

Factors associated with lost to follow up in patients with brain tumours: A multi-centre study in Pakistan

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Abstract

Objective: To identify populations at risk for lost to follow-up while undergoing management of brain tumours in a low-resource setting.

Methods: A retrospective study was conducted at the neurosurgical centre on patients presenting with a brain tumour from January 1, 2019, to December 31, 2019. Data on demographic characteristics, surgical characteristics, treatment, and outcomes such as mortality status, were collected by manual chart review. LTFU was defined as patients discontinuing clinical follow-up at the institute of surgical consultation within two years from the initial visit. Univariate (odds ratio) and multivariate (b-coefficient) logistic regression were used to determine factors' significance for LTFU.

Results: From a total of 2750 patients from 32 centres, 1140 (41.4%) were LTFU during the study period. Of these 1140 LTFU patients, 156 (13.7%) were LTFU without any intervention, 984 (86.3%) were LTFU after the primary surgery, and 872 (76.5%) patients were LTFU without any adjuvant treatment. On univariate analysis annual hospital case volume ($p < 0.001$), older age group (15-39 years ($p = 0.037$) and ≥ 40 years ($p = 0.016$)), and non-surgical treatment ($p < 0.026$) correlated with a higher risk of LTFU. Belonging to the middle-class cohort was correlated with a better chance of follow up ($p = 0.001$). Multivariate analysis demonstrated that larger centres had the largest b-coefficient of 1.53 (95% CI= 1.3-1.8, $p < 0.001$).

Conclusion: Our study demonstrated that almost half of patients diagnosed with brain tumours were LTFU within two years of diagnosis. Larger centres, non-surgical treatment, and older age seem to be associated with higher LTFU. Identifying vulnerable populations will allow the need-based provision of care and follow-up to improve health outcomes.

Keywords: Lost to follow-up, Brain neoplasms, Retrospective study, Epidemiology, Registries.
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Introduction

Brain tumours are relatively rare neoplasms but significantly impact the quality of life and poor survival. The proposed incidence of brain and central nervous system tumours in Pakistan is 4770, according to GLOBOCAN 2020, with 3934 patients passing away due to the disease every year.¹ However, these figures are estimates based on average data from other countries and are not representative of the actual incidence.

Another metric by the Pakistan Atomic Energy Commission (PAEC) reports an annual incidence of 1460 patients, however centres included were very limited.²

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The disparity in reported incidence and prevalence, along with the lack of data regarding treatment and survival, is a major barrier to quality healthcare provision and equity. Lost to follow-up (LTFU) is a particular issue that prevents long-term patient care tracking and policy development from extending care where it is needed most. Low to middle-income countries (LMICs) with low resources often cannot dedicate personnel to follow up with patients, particularly those from rural areas that may not be able to visit the clinic often. Therefore, it is important to understand the populations at risk of LTFU and design interventions to ensure follow-up with these patients.

The complex nature of brain tumour treatment and the risk of recurrence necessitates integrated programmes with good communication and follow-up with healthcare providers. Interruption in the continuity of care can lead to progression or recurrence, especially in malignant tumours such as glioblastoma multiforme (GBM). With the lack of a central registry to track patients as they move

between hospitals or doctors, often with no communication with the previous surgeon, the patients may need to repeat costly investigations adding to their financial burden or be lost from treatment entirely. Literature has shown that non-attendance and decreased follow-up in the clinic can have tangible effects on outcomes, particularly in oncological care.^{3,4} However, neuro-oncological surgery remains one of the fields with few papers on the subject, particularly in LMICs. Literature where available, even in HICs, addresses mostly LTFU in clinical trials and study attrition rates rather than hospital or population based LTFU, which is more indicative of the unmet burden of care.

In our study, we aimed to identify populations at risk for LTFU and their demographic, surgical and disease characteristics. We sought to find the significant risk factors for LTFU in our population for patients with brain tumours and provide cultural context for why these patients may be LTFU.

Methods

A descriptive cross-sectional retrospective study was conducted on 32 enrolled healthcare centres throughout the country. The catchment period was from January 1, 2019, to December 31, 2019, and patients with a histopathological diagnosis of brain tumour, primary or secondary, were included. The inclusion criteria were that patients needed to have both a radiological and histopathological diagnosis of the tumour. The centre inclusion criteria were that the centre needed to have an annual case volume of more than five brain tumour surgeries per year and existing dedicated neurosurgical facilities. Data were collected from hospital records by students, residents, and faculty.

