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Research Article

Care Transitions for People with Acquired Neurological Disability in the First 12 Months following Inpatient Rehabilitation: Health Service Use and Obstacles

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Due to their complex and fluctuating needs requiring multiple transitions of care through different services and systems, the early postdischarge period is one of the vulnerabilities for people with acquired neurological disability. This study aimed to (1) map and examine system-level care transitions, including change in transition patterns and service use among people with acquired neurological disability during the first 12 months postdischarge and (2) explore the relationship between early perceptions (3 months postdischarge) of obstacles and difficulty with health service access to the pattern of care transitions. From July 2019 to March 2020, this study recruited 93 participants with acquired neurological disability resulting from acquired brain (44%) or spinal cord injury (56%) from a tertiary hospital in Queensland, Australia. Data linkage methods were used to capture system-level care transitions as movements between three levels of health care: primary, specialist, and emergency care. Health service use during care transitions was also characterised. Standardised questionnaires were used to measure obstacles and difficulty accessing health services in relation to transportation, finance, and resource availability at 3 months postdischarge. The median number of care transitions was 8 (range: 0–47), and the most frequent category of care transition pattern was where participants transit between all levels of care: primary, specialist, and emergency ($n = 51/93$, 54.8%). However, the frequency, direction, and sequence of transitions between different levels of care were diverse amongst participants. Most participants used primary (96%) and specialist (97%) services, while 59% used emergency services. Overall, postdischarge care transitions were common and highly variable for people with acquired neurological disability. Early perceptions of transportation being an obstacle to service access was a marginally significant contributor ($p = 0.051$) to more care transitions. Further research to delineate the characteristics and complications of care transitions and service use will aid in developing more personalised, coordinated postdischarge trajectories.

1. Introduction

Acquired neurological disability resulting from acquired brain injury (ABI) or spinal cord injury (SCI) has a substantial impact on individuals, their families, the health system, and broader society [1, 2]. The often-protracted rehabilitation and recovery period for individuals with acquired neurological disability occurs within a complex mix of transitions between various services and providers [3].

The focus of research is often on transitions during acute admissions and at discharge [3, 4]. However, the early postdischarge period is equally significant as people with acquired neurological disability will transition through many systems and providers due to their complex and fluctuating needs, influencing recovery trajectories and access to health services [5, 6].

There is no single, uniformly accepted definition of care transitions. The World Health Organization [7] defines care

transitions as "the various points where a patient moves to, or returns from, a particular physical location or makes contact with a health care professional for the purpose of receiving health care." The Australian Commission on Safety and Quality in Health Care refers to care transitions as occurring within and between healthcare locations, settings, care delivery types, and levels of care, involving a range of care providers [8]. Previous research has focused on single or certain types of transitions such as hospital to home [9–12], but there is less understanding of the multiple transition patterns involving access to services across different levels of health care following hospital discharge [13]. A previous study, in an elderly cohort, investigated number and patterns of transitions between acute, postacute, and long-term care use, the frequency of emergency room visits, and other health care utilization patterns that could indicate transition problems [14]. However, the larger knowledge gap hampers the development of both high-quality postdischarge service systems and integrated, person-centred pathways for people with complex needs [15–18].

People with acquired neurological disability leaving inpatient rehabilitation in Australia, as in many countries, frequently use various follow-up services across different healthcare settings [19]. Australia's health system consists of publicly and privately funded services, with citizens primarily relying on Medicare, a universal public health insurance system, for accessing hospital and health professional services. Medicare entitles all citizens to free or low-cost access to public hospitals, medical services, and limited allied health services [20]. Private health insurance is available to those who can afford it and helps cover the cost of private hospital services and community-based healthcare, including allied health services. Beyond the healthcare system, various lifetime care systems provide access to individualised care and supports for eligible people. The National Disability Insurance Scheme (NDIS) provides individualised funded supports for personal care, aids, and equipment and housing needs for people with acquired neurological disability [21]. Most Australian states also operate lifetime care and support schemes (e.g., National Injury Insurance Scheme in Queensland, NIISQ), for people who sustain serious injuries through motor vehicle or work-related events [22].

