

Title: Factors associated with long-term functional outcomes, psychological sequelae and quality of life in persons after primary brain tumour

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Short title: Long-term functional outcomes in primary brain tumour

Abstract

To examine factors impacting long-term functional outcomes and psychological sequelae in persons with primary brain tumours (BT) in an Australian community cohort. Participants (n=106) following definitive treatment for BT in the community were reviewed in rehabilitation clinics to assess impact on participants' current activity and restriction in participation, using validated questionnaires: Functional Independence Measure (FIM), Perceived Impact Problem Profile (PIPP), Depression Anxiety Stress Scale, Cancer Rehabilitation Evaluation System–Short Form and Cancer Survivor Unmet Needs Measure. Mean age of the participants was 51 years (range 21-77 years), majority were female (56%) with median time since BT diagnosis 2.1 years and a third (39%) had high grade tumours. Majority showed good functional recovery (median *motor* FIM score 75). Over half reported pain (56%), of which 42% had headaches. Other impairments included: ataxia (44%), seizures (43%); paresis (37%), cognitive dysfunction (36%) and visual impairment (35%). About 20% reported high levels of depression, compared with only 13% in an Australian normative sample. Two-third (60%) participants reported highest impact on the PIPP subscales for *psychological wellbeing* (scores of >3 on six-point scale) and *participation* (45%). Factors significantly associated with poorer current level of functioning and wellbeing included: younger participants (≤ 40 years), recent diagnoses, aggressive tumour types and presence of pain. No significant differences in scale scores were found across various treatments (surgery, chemotherapy or radiotherapy) on outcomes used. Rehabilitation for BT Survivors is challenging and requires long-term management of psychological sequelae impacting activity and participation. More research into participatory limitation is needed to guide treating clinicians.

Key words: Brain tumour, Rehabilitation, Disability, Participation, Quality of life, Function

Introduction

Primary brain tumour (BT) a comparatively rare and diverse group of neoplasms, accounts for approximately 2% of all cancers [1] and affects 7 per 100,000 population annually worldwide [2]. The overall incidence of BT is increasing [3]. It was estimated that in 2009, there were 22,070 new cases in United States [4]. In Australia, a similarly high incidence rate is reported, with approximately 1400 new cases and more than 1200 deaths annually [5].

In recent years, therapeutic advances in the treatment of BT have prolonged survival rates [6, 7]. Despite these treatment options, BT survivors often have residual neurological deficits, functional and psychosocial sequelae, which limit everyday activity and participation [6, 8]. Further, treatment regimens can be associated with considerable adverse effects [8, 9]. The diagnosis of BT itself can have a distressing psychological impact, significant costs and socioeconomic implications, increased demand for health care, social and vocational services; and caregiver burden [8].

Persons after BT can present with various combinations of problems, such as physical, cognitive, psychosocial, behavioural and environmental issues. The BT-related impairments can limit 'activity' or function and 'participation' in society and reduce life span. Many ongoing concerns (relationship, employment, recurrence) may surface in post-acute phase in the longer-term [10]. Almost a quarter of the adult survivors of childhood brain tumours experience visual (26.9%) and hearing deficit (23.1%), loss of sensation (20.5%), significantly lower muscle strength (grip strength, knee extension strength) and exercise tolerance compared with matched controls [11]. These limitations in function can have a cumulative effect over time and cause considerable distress to the cancer survivor, their families, and reduce quality of life (QoL) [11]. Patients discharged back to the community are confronted by various adjustment issues, such as the patient's perceptions of self-worth, self-image and role reversal within the family. Further, families often struggle to cope with new demands associated with increased care needs, inability to drive and return to work, financial constraints, marital stress and general limitation in patients' participation.

Recovery from BT treatments can be prolonged with varied care needs after treatment (surgery, chemotherapy and radiotherapy) given the complex, multifactorial nature and multiple disabilities (which may

progress) in these persons [12]. Although there are several studies that evaluate the functional outcome of patients with BT from a rehabilitation perspective, there are no studies that address long-term issues affecting everyday activities in these persons in the Australian context. Participatory limitations in terms of social re-integration, return to driving and work, impact on caregivers and psychosocial outcomes have not yet been adequately studied. The **objective** of this study is to examine factors associated with residual disability and restriction in participation over a longer-term, including functional outcomes, psychosocial sequelae and QoL in BT survivors in an Australian community cohort.