Detailed methodology about the study process, parameters used, organization details, and the Pakistan Brain Tumour Consortium (PBTC) are available in the methodology⁵ and general findings⁶ papers in this special JPMA supplement.

Patients lost to follow-up (LTFU) were defined as patients who had been diagnosed with the tumour with histopathological and radiological studies and had then discontinued clinical follow-up at the institute of surgical consultation at any point within two years from the initial visit. This LTFU could be at several points in the continuum of care, as demonstrated in Figure-1. The points of LTFU are divided into five groups during treatment, before surgery, after surgery only, after surgery and chemotherapy only, after surgery and radiotherapy only, and after surgery, chemotherapy, and radiotherapy.

Data collected was divided into four components. Firstly, demographic characteristics, which included age, gender, residence, socioeconomic class, and marital status. Surgical and clinical characteristics collected included time to surgery, institutional characteristics, type of surgery done, and Karnofsky Performance Score (KPS).⁴ Pathological characteristics included type of tumour, grade, and tumour location. The final category was treatment and outcome characteristics, which included the post-operative KPS, current status (deceased vs alive), and chemotherapy and radiotherapy completion status.

Socioeconomic Status (SES) used in this paper has been derived from employment status and the job type that the patients presented within their demographical history. The jobs were used to estimate socioeconomic brackets according to the classification by the Pakistan Bureau of Statistics supplement.⁷

The WHO 2016 guidelines were used to classify tumour type, as those were the most recent guidelines available at the time of data collection.

Statistical Analysis: The normality of data was assessed using the Shapiro-Wilk test. Descriptive data was represented using the mean for normal data and median for non-normal data. The statistical significance of the association between measured variables and independent variables was assessed with the χ^2 test for categorical variables and the 2-sided t-test for continuous normally distributed variables. Significance for non-normally distributed variables was measured using Kruskal-Wallis analysis. $P < 0.05$ was considered to be statistically significant. A linear regression model was developed to investigate the effect of population characteristics on the LTFU rate. The dependent outcome was LTFU, while the independent parameter included type of institution (public or private), the average brain tumour surgery volume at the institution, the age group of the patients, their socioeconomic group, whether surgery was done, the KPS score pre-surgery, the difference in KPS pre and post operation and, the time to surgical intervention. The covariate effect on outcome (LTFU) was evaluated using univariate and multivariate logistic regression (STATA, v 16.0, StataCorp). The independent variables that were significant in the univariate model were carried forward in the multivariate model and included the surgical volume of brain tumours at the institution, the age group of the patients, the socioeconomic group, and surgical intervention. The univariate results were reported with odds ratio, while multivariate results were reported using beta-coefficient.

Results

Table-1: Demographic characteristics.

Demographic Characteristics		Current Status				Total	P-value
		Not LTFU		LTFU			
		N	Percentage	N	Percentage		
Age at diagnosis (years)	<15 years	196	68.30%	91	31.70%	287	<0.001
	15-39	616	61.50%	385	38.50%	1001	
	40 & above	597	60.40%	391	39.60%	988	
Gender of Patient	Male	923	57.50%	682	42.50%	1605	0.414
	Female	685	60.00%	457	40.00%	1142	
Marital Status of Patient	Unmarried	449	60.20%	297	39.80%	746	<0.001
	Married	1023	60.40%	671	39.60%	1694	
	Other	16	42.10%	22	57.90%	38	
Socioeconomic Status of Patient	Lower Class	757	57.30%	564	42.70%	1321	<0.001
	Middle Class	646	64.20%	361	35.90%	1007	
	Upper Middle or Upper Class	103	62.10%	63	38.00%	166	
Presentation in public vs private sector hospital	Public sector hospital	1113	58.60%	784	41.40%	1897	0.841
	Private sector hospital	497	58.30%	356	41.70%	853	

Table-2: Univariate logistic analysis.

Characteristics	Category	Odds ratio	Univariate Standard Error	p-value	95% CI	
Hospital	Public	ref				
	Private	1.02	0.09	0.84	0.86	1.2
Volume	Up to 100	ref				
	More than 100	1.57	0.12	<0.001	1.34	1.83
Age Group	<15 years	ref				
	15-39	1.35	0.19	0.037	1.02	1.78
	40 & above	1.41	0.2	0.016	1.07	1.87
Socioeconomic Status	Lower class	ref				
	Middle class	0.75	0.06	0.001	0.63	0.89
	Upper-upper middle	0.82	0.14	0.24	0.59	1.14
Surgery done	Yes	ref				
	No	1.3	0.15	0.026	1.03	1.64
Difference in KPS Score	KPS pre-surgery	0.99	0.03	0.67	0.94	1.04
	Time to surgery	0.99	0	0.69	0.99	1
Total Hospital patients		0.99	0	0	0.99	0.99

Table-3: Multivariate logistic analysis.