Hospital readmissions and emergency department visits are not uncommon for people with neurological disability [23–25]. Patterns of care transitions involving emergency care are especially noteworthy as they may highlight gaps in care transition processes [26, 27]. For example, inappropriate emergency care may indicate poorly coordinated transitions and limited access to primary health services [28–30].

Obstacles to service access for people with acquired neurological disability in the postdischarge period are relatively well understood [31–34] and are known contributors to complicated care transitions and access disparities [34–37]. Of note, despite the criticality of ongoing therapies for people with acquired neurological disability, challenges in accessing allied health services have been repeatedly described [35, 38]. However, the impact of obstacles and

service access difficulties in the early postdischarge period on long-term care transitions in people with ABI and SCI remains unexplored.

To ensure seamless transitions and timely service access for people with ABI and SCI, a comprehensive system-wide picture of the postdischarge period must be established. Moreover, there is a need for greater research focus on the pattern of care transitions in the first 12 months postdischarge due to periods' importance to the individuals' future rehabilitation and recovery trajectory. As such, this study aimed to (1) map and examine system-level care transitions including patterns of transitions and service use among people with ABI and SCI during the first 12 months postdischarge from inpatient rehabilitation and (2) explore the relationship between early perceptions (3 months postdischarge) of obstacles and difficulty with health service access to the pattern of care transitions.

2. Materials and Methods

2.1. Research Design. This exploratory study involved survey and data linkage methods and was part of a broader research program: the Trajectories of Rehabilitation across Complex Environments (TRaCE) study [39] investigating service access and wellbeing after ABI and SCI. Ethical approval was granted by the relevant Hospital (HREC/2019/QMS/50271) and University Human Research Ethics Committees (2019/ 456). All participants or their substitute decision makers provided written informed consent before study involvement.

2.2. Participants and Setting. From July 2019 to March 2020, participants with a primary diagnosis of ABI or SCI were recruited from a tertiary health care centre in Queensland, Australia. The centre hosts SCI and ABI specialist services, including inpatient, outpatient, transitional rehabilitation, and community outreach services. Participants were eligible if they (1) had a new diagnosis of SCI or ABI; (2) were aged ≥18 years; and (3) had the ability to provide informed consent or consent via a substitute decision maker. Exclusion criteria were (1) short-term visitors to Australia unavailable for follow-up and (2) health service use data unavailable from any of the required datasets.