Methods

Participants and Setting

This prospective cross-sectional study was part of a rehabilitation outcomes research programme for BT survivors at the Royal Melbourne Hospital (RMH), a tertiary referral centre in Victoria, Australia; and approved by its Ethics committee (HREC No. 2010.216). The RMH programme provides acute and rehabilitative care for inpatients and in ambulatory settings. A preliminary audit found 862 consecutive same and multiday patients and those with recurrent admissions (details available from authors) to RMH for acute care between 2007-2011; with the ICD Code (C71) for BT (main diagnosis) incorporating all 10 sub-codes that localize the brain tumour (C71.0- 71.9) (*first admission only and excludes cranial nerves, recurrent and metastatic tumours*). The RMH Access Database was used for cross-indexing of diseases from the Patient Administrator System (HOMER) of Hospital Information Systems, Department of Health Victoria, Australia. All eligible patients were contacted by mail and invited to participate in this project by an independent project officer, and those who returned signed consent forms were recruited for the study. The sample comprised a pool of persons residing in the community, referred to the RMH from public and private medical clinics across greater Melbourne in Victoria. All participants were aged >18 years and fulfilled standard diagnostic criteria for brain tumour grading system as outlined by the World Health Organisation (WHO) for central nervous system tumours [13]; had completed definitive treatment (and not currently on treatment) and assessed by a surgeon/oncologist at the RMH. These participants resided in the community (area of greater Melbourne <60 km radius), and were able to communicate in English. Those

who had metastatic brain tumours, significant co-morbidities or medically unstable, or psychiatric disorders limiting participation in rehabilitation, those bed-bound and/or institutionalized in nursing homes were excluded.

Data collection

A total of 152 patients on the RMH Database were eligible for this study based on selection criteria. All were invited by mail to participate in the study and 106 subjects who consented were recruited for the project (Fig. 1). An independent research officer contacted the participants (and/or their carers) to explain the study further and organized the interview appointments. All interviews and assessments (45 minutes each) were conducted by two independent trained physicians and one research assistant (in clinic or patients' homes) using a structured format, in a 6-week period. Data collected include: demographic and medical information, cognitive and functional ability assessment and health related QoL measures using standardized instruments (see Measures). The assessors did not prompt patients, but provided assistance for those who have difficulty with completing the questionnaires. Appropriate rest breaks were provided during these interviews. All assessments were secured and filed, and opened at the time of entry into the database by independent data entry officer.

(Insert Fig. 1 here)

Measurement

The International Classification of Functioning, Disability and Health [14] was used as a conceptual basis for choice of best outcomes for measurement. It provides a framework that describes the impact of disease at the level of impairment, limitation in activity and participation; incorporating contextual (environment and personal) factors which may act as barriers or facilitators in these persons [14].

Brain tumour related information

This included socio-demographic data and clinical characteristics data (co-morbid conditions, BT-related symptoms, tumour type and grade; and treatments received: surgery/surgery episode; chemotherapy/chemotherapy episode (initial acute admission only).

Measures for impairment

A single item Visual Analogue Pain scale [15] was used to assess pain (score range 1 to 10). The Medical Research Council (MRC) scale [16] graded muscle power (0=no contraction, 5=normal power).

Measures for activity and functioning

Functional Independence Measure (FIM) [17] assessed function (activity), cognitive impairment and need for assistance (physician assessed). The FIM motor scale has 13 items in four subscales: Self-care, Transfers, Locomotion and Sphincter control; while FIM cognition scale has 5 items in three subscales: Communication, Psycho-social and Cognition. Each item is rated on a scale of 1 to 7 (1=total assistance to 5= needs supervision, 6= modified independence, 7=independent). A low score reflects burden of care in each area measured. FIM has good reported reliability and validity [18, 19].

Measures for participation and QoL

The Depression Anxiety Stress Scale- 21 (DASS) [20] which consist of three 7-item self-report scales, was used to measure the negative emotional states of depression, anxiety and stress. Participants rated the extent to which they experienced each state over the past week on a 4-point Likert rating scale. Sub-scale scores were derived by totalling the scores, and multiplying by two to ensure consistent interpretation with the longer DASS 42-item version. The scores for each domain range from 0-42, with higher scores indicating more dysfunction. It has good internal consistency [20].

The Perceived Impact of Problem Profile (PIPP) [21], a 23-item scale with five subscales (Mobility, Self-care, Relationships, Participation and Psychological Wellbeing), assessed the impact associated with a health condition. For each item, respondents were asked to rate '*how much impact has your current health problems had on (item of function or activity)*' using a 6-point scale ('no impact' and 'extreme impact'), with high scores indicating greater impact [21].

Cancer Rehabilitation Evaluation System–Short Form (CARES-SF) [22] a self-administered cancer-specific measure with 59 items assessed the QoL. The items generate a single global score indicating QoL with summary scores for the 5 domains: physical (problems with daily activity), psychosocial (communication and relationship), sexual (interest and performance), marital (problems with a significant relationship) and medical interaction (communication with medical team). The participants rate the degree to which a given problem applied during the 4 weeks prior to the survey using a four point Likert scale (0 = not at all to 4 = very much), with higher scores indicating more difficulty or impairment. This scale is widely used in cancer survivors, especially in outpatient setting [22].