Characteristics	Category	Coefficient	Multivariate Standard Error	p-value	95% CI	
Volume	Upto 100	ref				
	More than 100	1.53	0.13	<0.001	1.301	1.797
Age Group	<15 years	ref				
	15-39	1.26	0.18	0.107	0.951	1.675
	40 & above	1.31	0.19	0.061	0.988	1.743
Socioeconomic Status	Lower class	ref				
	Middle class	0.74	0.15	0.378	0.611	1.204
	Upper-upper middle	0.86	0.23	0.001	1.238	2.169
Surgery done	Yes	ref				
	No	1.3	0.16	0.032	1.023	1.652

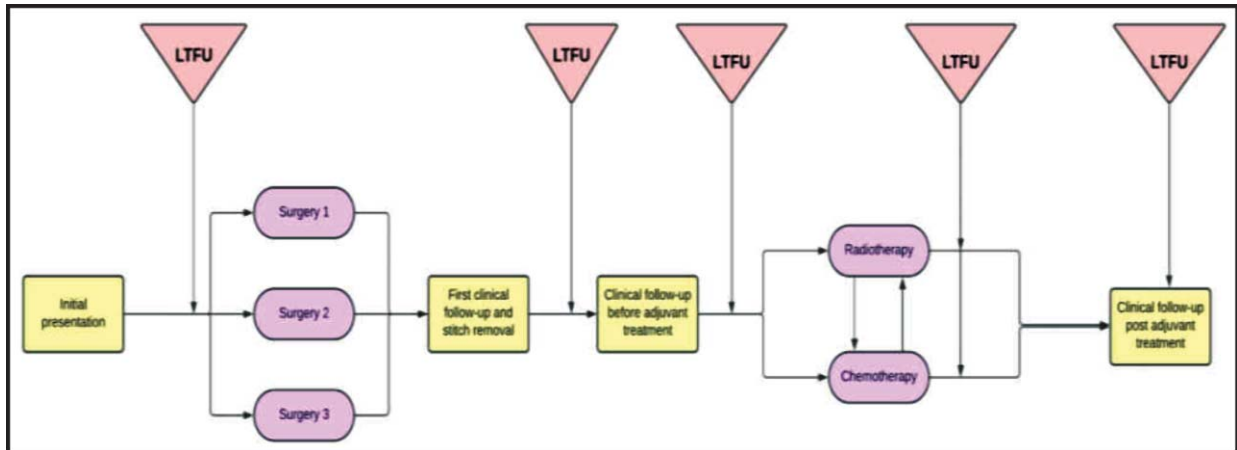


Figure-1: Algorithm for LTFU at different points of care.

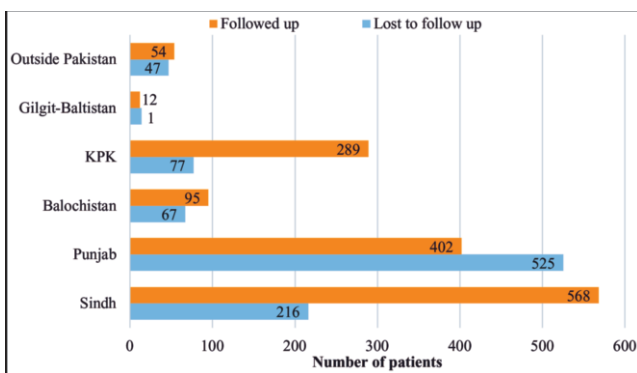


Figure-2: Patients LTFU and following up in each province.

Our cohort had a total of 2750 patients diagnosed with brain tumours in 2019 across the 32 enrolled centres. From this cohort, a subset of 1140 (41.4%) patients were LTFU at different stages of care. The mean age for patients LTFU was 37 ± 16.9 years as compared to 35.4 ± 17.3 years for the patients that did follow up. Amongst this full cohort, 91(10.5%) patients were below the age of 15, 385(44.4%) were between 15 to 39 years of age, and 391(45.1%) patients were aged 40 and above. There was a significant difference in follow-up attrition according to age group ($p < 0.001$), with patients LTFU generally older in age.