2.3. Design and Measures

2.3.1. System-Level Care Transitions. In this study, care transitions were considered at a system level across three levels of care: primary health care (community-based), specialist health care (hospital or community-based specialist services), and emergency care (emergency services) (Figure 1). Transitions of care directly from one health service to another within the same level of care (i.e., between a primary care general practitioner (GP) and a primary care allied health professional) were not countered as separate care transitions. This transition categorisation of levels of care into primary, specialist, and emergency was chosen to enable distinct examination of aspects of the health care
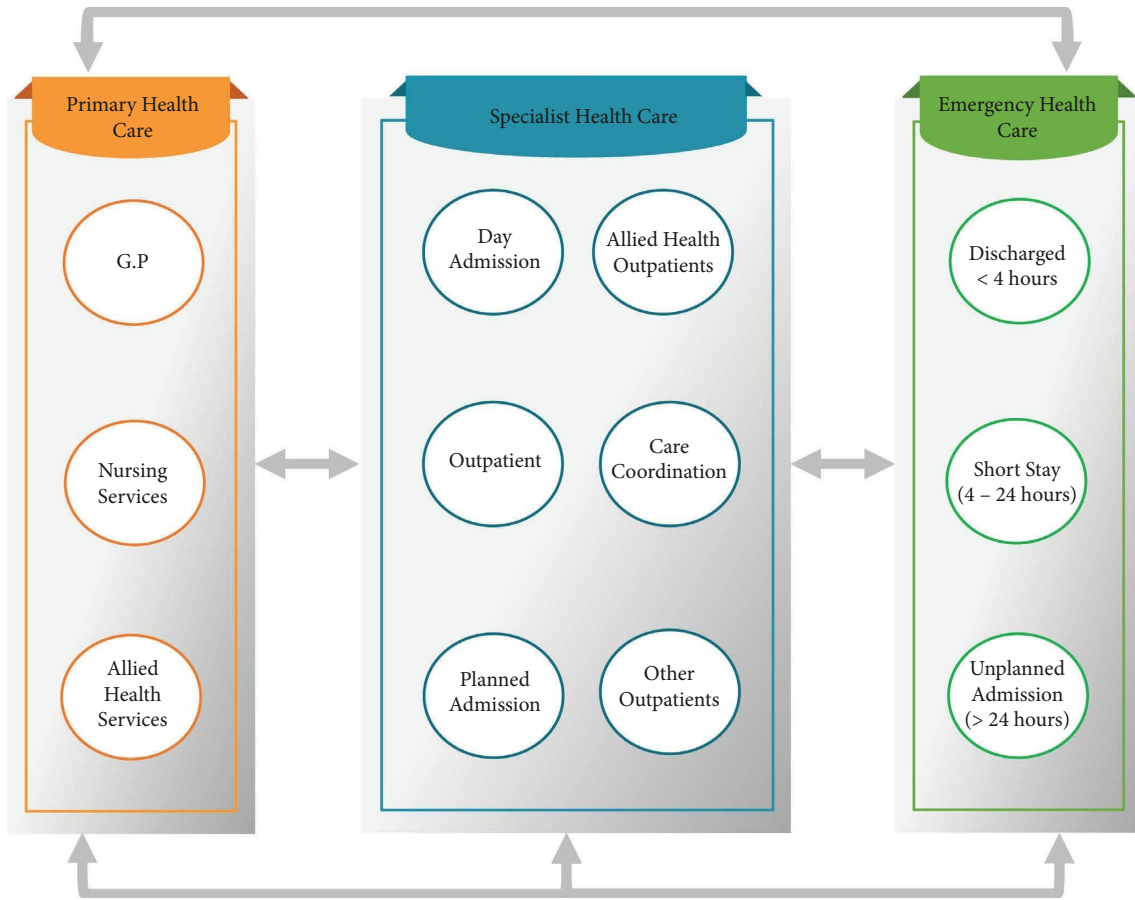
FIGURE 1: Diagrammatic representation of the 3 levels of health care (rectangles), services accessed within each level of care (circles), and broad care transition pathways (arrows).

system most relevant to people with ABI and SCI. It also enabled emergency care to be considered independently from other planned admissions which were included in the specialist health care category (Figure 1). This categorisation was also facilitated by the composition of the Medicare Benefits Scheme (MBS) and Queensland Health datasets.

2.3.2. Data Linkage for Care Transitions and Health Service Use. The data linkage framework for the study was designed to cover specialist and mainstream health service use in the 12 months postdischarge from inpatient rehabilitation and included MBS data, Queensland Health datasets, and local electronic medical records (EMRs). Data linkage methods were used to capture care transition patterns and health services accessed during transitions. The local EMRs were used to describe the cohort and identify characteristics of inpatient rehabilitation and discharge.

Primary health care use was obtained through the MBS data collection [40], based on participants' unique IDs, which were provided to the data custodian. GP visits, and nursing and allied health services were fundamental, with other MBS items, such as diagnostic procedures, investigations, pathology, and therapeutic procedures, not included as they were reasons for service contacts or interventions rather than service use categories. Specialist

health care use was recorded using the Queensland Hospital Admitted Patient Data Collection and Queensland Health Nonadmitted Patient Data Collection, accessed through the Statistic Services Branch (SSB), Queensland Health [41]. Data linkage of Queensland Health data sets was performed by the SSB. Both deterministic and probabilistic methods of linking records are used, with clerical review used to manually inspect the "grey area" of uncertain matches in probabilistic linkage. Events were considered specialist care if they were (1) day admissions at public or private hospitals or day surgery units; (2) planned hospitalisations; or (3) nonadmitted, outpatient attendances for medical specialists or allied health services, care coordination, and other services, such as fitting of aids and appliances or wound management. Emergency care use was sourced from the Emergency Data Collection, also part of the SSB data collection and linkage process. Emergency care events included those resulting in physician consultation and discharge within 4 hours, short-stay events (4–24 hours), and unplanned hospitalizations (≥1 overnight stay) (Figure 1).