Cancer Survivor Unmet Needs Measure (CaSUN) [23], assessed and identified needs of the BT survivors, using 35 need items, six positive change items and an open-response item. Participants choose response options for each item as: no need (0), met need (1), weak unmet need (2), moderate unmet need (3), and strong unmet need (4). The sum of responses is used to calculate total unmet (2–4) and total need (1–4). Further, the need items are categorised into 5 domains: existential survivorship (e.g., cope with changes to my beliefs); comprehensive cancer care (e.g., complaints addressed), information (e.g., up-to date information), and QoL (e.g., changes to my QoL) .and relationships (e.g., impact on my relationship). This scale has good internal consistency, construct, content and face validity, and test–retest reliability [23].

Statistical analysis

Outcome variables included five summary scales (FIM, PIPP, DASS, CARES-SF and CaSUN) and their subscales. A series of analyses were conducted to describe the current level of function, wellbeing and QoL of participants and to identify those factors associated with scores on these scales. Given the skewed distributions, continuous predictor variables (age, time since diagnosis) were split at the median to form approximately equal groups for comparison. Non-parametric analyses (Mann-Whitney U, Kruskal-Wallis tests) were used to compare scores across groups. Although a substantial number of univariate analyses were conducted, increasing the likelihood of a Type 1 error, it was decided to report all p values above 0.05 as significant. This was consistent with the descriptive nature of the study to ensure all potentially important predictors of the long-term sequelae of

BT were identified. All data was entered twice to avoid errors on data entry and SPSS 18.0 for Windows was used for analysis.

Results

Sample characteristics

The mean age of the participants (n = 106) was 51 ± 13.6 years (range 21 – 77 years), majority were female (56%) and married (76%); median time since brain tumour diagnosis was 2.1 years (Inter Quartile Range (IQR) 0.9 to 4.0 years). More than a third (39%) had high grade brain tumours (Grade IV) and underwent surgery; two thirds had radiotherapy (64.2%) and less than half had chemotherapy (43%) (Table 1).

Current symptoms

More than half of the sample reported some degree of pain related to BT (n = 59, 56%), with 27% (n = 16) rating pain as > 5 on a 10 point scale. Of those with pain, headache was reported by 42% (n = 25). The common impairments included: ataxia (44%); seizures (43%), paresis (37%), cognitive impairment (36%), visual impairment (35%), dysphasia (29%), dysarthria (26%) and sensory perceptual deficits (24%). The report of bladder/bowel dysfunction (20%) (urinary urgency/frequency and constipation) was higher than expected.

Surprisingly, most participants were satisfied with their current QoL (Median 3, IRQ = 2 to 5 in 6 point scale), with only 12% reporting dissatisfaction (>3 scores) (Table 1).

(Insert Table 1 here)

Current level of functioning, participation, psychological wellbeing and QoL

Participants reported minimal change to their physical function as indicated by high FIM motor subscale scores. Compared with a normative sample of the Australian population (13%), a higher percentage of participants reported moderate, severe or extreme levels of depression (20%), although anxiety and stress scores were almost similar (12% each) (Table 2).

Although median scores on the PIPP subscales were low for most participants (indicating low levels of impact); participant scores extended across the full range of possible scores. Almost two third (n = 64, 60%) participants

reported high impact on the PIPP subscales for *psychological wellbeing* (scores of > 3 on the six-point scale), and substantial impact on the *participation subscale* 45% (n=48), indicating impact on satisfaction with life, mood, confidence, ability to live independently and ability to participate in work, family, leisure and social activities. (Table 2)

The highest median scores (indicating greatest distress or disability) in the CARES-SF were found on the subscales for physical (median (Md) =1.0, IQR=0.5, 1.5) (evaluating problems with daily activity); and psychological factors (evaluating communication and relationship) (Md=0.6, IQR=0.4, 1.1) (Table 2).

(Insert Table 2 here)

Supportive care needs and positive outcomes

All participants endorsed at least one need (met or unmet) in the CaSUN. More than three fourth (n = 81, 76%) participants endorsed at least one unmet need, with an average of 4.1 (range 0 - 26) unmet needs (Table 2). The most highly endorsed total needs were in *comprehensive cancer care* (mean 3.5, range 0 – 6), and *existential survivorship* (mean = 3.5, range 0 – 13). The most highly endorsed unmet needs was in *existential survivorship* (mean = 1.9, range 0 – 12), and met needs was in *comprehensive cancer care* (mean 2.8, range 0 – 5) (Table 3). The 10 most frequent endorsed unmet need items are shown in Figure 2.

(Insert Table 3 and Fig. 2 here)

Factors associated with current level of functioning and wellbeing

A series of univariate analyses were conducted to identify predictive factors associated with current levels of functioning, participation, and wellbeing.

Demographic and disease factors

Gender: The CARES-SF subscales (Psychological, p = 0.032, Sexual p = 0.038) showed statistically significant differences higher levels of psychological and sexual dysfunction in females.