Of the LTFU patients, 682 (59.9%) were male, and 457 (40.1%) were female, with no significant difference in the rate of follow-up between the two genders ($p = 0.414$). Of the overall male population, 682 (42.5%) patients were LTFU, while 457 (40%) patients were LTFU from the overall female population. There was a significant difference in LTFU based on marital status, with 671(69.8%) patients being married and 291 (30.2%) unmarried ($p < 0.001$). However, both the married and unmarried patients had a similar proportion of patients that were LTFU, with 671 (39.6%) patients for married and 291 (39.8%) patients for

unmarried patients. Most of the patients who were LTFU were part of the lower socioeconomic status (LSES), numbering 564 (42.7% of all LSES), followed closely by the middle socioeconomic class (MSES) at 361 patients (35.9% of all MSES) and the lowest number belonged to the upper socioeconomic status (USES) with only 63 (38% of all USES) patients were LTFU ($p < 0.001$). The demographic breakdown of our patients is summarized in Table-1.

Patients presenting to public hospitals were more likely to be LTFU and comprised 784 (69%) patients as compared to 356 (31%) patients in private sector hospitals ($p = 0.841$). The ratio of patients in public to private hospitals was 2.2 for both the general population and LTFU patients. The difference between the hospital types was not significant, and only 784(41.4%) patients presenting to public sector hospitals were LTFU compared to 356 (41.7%) in private sector hospitals. Patients presenting to a high-volume-centre (more than 100 cases per year) were more likely to be LTFU ($p < 0.001$), with 724 (46.1%) in high volume centres being labelled as LTFU. Relatively lower volume centres (≤ 100 cases per year) had 416 patients who were LTFU (35.3% of all patients in lower volume centres). The ratio of high volume to low volume centres was 0.75 for the general population and 0.57 for patients who were LTFU.

The proportion of LTFU patients from each province was quite different. The province of Punjab's rate of LTFU was 56.6%, Baluchistan's was 41.4%, Sindh's was 27.5%, Khyber Pakhtunkhwa's was 21%, and outside Pakistan (mostly Afghanistan and Syria) was 46.5%. These findings are summarized in Figure-2.

Patients with a history of substance abuse had a LTFU of 214 (41.8%) patients however, due to the low number of patients with a history of abuse, it was not significantly associated with LTFU ($P > 0.05$). In our cohort, 37 (44.6%)