2.3.3. Sociodemographic, Injury, and Discharge Variables. Sociodemographic, injury, and discharge variables were retrieved from hospital EMRs. Sociodemographic variables included age, gender, relationship status, education, and

employment status at time of injury. Injury-related variables included diagnosis (i.e., ABI and SCI), aetiology (i.e., nontraumatic and traumatic), and Functional Independence Measure (FIM) at discharge. Discharge variables were also recorded, including discharge destination, transportation independence at 3 months, and funding arrangement at discharge. As some participants were discharged following the start of the COVID-19 pandemic, discharge after the date of hospital-wide pandemic-related service closures (29 January 2020) was also recorded. This was considered as a potential confounding factor for the relationship between obstacles and difficulty accessing health services and care transitions.

2.3.4. Survey

(1) Perception of Obstacles to Health Service Access. Participants' perceived obstacles to health service access in relation to transportation, finance, and resource availability were assessed at 3 months postdischarge using the Service Obstacles Scale [42]. The scale comprises six items with three subscales: transportation as an obstacle (1 item), finance as an obstacle (1 item), and satisfaction with treatment resources (4 items). Participants rated each item, from 1 (strongly disagree) to 7 (strongly agree). Transportation and finance obstacles scores range from 1 to 7, while satisfaction with treatment resources ranges from 4 to 28. Higher scores indicate greater agreement that transportation and finance are obstacles and lower satisfaction with treatment resource availability. In the current sample, internal consistency of treatment satisfaction was adequate ($\alpha = 0.71$, 95% CI = 0.58 to 0.80).

(2) Perceived Difficulty Accessing Health Services. Perceived difficulty accessing health services and support was measured at 3 months postdischarge using the modified Care Access Scale [43]. Participants rated their access to healthcare and support when unwell on a scale of 1 (strongly disagree) to 5 (strongly agree). The scale comprised six items measuring access frequency (i.e., "I don't always access healthcare and support when I should" and "Sometimes I feel unwell for a while before I access healthcare and support"). A care access score was calculated by averaging the six scale items, ranging from 1 to 5, with higher scores indicating greater difficulty accessing healthcare services and supports [43]. The Care Access Scale demonstrated good internal consistency in the current sample ($\alpha = 0.81$; 95% CI = 0.73 to 0.87).

2.4. Data Analysis. Data were analyzed using R Statistical Software version 4.2.0 [44]. All measured variables were not normally distributed based on the Shapiro–Wilk test and visual inspection of histograms. Therefore, median (interquartile ranges) or frequency (%) was presented. Potential sample bias was explored by comparing the characteristics of

participants with and without missing questionnaire data. Complete case data with no imputation of missing values were used for all analyses.

For the relationship between the number of care transitions (dependent variable) and care access, transportation obstacles, finance obstacles, and satisfaction with treatment resources at 3 months postdischarge (independent variables), multivariate negative binomial regression was used due to overdispersion and lack of Poisson distribution in the data [45]. Prescreening of independent variables and theoretically relevant covariates (age, sex, relationship status, education, diagnosis, traumatic nature of the injury, FIM scores at discharge, types of insurance funding at discharge, and discharge after COVID-19 related service closures) was performed using Spearman correlation matrix and univariate regression analysis. Variables with a p value <0.25 [46, 47] in the univariate regression were selected for the final regression model. Two final models were built, one with and one without covariates. Key assumptions of the final models were checked, including the distribution of dependent variables, linearity of independent variables, independence of observations, and detection of outliers and influential observations. Multicollinearity was assessed using a variance inflation factor of <5. [48].