Age: Scale scores were compared by splitting the age into three groups (≤ 40 years, 41 - 59 years and ≥ 60 years) using Kruskal-Wallis tests. The younger group showed significant differences in four of the FIM subscales (Sphincter, $p = 0.033$; Communication, $p = 0.026$; Psychological, $p = 0.013$; and Cognition, $p = 0.003$); three of the PIPP subscales (Self-care, $p = 0.005$; Mobility, $p = 0.014$; and Participation, $p = 0.014$) and CARES-SF physical subscale ($p = 0.017$).

Tumour type

Kruskal Wallis tests showed significantly different scores across the WHO tumour groups on most of the FIM subscales (Sphincter, $p < 0.001$; Mobility, $p = 0.009$; Communication, $p < 0.001$; Psychological $p = 0.001$; and Cognition, $p = 0.014$). Participants in WHO Grade IV reported higher impact on their PIPP Mobility subscale ($p = 0.031$).

Time since diagnosis

Time since diagnosis was divided into two approximately equal groups (≤ 2 years and 2+ years). Higher functional and psychological dysfunction levels and greater impact were found for the more recently diagnosed. Mann-Whitney U tests showed significant different scores across these groups on all of the FIM subscales except self-care (Sphincter, $p < 0.003$; Mobility, $p = 0.008$; Locomotion, $p = 0.005$; Communication, $p = 0.041$; Psychological $p = 0.012$; and Cognition, $p = 0.047$), all of the PIPP subscales except Relation (Psychological, Self-care, Mobility, and Participation, ($p < 0.001$ for all except $p = 0.044$ for Relation) and CARES-SF Physical subscale ($p < 0.001$).

Treatment related factors

There were no significant differences in scale scores across different surgery types, or for participants who received chemotherapy. Individual who received steroids during their treatment period recorded slightly higher CARES-SF Physical scores ($p = 0.026$) and those who underwent radiotherapy reported significantly higher score in CARES-SF sexual subscale ($p = 0.047$).

Current symptoms

Participants reporting BT-related pain recorded higher scores on all DASS subscales (Depression, $p = 0.011$; Stress, $p = 0.003$) and Anxiety, $p = 0.025$) and CARES-SF overall score ($p = 0.014$) and CARES-SF Psychological subscale ($p = 0.033$). There was a significant difference in various scales across the most common symptoms assessed. Table 4 provides the summary of results of the non-parametric tests showing the significant scores ($P < 0.05$) for the various scales. In general, women with presence of BT-related symptoms at assessment had lower functioning and QoL scores than those without BT-related symptoms across the outcome measures. No significant relationship was present in scale scores with various treatment procedures including surgery, chemotherapy, and radiotherapy, on outcomes used (Table 4).

(Insert Table 4)

Discussion

This is the first report of factors associated with long-term functional, psychosocial outcomes and QoL (median > 2 years) for persons with BT residing in the Australian community. The BT survivors in this study are similar to those in other studies in terms of age, gender, disease severity and treatment [24-26]. Although participants in this study made good functional recovery after treatment (high FIM motor scale scores) consistent with other studies [27, 28], they reported residual neurological deficits (predominantly sensory and psychological). This was similar to an earlier report ($n = 50$) of predominantly ambulant group, in an outpatient settings where 80% reported multiple impairments affecting their health status, due to changes in sensation, emotional issues and cognitive impairment [29].

Improved survival resulting from advanced medical management in BT has produced a growing acceptance of BT as a long-term illness impacting psychological functioning and QoL. However, long-term physical and psychological morbidity associated with brain tumour as in other cancer patients can be underestimated [6, 30]. Psychological morbidity (anxiety, depression, stress, altered mood and emotional reactions, sleep disturbance, social isolation) are common in brain tumour [3, 31, 32]. These responses may be due to various tumour-related symptoms (such as fatigue, seizures, paresis etc.), treatment side effects; and diagnosis itself [3, 31]. Rate of depression reported in cancer population varies, ranging from 14% [33] to 33% [34].

Participants in our study, with a median time since diagnosis of 2.1 years, reported elevated level of depression (20%) which is higher than normative Australian data, highlighting the emotional impact in BT survivors. This is consistent with previous reports of higher psychological distress in BT cohort than normative population [1, 29, 32]. This has important clinical implications for long-term monitoring, education, support and counselling of the BT patients (and their carers).

Approximately 56% of the participants' reported BT-related pain (mixed pattern), higher than other reports [29], however, headache (42%) reported was low compared to reported prevalence in BT population (53% - 77%) [31]. The participant report of seizures, dysarthria and dysphasia, were consistent with other studies [35], and hinder communication between physician and patients [12]. These, however, were beyond the scope of this study and needs further exploration.