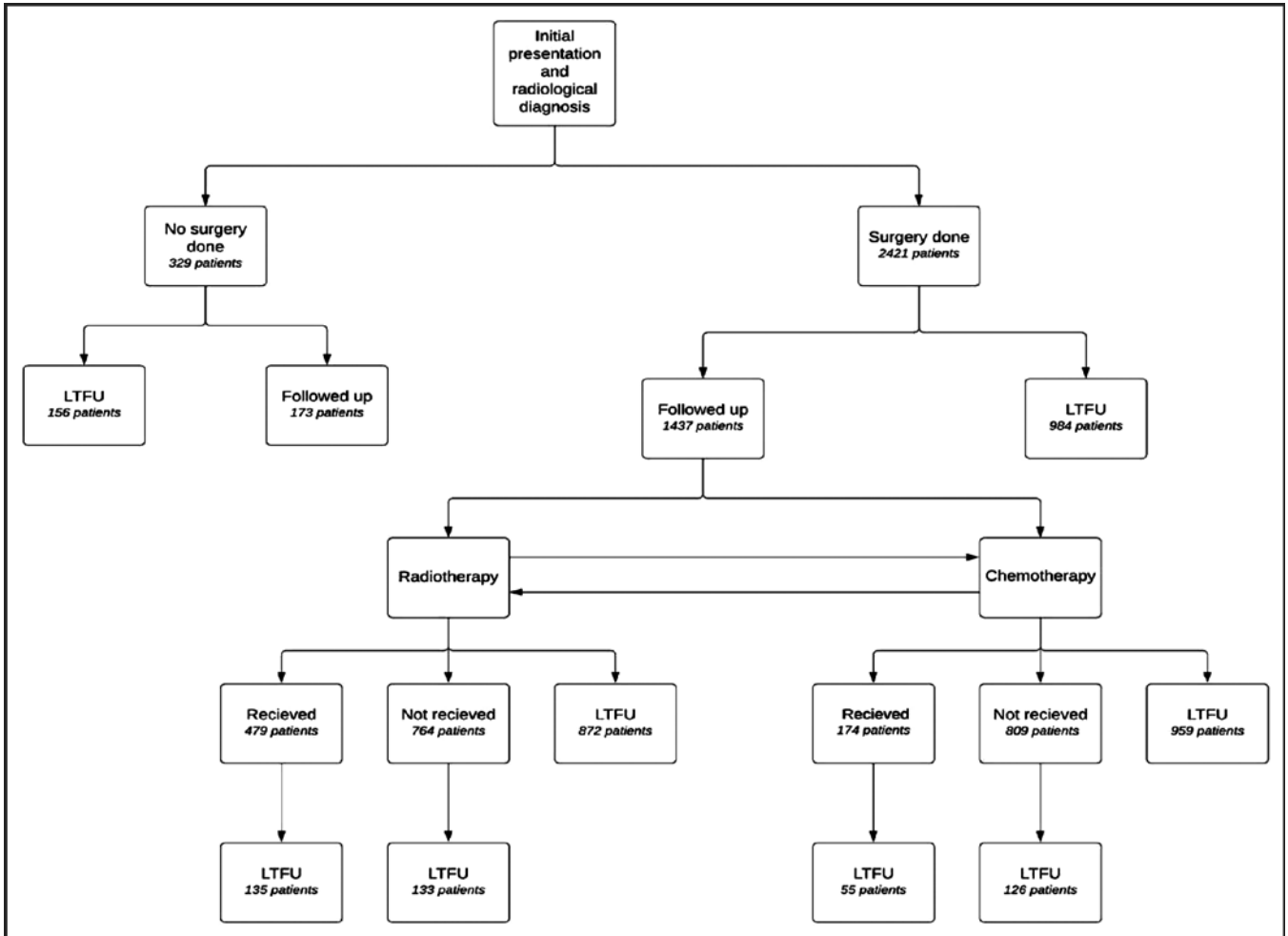


Figure-3: Patients LTFU at each point of care.

patients were LTFU out of a total of 83 patients with a history of brain tumour and Paan and Gutka use. The second most common addiction was smoking, with 155 of 355 (43.6%) actively smoking patients (with a brain tumour) not following up in the clinic. Patients using Naswar had figures of 46 of 122 (37.7%) as LTFU.

From a total of 329 patients who had not received surgical intervention, 156 (47.1%) were lost to follow-up without having had surgery. From the surgical cohort, 984 out of 2421 (40.6%) were LTFU after surgery. Among our patients, 55 patients had been LTFU after receiving chemotherapy, and 135 patients were LTFU after receiving radiotherapy. Figure-3 illustrates the patients who were LTFU and their time of LTFU.

The tumour with the highest rate of LTFU was metastatic lesion with an attrition rate in 34 (55.8%) patients. The number of patients presenting with metastatic brain lesions was very small, and surgery is usually deferred for metastatic lesions at most centres in our region. These

patients are generally referred to palliative care and are not commonly seen in neurosurgical care. The one with the lowest rate of LTFU was haemangioblastoma (25%), with 9 (25%) of 36 patients not following up in clinic. The rest of the tumours and their attrition rates are summarized in Figure-4.

The median time to surgery was 16 days (IQR= 2 - 87.8), and patients that had their surgery within one week of diagnosis were associated with a significantly higher LTFU rate (p<0.001). The median KPS before surgery was 80 (IQR= 60-80), and the median KPS post-surgery was also 80 (IQR= 80-100). There was no significant difference in KPS pre and post-surgery for the population LTFU. The proportion of patients with post-op KPS available was very low (n=11) due to limitations with follow-up.

On univariate analysis, annual case volume, older age group (15-39 and >=40), and not having surgery all correlated with a higher risk of LTFU, with an annual volume of more than 100 cases per year (at the institution)

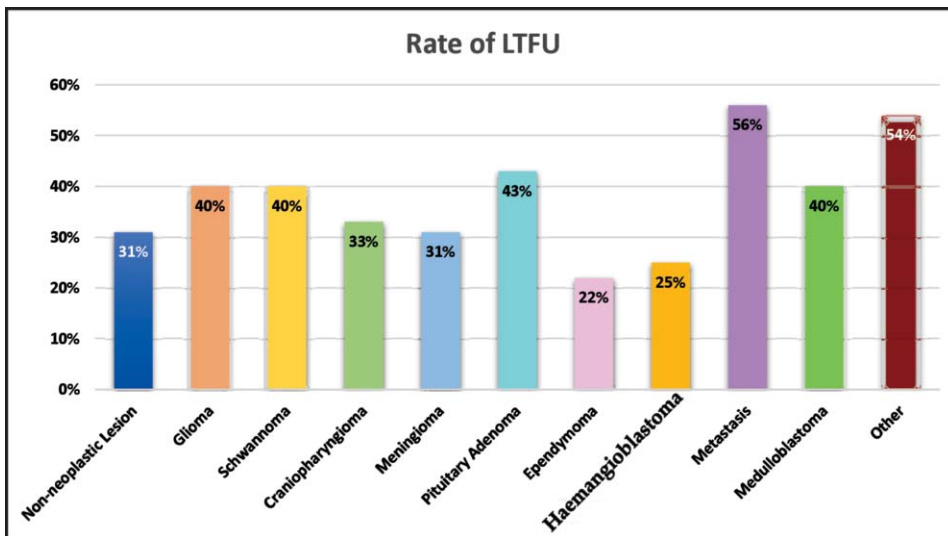


Figure-4: Rate of LTFU according to type of tumour.