Care transition patterns were categorised based on the combination of different levels of care accessed at least once, that is, primary only, specialist only, primary-emergency, specialist-emergency, primary-specialist, and primary-specialist-emergency. No participants accessed emergency level care only. Hierarchical logistic regression was used to examine the relationship of the pattern of care transition involving emergency care (binary independent variable: yes/no) to care access, transportation obstacles, finance obstacles, and satisfaction with treatment resources at 3 months postdischarge (independent variables). The prescreening process for independent variables and covariates, as well as the validation of logistic regression assumptions, followed the same approach as the negative binomial regression. Two models were built: first with the selected covariates and the second included the selected covariates and independent variables. Regression analyses could not be conducted with the care transitions patterns that included primary or specialist care as dependent variables due to nearly universal involvement of primary or specialist care in participants' transitions. Odds ratios (ORs), coefficients, 95% confidence intervals (CIs), and p values were reported, with a statistically significant level set at 0.05.

3. Results

Ninety-three participants (56% SCI) with available health service data were included in this study, with 73 (78.5%) completing the survey (Figure 2). Characteristics of participants with and without missing survey data were largely comparable; however, those with missing survey data had less than half the number of care transitions (3.5 versus 9)
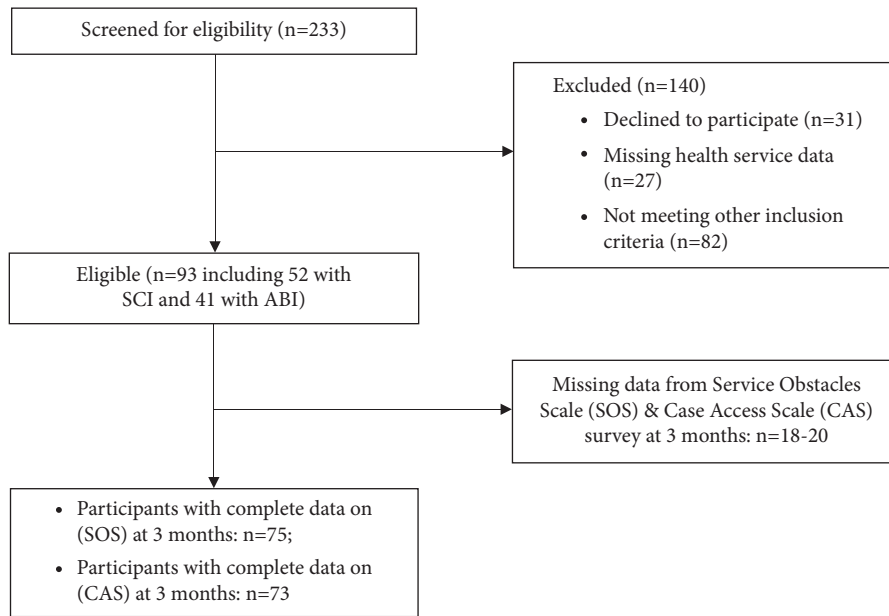
FIGURE 2: Participant flowchart. SCI, spinal cord injury; ABI, acquired brain injury.

compared to those with complete survey data Table 1. Sociodemographic, injury, and discharge related data for included participants are presented in Table 2.

3.1. Care Transitions and Health Service Use during Transitions. The median number of care transitions in the 12 months postdischarge was eight, with an interquartile range of 3–12 (Figure 3). Only three (3.2%) participants did not have any care transitions, while most participants (74.2%) experienced more than 3 transitions (Figure 3). A small number of participants (9.7%) had greater than 19 care transitions over the 12-month period with the maximum number being 47. Based on the level of care that participants accessed at least once in the first 12 months, six major categories of care transition patterns were identified (Figure 4). The most frequent category of care transition ($n = 51/93$, 54.8%) was where care transitions occurred between all three levels: primary-specialist-emergency. The second most frequent category ($n = 35/93$, 37.6%) was the primary-specialist pattern. Within each broad category of care transition, there was considerable variability amongst participants in terms of frequency, direction, and sequence of transitions (Figures 5(a) and 5(b)).

Almost all participants had accessed various primary (96%) and specialist (97%) health services during the 12-months postdischarge, with GPs and medical specialist's outpatient consultations being the most common in their respective categories (Table 3). Allied health services were the next most common in both categories. A planned hospital admission occurred for 13% of participants. Fifty-nine percent of participants used the various types of emergency services with 26% requiring a hospital admission for greater than 24 hours (Table 3).