The likelihood of progressive functional decline, the difficulty in psychological adjustment due to constantly changing disability and uncertain prognosis in BT survivors is challenging in ambulatory settings in terms of participatory restriction [35]. Restricted activity alone explains only a minor part in the variance of health-related QoL [36], as many factors (functional, emotional, physical, vocational, social and psychological) may influence QoL [26]. In this study, only 12% of participants reported dissatisfaction with their current QoL (>3 in 6 point VAS scale), and each person had a unique theme and meaning of QoL and focused on how well they felt rather than considering influence of other factors. This is evident in results showing *high* impact on PIPP Psychological wellbeing (60%), Participation (45%) subscales and *substantial* impact on Mobility (35%). These are consistent with reports of participatory limitation (work, social and recreational activity, family life, caregiver stress, activities of daily life) in other BT cohorts [26, 35]. The interpretation of CARES-SF scores was difficult, as there are no reference data from general population samples [37]. A standardised score calculated, based upon data from approximately 1000 American heterogeneous cancer patients was created by Shag et al [38], however, this sample did not contain data specifically for BT and may not necessarily be representative for comparison with the other cohorts from different settings [37].

This study identified various factors associated with poorer current level of functioning and wellbeing, and QoL (i.e., high impact on FIM, PIPP, and CARES-SF subscales), which include: younger patients, recent

diagnoses, aggressive tumour, those receiving chemotherapy, pain, and other symptoms (such as cognitive impairment, paresis, ataxia, seizures, bladder and bowel dysfunction, sensory-perceptual deficit). No significant differences in scale scores were found across various treatments including surgical procedures, chemotherapy, and radiotherapy, on outcomes used.

Supportive care needs were frequently experienced by BT survivors many years after apparently successful cancer treatment. Most BT survivors in this study seem to have adjusted well, although a significant proportion experienced transient and/or persistent physical and psychosocial morbidities which necessitated some form of care needs. Almost all participants reported at least one met need (98%) and over three quarter reported at least one unmet need (81%). Highest levels of needs across the survivorship continuum were in the *comprehensive care, information and existential survivorship* domains, which is consistent with reports for other oncological cohorts such as breast, gynaecology, prostate, colorectal [23, 39]. This information can improve clinical service delivery in the identified areas to improve patient outcomes for cancer survivors [39].

This study has some potential limitations. Firstly, this is a cross sectional survey and does not provide longitudinal information. Secondly, the study cohort is a selective cohort listed on a database held at single tertiary institution (RMH) and with strict inclusion criteria who agreed to participate in research projects, which may limit the generalizability and validity of these findings. The study cohort, however, covers a wide geographical population in Victoria, and represents the wider sample of BT survivors in the community. The BT survivors in this study are similar to cohorts in other studies in terms of their age, gender, disease severity and course. Some caution needs to be exercised in the interpretation of the group comparisons conducted in this study due to the substantial number of univariate statistical analyses undertaken, with no adjustment to the alpha value used to indicate statistical significance. This study was intended as a preliminary descriptive study, with the aim to identify possible factors that may impact on long-term outcomes, including information from perspective of the BT participants in the community. All questions were limited in the main to the current situation, in an attempt to reduce recall bias, and medical records were used only to confirm participant report and no additional information was obtained. Problems not included within the domains of the outcome measures used were not able to be identified; the measures used however were broad and expansive. We acknowledge that other factors may have impacted psychological factors in BT participants and were not explored in this

study. More research into ongoing pain, seizures and fatigue outcomes in these persons is needed. Further research using larger sample size and sophisticated multivariate analyse need to be undertaken to extend these finding.

Primary BT is a complex and challenging condition due to high mortality rates, often progressive in nature, uncertain prognosis, with multifaceted physical, psychological and cognitive disabilities and participatory limitations that require an integrated interdisciplinary approach [5]. Understanding the impact of BT in longer-term (beyond the acute phase) is important as current medical advances have improved patient survival and shifted care patient management to ambulatory care. Cognitive and psychosocial problems were more frequently reported by BT survivors than physical disability. These factors associated with long-term functional and psychological sequelae in BT survivors in this study have important implications for the treating clinicians and need to be explored in larger and different cohorts. Further studies are needed to understand the extent and time duration for recovery; and issues of aging and disability in these survivors.

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Ethical approval

The study was approved by the Royal Melbourne Hospital Ethical Committee and informed consent was obtained from all the subjects.

Conflict of interest statement

The authors declare that they have no conflict of interest.

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Fig.1 Flow chart of recruitment process