being the largest factor for LTFU. Belonging to the middle- or higher-class socioeconomic status was protective against LTFU, and the middle-class cohort was more strongly correlated with a better chance of following up.

Multivariate analysis demonstrated that annual volume of more than 100 patients remained the strongest predictor for LTFU (OR=1.53), with not having surgery and being more than 40 years of age having the same degree of correlation with LTFU (OR=1.3). With multivariate analysis belonging to the middle socioeconomic class no longer had a significant correlation with LTFU. The univariate and multivariate analysis is summarized in Table-2 and 3.

Discussion

A significant portion (41.4%) of patients were LTFU, as seen from the primary surgeon/centre perspective. The most significant factors for LTFU were age group (older age groups), lack of surgical intervention (n=146), socioeconomic status (lower SES), and presenting to an institution with an annual case volume of more than 100 brain tumours.

Lost to follow-up in different practices can vary significantly. Our study with a LTFU rate of 41.4% (for only one year) is comparatively very high and casts a big shadow on research findings within the region. Granted, the mean KPS score between pre and post-operative was not significantly different, but the number of patients with an available post-op KPS was too low to make a definitive conclusion. In studies such as by Murray et al., LTFU rate is reported as 6% for patients with total hip replacement and a cumulative 20% loss over a period of 15 years (a number they propose is very high), with most of these patients having significantly worse outcomes on

last follow up.⁸ Hence, they propose that a study that does not consider these LTFU patients may be too optimistic in its findings. Unlike our study, which was exclusive to brain tumours, a study by Gill et al. on all cancer types was significant in the fact that it did address cancer survivorship and LTFU, albeit only in patients receiving intravenous chemotherapy, to identify the proportion of patients LTFU, the timing of their cessation of follow up, and their characteristics. Most of their patients (62%) died during the follow-up period, a finding that is important as, in most cases,

we don't know how many of the patients LTFU are alive, with women following up more often than men (55% vs 39% respectively), but age, race, and insurance status not being significant.⁹ Of the known surviving patients, 50% were LTFU. Other studies looking at LTFU report rates of 32.7% for cleft lip/palate patients,¹⁰ 12.9% were LTFU within the first year, and 26.8% were LTFU at five years for breast cancer patients⁹ Gill et al. followed patients with cancer who received chemotherapy and determined that the LTFU rate for their surviving cohort was 50% at five years, and 25% were lost within the first year.

Age was a significant factor for LTFU in several studies; in our study, the paediatric age group (0-15 years of age) was the most likely to follow up, with older age categories having higher odds (1.26 and 1.31 for '15-39 years' and '40 and above' respectively on multivariate analysis) of LTFU. Ouyang et al. demonstrated that younger and older patients were more likely to be LTFU.¹¹ Their univariate and multivariate analysis demonstrated that patients below the age of 40 and above the age of 54 were at greater risk of LTFU. Sharif-Askary et al.¹⁰ reported that within their sample, younger age was a strong predictor of LTFU ($P < 0.0001$). In the Carotid Revascularization Endarterectomy versus Stenting Trial (CREST), Sheffet et al.¹² found older participants less likely to consent to extending follow-up. This was attributed to older patients having trouble complying with protocol visit requirements — more than 10% of patients were unable to drive, and more than 50% had mild or greater difficulty walking at baseline. This suggests that the disability often accompanying old age may serve as a barrier to long-term follow-up for such patients. Similarly, in a study assessing factors associated with non-participation and dropout

among cancer patients in a cluster randomised controlled trial, Roick et al. found older age to be associated with increased risk of attrition.¹³ The high prevalence of comorbidities made such patients functionally dependent, thus making it difficult for them to continue follow-up. Vega et al. identified older age to be a risk factor for study attrition due to both contact failure and death.¹⁴ The study suggested that dementia patients tend to switch between different family caregivers, thus resulting in contact failure.