3.2. Relationship between Care Transitions and Service Obstacles and Access. The rating of difficulty accessing health services at 3 months was low, with the median (interquartile range) being 1.6 (1.2–2.0). The median (interquartile range) rating for transportation obstacles at 3 months was 3.0 (2.0–6.0), with 42.2% of participants agreeing that transportation was an obstacle to health service access. Similarly, the median (interquartile range) rating for finance obstacles at 3 months was 3.0 (2.0–5.0), with 33.3% of participants agreeing that finance was an obstacle to health service access. The median (interquartile range) rating for satisfaction with treatment resources at 3 months was 12.0 (9.0–16.0).

The spearman correlation matrix showed small to medium, positive, and significant correlations between finance obstacles and transportation obstacles and satisfaction with treatment resources at 3 months (Table 4). There were no collinearity concerns for the continuous independent variables and potential covariates (Table 4). Based on the results of univariate regression analyses, transportation obstacles, finance obstacles, and satisfaction with treatment resources at 3 months were selected as independent variables while age, discharge after COVID-19 related service closures, and NIISQ funding were selected as covariates for the negative binomial regression analyses with frequency of care transitions as the dependent variable. For the hierarchical logistic regression with care transition patterns that included emergency care as the dependent variable, transportation obstacles at 3 months were selected as the independent variable and injury type, FIM at discharge, and NDIS funding as covariates.

Univariate regression analyses indicated that both transportation and finance obstacles and satisfaction with treatment resources at 3 months were significantly

TABLE 1: Comparisons between participants with and without missing survey data in sociodemographic, injury, and discharge related variables, and number of health service use.

Variable	With missing survey data (n = 20)	Complete survey data (n = 73)	p-values
Age, median (interquartile range) years	50.0 (30.2, 58.8)	51.7 (42.4, 60.6)	0.575
Gender—male, n (valid %)	11/20 (55.0%)	51/73 (69.9%)	0.284
Relationship status, n (valid %)			0.606
Single	9/19 (47.4%)	29/73 (39.7%)	
Have a partner	10/19 (52.6%)	44/73 (60.3%)	
Education, n (valid %)			0.070
High school or lower	8/19 (42.1%)	48/73 (65.8%)	
Tertiary education	11/19 (57.9%)	25/73 (34.2%)	
Employment at time of injury, n (valid %)			0.439
Employed (full time, part time or casual)	8/19 (42.1%)	43/72 (59.7%)	
Unemployed	4/19 (21.1%)	9/72 (12.5%)	
Home duties or volunteer work	2/19 (10.5%)	3/72 (4.2%)	
Retired	4/19 (21.1%)	8/72 (11.1%)	
Other	1/19 (5.3%)	9/72 (12.5%)	
Diagnosis, n (valid %)			0.356
Acquired brain injury	7/20 (35.0%)	34/73 (46.6%)	
Spinal cord injury	13/20 (65.0%)	39/73 (53.4%)	
Discharge destination, n (valid %)			0.097
Private residence (includes rental and owner occupied)	4/17 (23.5%)	6/67 (9.0%)	
Interim discharge location	13/17 (76.5%)	61/67 (91.0%)	
Discharge after COVID-19 related service closures	7/20 (35.0%)	24/73 (32.9%)	1.000
Total scores of Functional Independence Measure at discharge, median (IQR)	99.0 (78.0, 111.0)	112.0 (86.0, 116.0)	0.066
Funding arrangement at discharge, n (valid %)			0.295
National disability insurance scheme	13/20 (65.0%)	44/73 (60.3%)	
National injury insurance scheme Queensland	2/20 (10.0%)	13/73 (17.8%)	
My aged care	3/20 (15.0%)	7/73 (9.6%)	
No funding	2/20 (10.0%)	2/73 (2.7%)	
Others	0/20 (0.0%)	7/73 (9.6%)	
Primary health care	7.5 (3.0, 11.0)	9.0 (5.0, 15.0)	0.130
General practitioners	5.0 (3.0, 10.5)	7.0 (5.0, 13.0)	0.157
Nursing	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.171
Allied health	0.0 (0.0, 0.5)	1.0 (0.0, 2.0)	0.051
Specialist care	13.5 (5.0, 26.5)	13.0 (7.0, 24.0)	0.903
Medical specialist-day admission	0.0 (0.0, 0.5)	0.0 (0.0, 1.0)	0.438
Medical consultation-outpatient	4.5 (3.0, 8.0)	5.0 (3.0, 8.0)	0.596
Planned hospitalisation	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.809
Allied health-outpatient	3.5 (0.0, 12.5)	4.0 (1.0, 8.0)	1.000
Care coordination-outpatient	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.085
Other-outpatient[A]	0.0 (0.0, 1.0)	0.0 (0.0, 1.0)	0.640
Emergency care	1.0 (0.0, 1.5)	1.0 (0.0, 2.0)	0.777
Seen and discharged	0.0 (0.0, 1.0)	0.0 (0.0, 1.0)	0.518
Short stay (4–24 hours)	0.0 (0.0, 1.0)	0.0 (0.0, 1.0)	0.767
Hospitalised[B] (>24 hours)	0.0 (0.0, 0.0)	0.0 (0.0, 1.0)	0.526
Number of care transitions	3.5 (2.0, 8.5)	9.0 (5.0, 13.0)	**0.007**