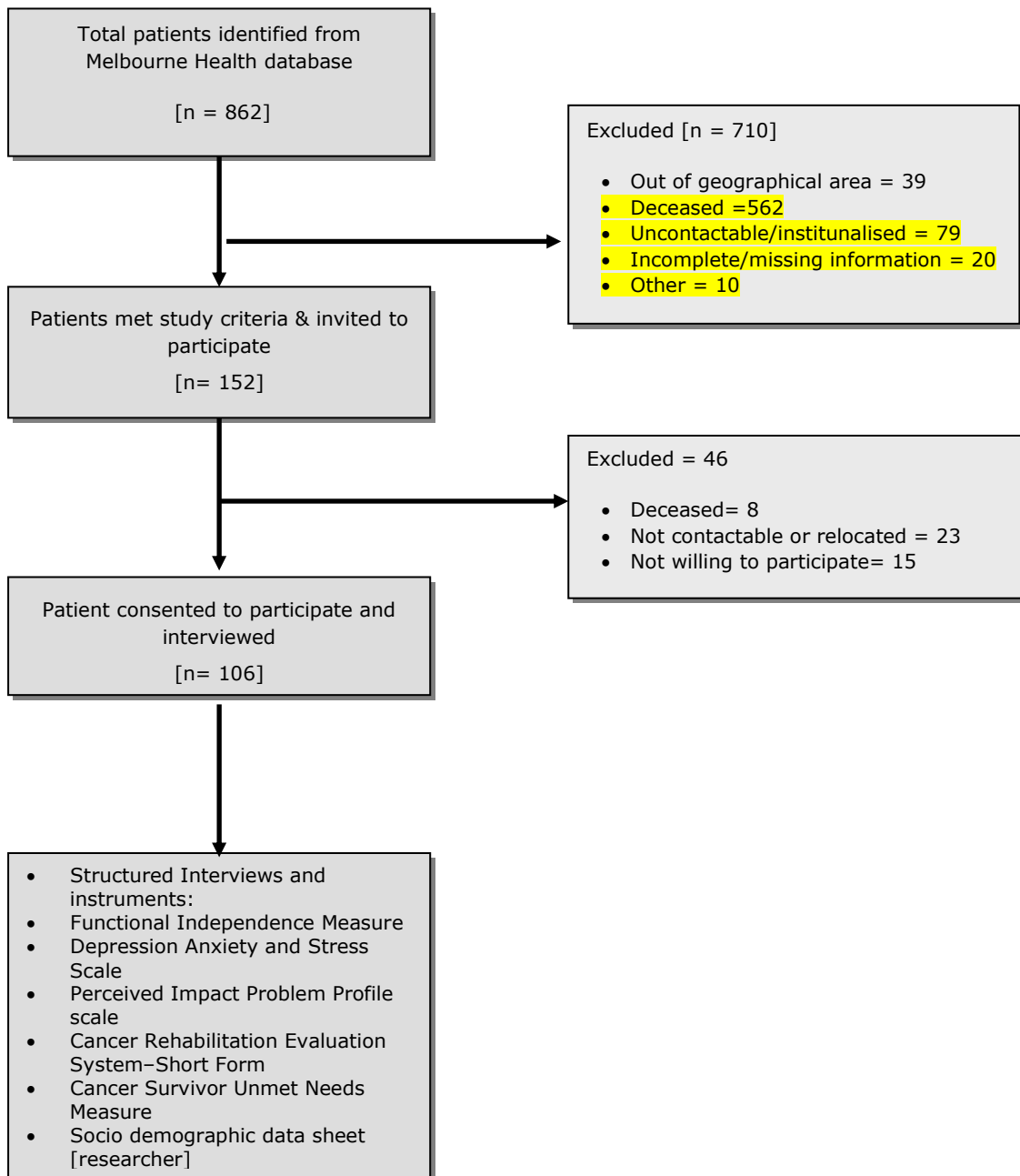


Fig. 2 Ten highest unmet needs identified by brain tumour survivors in Cancer Survivor Unmet Needs Measure (CaSUN)