Younger age was significantly associated with LTFU in several studies on patients receiving spine surgery.¹⁵ Younger patients are often busier with careers than elderly patients, and the cost of healthcare appointments, especially with manageable symptoms, is often seen as too high. This cost constitutes both the direct financial cost and the missed opportunity cost in pivotal career points. Vikane et al. explored follow-up in traumatic brain injury and found LTFU was associated with both younger age and return to work percentage at 12 months post-injury.⁴ Similarly, Solberg et al. also demonstrated a positive correlation between LTFU and younger age in patients with degenerative lumbar spinal disorders.¹⁶ They found a 1-year increase in age to be associated with a corresponding 2% increase in probability of following up.

Socioeconomic status was similarly a factor in several studies; our study showed that people from lower socioeconomic brackets were the most likely to be LTFU, with the middle-class socioeconomic bracket having the least risk (OR=0.74 on multivariate analysis) and upper class also having a protective effect (OR=0.86). Nayeri et al. demonstrated that lack of college education (RR = 3.9) and Medicaid coverage (RR = 3.7) was a significant factor for LTFU in meningioma.¹⁷ Roick et al. similarly found that patients with higher income tended to stay part of clinical studies longer than those at risk of poverty.¹³

In traumatic brain injury patients, Jourdan et al. found LTFU to be associated with pre-injury unemployment; our study estimates SES from vocation, which also shows that people working for daily wages do tend to be lost to follow-up more often.¹⁸ Sharif-Askary et al. also found low socioeconomic status to be a predictor of LTFU in their study.¹⁰ An interesting point may be the indirect effect of SES on follow-up; several studies (Gallo and Mathews, Nayeri) suggest that in addition to finances directly, psychological stress is a major factor for poor follow-up. These patients tend to have a poor outlook on expected outcomes and the efficacy of treatment.^{17,19} Merritt et al., in their study assessing the financial impact of traumatic spinal cord injuries (TSCI), found only 35% of patients

were ever able to return to active employment and that five years post-injury, 25% of patients filed for bankruptcy.²⁰ The severe debilitation accompanying TSCI that limits both an individual's ability and choice of work, coupled with the high costs of rehabilitative treatment, put an excessive financial burden on this patient population and may contribute to their low follow-up compliance. This catastrophic expenditure can also be seen in cancer patients (especially with brain tumours), where treatment can be long and prohibitively expensive.

Gender may affect follow-up in communities where traditionally, women are marginalised and receive higher priority for healthcare than males. Our region does have parts of healthcare that do show gender disparity; our cohort, however, did not have a significant difference in follow-up between the different genders. While 59.9% of our LTFU cohort were male and 40.1% were female, this may be more reflective of the fact that our sample had more males than females overall; the actual LTFU rate within the genders was very similar (42.5% for males and 40% for females).

There was no consensus in literature regarding marital status and LTFU. Our study demonstrated that married patients were more likely to be LTFU than unmarried patients, which matches the findings of Roick et al.¹³ Roick et al. found that being married (OR=2.4) as well as being divorced, separated, or widowed (OR=1.3) were associated with increased likelihood of dropout from studies. However, Kim et al. found that being unmarried was significantly associated with LTFU,²¹ a finding reflected by Vega et al. in their study on neurological disorders in Spain.¹⁴ On one hand, being married (especially in a society where a major proportion of the population identifies it as the only route to cohabitation and having children) adds more responsibilities from a financial, temporal, and emotional perspective. Thus, the members primarily responsible for the family may not be able to afford enough time off to access healthcare or follow up properly. On the other hand, a family provides support from both financial and emotional standpoints, a caretaker (whether that be a spouse, parent, or child) is more likely to push for follow-up. The latter argument may be dependent on the number of family members actively earning, the age of the patient and their children, and the financial situation of the family.

Substance abuse was also significantly associated with LTFU in several studies, including Vega et al. (smoking), Sielatycki et al. (smoking), Jourdan et al. (alcohol), and Nayeri et al. (alcohol).^{14,15,17,18} In several of these papers' substance abuse is also correlated with low socioeconomic status, with may be an additional factor

for LTFU. Our study demonstrated that smoking, alcohol, opioid, niswar, paan, and gutka were not significantly associated with LTFU in our population. However, due to cultural and legal constraints, the rate of abuse might be higher than reported; other studies have shown that the use of smokeless tobacco products (such as Niswar and gutka) are around 8.6% of the population, compared to around 7.5% in our population. Alcohol purchase and use is not legal for most of the population, which is Muslim, and there is significant social stigma associated with the use of alcohol which is why patients might not disclose their ingestion. Niswar, Paan, and Gutka are relatively localized substances available in south and southeast Asia. The rate of use is significantly higher in specific geographical substrata.²²

Public sector hospitals are sponsored by the government for the most part and offer free or subsidized healthcare. Interestingly there was no significant difference in LTFU between public and private hospitals. The number of patients LTFU in public hospitals was higher (69%) than in private hospitals, but that reflects an overall larger population presenting to public sector hospitals with brain tumours.

