysarthria, dysphagia, aphasia, ataxia or incoordination, diaphoria and seizures.

(iv) Treatment of brain tumour, including prior surgical resection, prior or concurrent radiation therapy, prior or concurrent chemotherapy, and daily dose of dexamethasone on admission to rehabilitation.

(v) Functional outcomes, using the Functional Independence Measure (FIM™) on admission and discharge, using both motor and cognitive categories. Data were from the National Rehabilitation Reporting System (NRS) at the Canadian Institute for Health Information (CIHI). The FIM™ change was the difference between admission and discharge FIM™ scores. The FIM™ efficiency was calculated as the FIM™ change divided by the length of stay in days.

(vi) Survival time was defined as the date of discharge from rehabilitation until the date of death. Censored data were from the date of discharge to the date of last known follow-up.

Functional Independence Measure

The Functional Independence Measure (FIM™) consists of 18 categories under motor and cognitive groups [26]. The 13 categories of motor FIM™ include 6 areas of self-care (eating, grooming, bathing, dressing of upper body, dressing of lower body and toileting), 2 of sphincter control (bladder and bowel), 3 of transfer ability (in a bed, chair, and/or wheelchair; on and off a toilet; and in and out of a tub and/or shower), and 2 of locomotion (walk/wheelchair and stairs).