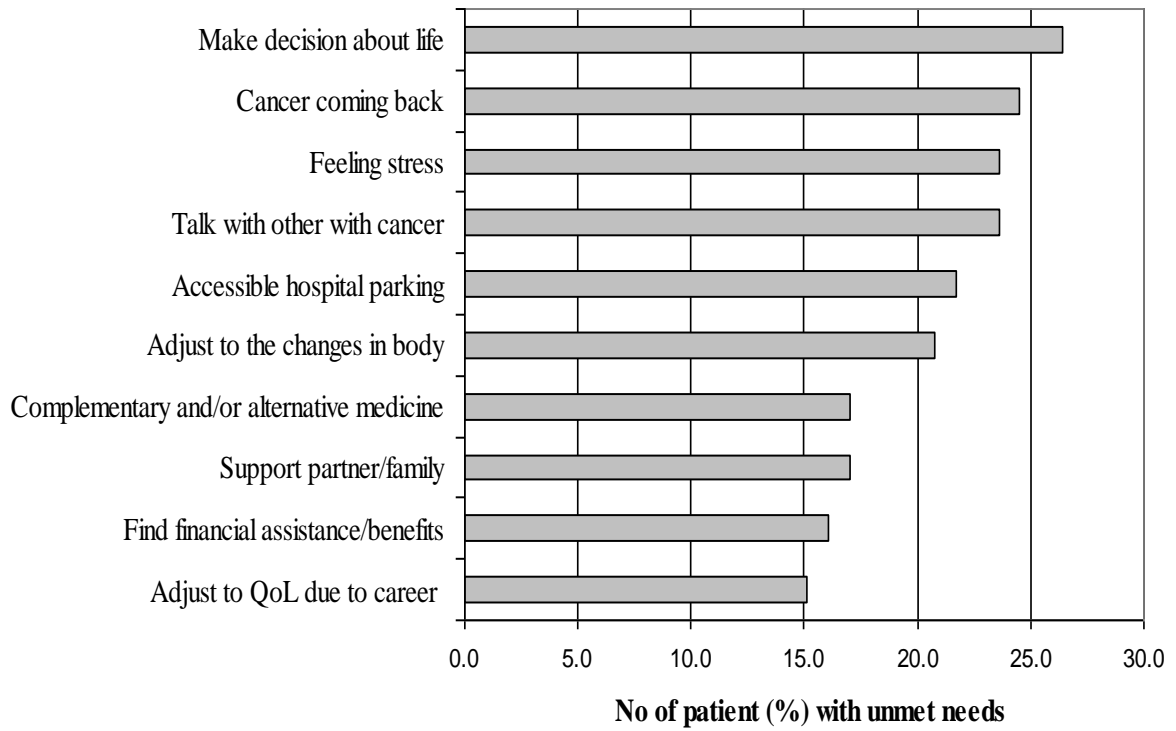


Table 1 Socio-demographic characteristics of participants (n = 106)

Characterisitics		n, (%)
		(unless stated different)
Age (years)	[Mean (SD), range]	51.3 (13.6), 20.8-77.2
Sex	Female	61 (57.5)
Marital status		
	Married/Partner	81 (76.4)
	Single/Divorced/Separated/Widow	25 (23.5)
Living with		
	Alone	18 (17.0)
	Partner/ Family	88 (83.0)
Education		
	Secondary	55 (51.9)
	Tertiary	47 (44.3)
Smokers		17 (16.0)
Consumes alcohol		45 (42.5)
Disease duration (years)	[Md, (IQR)]	2.1 (0.8,4.0)
WHO tumour grade* (n =96)		
	Grade I	14 (14.6)
	Grade II	30 (31.3)
	Grade III	15 (15.6)
	Grade IV	37 (38.5)
Steriods during treatment		72 (67.9)
Surgery, ≥2 surgery episodes		105 (99.1), 33 (31.4)
Type of surgery(n =91)		
	Debulk	74 (70.5)
	Complete excision	25 (23.8)

Chemotherapy, Multiple episode	45 (42.5), 19 (42.2)
Side effects, Severe side effects	31 (68.9), 1 (2.2)
Radiotherapy, Multiple episode	68 (64.2), 44 (64.7)
Side effects, Severe side effects	45 (66.2), 5 (7.4)
Co-morbidities	65 (61.3)
Hypertension	30 (28.3)
Diabetes	5 (4.7)
Depression	12 (11.3)
Pain	59 (55.7)
Pain score (0 no pain; 10 = extreme pain) [Md, (IQR)]	3.0 (2.0,5.0)
Pain score >5	16 (27.1)
Headaches	25 (42.4)
Limb weakness (MRC motor scale) (0=no contraction; 5= normal power)	
Left upper limb, Right upper limb, [Md, (IQR)]	4.0 (4.0,5.0), 4.0 (4.0,5.0)
Left lower limb, Right lower limb [Md, (IQR)]	4.0 (4.0,5.0), 4.0 (4.0,5.0)
Symptoms	
Ataxia/incoordination	47 (44.3)
Seizures	45 (42.5)
Paresis	39 (36.8)
Cognitive impairment	38 (35.8)
Visual impairment	37 (34.9)
Dysphasia	31 (29.2)
Dysarthria	27 (25.5)
Sensory-perceptual deficit	25 (23.6)
Bowel/bladder dysfunction	21 (19.8)
QoL (0= delighted; 6= terrible) [Md, (IQR)]	3.0 (2.0,4.0)
QoL score >3	13 (12.1)

IQR = Interquartile range; Md = median; MRC=Medical Research Council; n = total number; QoL = quality of life;
ROM= Range of Motion; SD = standard deviation; WHO=World Health Organisation

**WHO grading:*

Grade I: slow growing, discrete, often surgical cure eg, Astrocytic tumours, meningiomas;

Grade II: slow growing but ability to invade adjacent normal tissue and higher grade of malignancy eg, Oligodendrogliomas;

Grade III: tumours actively reproducing abnormal cells that can infiltrate adjacent cells eg, anaplastic oligodendroglioma;

Grade IV: highly malignant and infiltrating into adjacent tissue eg, Glioblastoma

Table 2 Descriptive Statistics for subscales of the Depression Anxiety Stress Scale (DASS-21), Functional Independent Measure (FIM), Perceived Impact of Problem Profile (PIPP), Cancer Rehabilitation Evaluation System–Short Form (CARES-SF) and Cancer Survivor Unmet Needs Measure (CaSUN) (n=106)