High volume centres (>100 cases per year) saw a larger number of patients altogether, and the rate of LTFU is significantly higher at these centres. This may be due to the high volume of patients presenting at these centres, longer wait times, or increased inter-centre drift.

Geospatial distribution and the effect of distance on follow-up is gaining increasing traction in literature. Most of our patients overall (927, 39.2%) were from the province of Punjab (the largest province in Pakistan), and among these, 524 (56.6%) patients were LTFU. In Sindh, 215 (27.6%) patients were LTFU, possibly due to a lesser number of centres within Sindh, with most being concentrated in Karachi (the biggest city in the country and in Sindh). Vega et al., in their study, found rural residences to have the lowest rate of follow-up in their cohort.¹⁴

LTFU does not simply mean patients that do not follow up, whether that be in clinic or in a research setting; it also means failure to find. Systems and checks have been put in place, with basic identification and contact methods recorded all around the world. In high-income countries with more resources, there are civil and online records that can be accessed to find patients if the contact information is changed or lost. However, in an LMIC, where both budget and personnel are constrained, patients presenting to clinic are often focused on instead of devoting resources to contact past patients. In our

study, we highlight the gaps in care and highlight the need for a systematic reform in neuro-oncological care in LMIC's to improve the quality and consistency of healthcare.

LTFU is a significant factor for interruption in continuity of care, especially in LMIC's where lack of central registries and patient tracking systems allow for an unchecked LTFU population. LTFU is a major issue, in part, due to lack of centralised patient identifiers. In our region and other LMICs, where healthcare is not linked to insurance and expenditure is majorly out-of-pocket, patients are assigned unique identifiers in each hospital that are usually only followed within the hospital itself. Some healthcare centres still do not assign unique identifiers at all, relying on patient memory and patient-held documentation to recall their history. With the introduction of electronic health management systems, this norm is starting to change, but there is still a long way to go. Many hospitals and clinics still use paper-based systems to note down patient details, which due to high volume, can make even tracking patients within the same hospital system very hard. Where unique identifiers are present, they are not shared between hospitals (and may or may not be linked to the patient's National Identity Card number). This makes following patients who have transferred care to another centre impossible unless the patient comes to the primary surgeon themselves or the patient is called and asked their status.

The primary reason for identifying these patients LTFU is to address root causes for underlying social and economic issues that lead to these patients not following up in the first place. While LMICs have limited resources, welfare programmes and support groups do exist that help patients with cancer, such as the Brain Tumour Foundation in Pakistan. These groups provide valuable support to patients and their families in coping with brain tumours, and a central registry and integration with these groups would help address gaps in care and prevent patients from slipping through the cracks. More recently, especially with COVID-19, telemedicine and mobile health have become viable and widespread alternatives to follow-up, particularly if imaging or laboratory services are available near the patient's residence. While technological, infrastructural, and resource constraints still apply, especially in a population with poor internet availability and low literacy rate, distance and other significant factors are mitigated through remote consults and allow greater flexibility in follow-up. Smartphones are common in LMICs as well, and mobile app-based follow-up might be an avenue worth exploring. While this problem is too big to be addressed by one or even a

group of institutions, identifying these issues would help to highlight the need for a larger call to action. As Virchow put it, "physicians are the natural attorneys of the poor, and social problems fall largely within their jurisdiction".^{23,24}

Conclusion

LTFU is a significant barrier to both quality healthcare and study validity. Our study demonstrates an inordinately high LTFU rate from a surgical perspective for brain tumour patients in our population and shows that age, distance, marital status, socioeconomic status, and presentation to high-volume centres are all significant predictors of LTFU. This study leads to the identification of patients at risk of LTFU. This information can be used to develop intervention strategies to improve follow-up care of cancer patients in Pakistan.

Limitations: This study was unfunded, and the hospitals provided information on a volunteer basis. The study has limited generalizability as not all hospitals in the country were enrolled in the study, and those that were included were tertiary care hospitals with dedicated neurosurgical facilities.

Disclaimer: None to declare.

Conflict of Interest: None to declare.

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