Scales	Statistics
DASS (Md, IQR)	
Depression (0-42)	Md=4, IQR=0 to 10
Anxiety(0-42)	Md=2, IQR=0 to 6
Stress (0-42)	Md= 6, IQR=2 to 14
DASS group: (n,%)	
Depression	
Normal/mild	85 (80.2)
Moderate/severe/extreme severe	21 (19.8)
Anxiety	
Normal/mild	93 (87.7)
Moderate/severe/extreme severe	13 (12.3)
Stress	
Normal/mild	93 (87.7)
Moderate/severe/extreme severe	13 (12.3)
FIM motor (Md, IQR)	
Self care (6-42)	Md= 31.5, IQR=31 to 36
Sphincter control (2-14)	Md=12, IQR= 10 to 12
Mobility (3-21)	Md=15, IQR=15 to 18
Locomotion (2-14)	Md=10, IQR=8.25 to 12
FIM cognition (Md, IQR)	
Communication (2-14)	Md=11, IQR=10 to 12
Psycho-social (1-7)	Md=5, IQR=5 to 6
Cognition (2-14)	Md=10, IQR=9 to 11
PIPP (n, % recording score of 3 to 6 indicating moderate to	

extreme impact, Md, IQR)

Psychological (1-6)	64 (60.4%) Md=3.4, IQR=2.4 to 4.6
Self Care(1-6)	13 (12.3%) Md=1, IQR=1 to 2
Mobility (1-6)	35 (33.0%) Md=2.2, IQR=1.4 to 3.2
Participation (1-6)	48 (45.3%) Md=2.7, IQR=1.84 to 2
Relationship (1-6)	9 (8.5%) Md=1.25, IQR=1 to 2

CARES-SF (Global scores) (Md, IQR)

Physical (0-4)	Md=1.0, IQR=0.5 to 1.5
Psychological (0-4)	Md=0.6, IQR=0.4 to 1.1
Medical (0-4)	Md=0, IQR=0 to 1
Marital (0-4)	Md=0.2, IQR=0 to 0.8
Sexual (0-4)	Md=0.3, IQR=0 to 1.5
Overall (0-4)	Md=0.6, IQR=0.4 to 1.0

CaSUN (Meand (SD), Rrange)

Total needs	11.6 (5.9), 0-29
Total unmet needs	4.1 (4.9), 0-26
Total met needs	7.3 (4.0), 0-24

CARES-SF = Cancer Rehabilitation Evaluation System–Short Form; CaSUN = Cancer Survivor Unmet Needs Measure; DASS= Depression Anxiety Stress Scale, FIM = Functional Independent Measure; PIPP = Perceived Impact of Problem Profile, n = total number; Md=median, IQR=interquartile range

Table 3 Brain tumour survivors' endorsement of the Cancer Survivor Unmet Needs Measure (CaSUN) ranked by total need (n=106)

Rank	CaSUN factor	Total need		Total met need		Total unmet need	
		<i>Mean (SD)</i>	<i>Range</i>	<i>Mean (SD)</i>	<i>Range</i>	<i>Mean (SD)</i>	<i>Range</i>
1	Comprehensive cancer care	3.5 (1.5)	0-6	2.8 (1.4)	0-5	0.8 (1.1)	0-5
2	Existential survivorship	3.5 (3.2)	0-13	1.6 (1.9)	0-11	1.9 (2.6)	0-12
3	Information	2.0 (1.2)	0-3	1.7 (1.2)	0-3	0.3 (0.7)	0-3
4	Quality of life	0.7 (0.7)	0-2	0.5 (0.6)	0-2	0.3 (0.6)	0-2
5	Relationship	0.5 (0.8)	0-3	0.1 (0.4)	0-2	0.4 (0.8)	0-3

CaSUN = Cancer Survivor Unmet Needs Measure; n = total number; SD = Standard deviation

Table 4 Common symptoms associated with the outcome measures (n=106)*

Outcome measures	Symptoms								
	Dysphagia	Paresis	Cognitive impairment	Ataxia	Visual impairment	Seizures	Dysarthria	Bladder/bowel dysfunction	Sensory-perceptual deficit
DASS									
Depression					.01			.001	
Anxiety				.003	.029				
FIM motor									
Sphincter		.012		.015				.006	.015
Mobility			.029	.015		.017		.009	.036
Locomotion	.025	.008	.008	.001				.006	.044
FIM cognition									
Communication			.000	.049					
Social interaction			.000						.026
Cognition			.000	.042				.001	
PIPP									
Psychological			.041	.001				.000	
Self-care		.000	.005	.000			.022	.04	.002
Mobility	.008	.000	.032	.000		.036	.013		.010
Participation		.000	.001	.000		.044	.017	.004	.003
Relation								.003	
CARES-SF (global score)									
Physical	.001	.000		.000			.003	.001	.028
Psychological	.035			.022	.02			.009	

Medical interaction				.036	
Marital			.039		.012
Sexual				.006	
Overall	.003	.017	.000	.012	.000

*Values significant at 0.05 level

CARES-SF = Cancer Rehabilitation Evaluation System–Short Form; DASS= Depression Anxiety Stress Scale,
 FIM = Functional Independent Measure; PIPP = Perceived Impact of Problem Profile