Note. [A]Other includes aids and appliances, midwifery and maternity, wound management, post-acute care, telehealth consultations and respiratory. [B]Hospital presentations include public and private hospitals.

associated with greater care transitions over 12 months (Table 5). However, in the multivariate analysis, only transportation obstacles at 3 months was found to be a marginally significant contributor ($p = 0.051$) to the number of care transitions over the 12 months after adjusting for age, discharge after COVID-19 related service closures, and NIISQ funding (Table 6). For the hierarchical logistic regression for care transitions that included emergency care, while there was a significant association with transportation as an obstacle in the univariate regression analysis (Table 5), after adjusting for injury type and FIM at discharge, no significant association was found (Table 7).

4. Discussion

This exploratory study is the first to examine system-level care transitions for people living with acquired neurological disability resulting from ABI or SCI in the first 12 months following acute inpatient rehabilitation. As a further novel aim, we examined relationships between early perception of

TABLE 2: Participant sociodemographic, injury, and discharge related variables.

Variable	n/total n (valid %) or median (IQR)
Age, years	52 (42, 60)
Gender-male	62/93 (66.7%)
Relationship status	
Single	38/92 (41.3%)
Have a partner	54/92 (58.7%)
Highest education level	
High school or lower	36/92 (39.1%)
Tertiary education	56/92 (60.9%)
Employment at time of injury	
Employed (full time, part time, or casual)	51/91 (56.0%)
Unemployed	13/91 (14.3%)
Home duties or volunteer work	5/91 (5.5%)
Retired	12/91 (13.2%)
Other	10/91 (11.0%)
Diagnosis	
Acquired brain injury	41/93 (44.1%)
Nontraumatic	22/41 (53.7%)
Traumatic	19/41 (46.3%)
Spinal cord injury	52/93 (55.9%)
Nontraumatic	24/52 (46.2%)
Traumatic	28/52 (53.8%)
Functional independence measure at discharge	
Motor subscale, scored 13 to 91	78 (54, 86)
Cognitive subscale, scored 5 to 35	33 (25, 35)
Total, scored 18 to 126	108 (85, 116)
Discharge destination	
Private residence (includes rental and owner occupied)	74/84 (88.1%)
Interim discharge location	10/84 (11.9%)
Discharge after COVID-19-related service closures	31/93 (33.3%)
Transportation independence	
Independent in all modes of transportation including driving	10/71 (14.1%)
Independent in all modes of transportation, but others have concerns about safety	1/71 (1.4%)
Requires a little assistance or supervision from others 5–24% of the time; cannot drive	25/71 (35.2%)
Requires moderate assistance or supervision from others 25–75% of the time; cannot drive	19/71 (26.8%)
Requires extensive assistance or supervision from others more than 75% of the time; cannot drive	16/71 (22.5%)
Funding arrangement at discharge	
National Disability Insurance Scheme	57/93 (61.3%)
National Injury Insurance Scheme Queensland	15/93 (16.1%)
My aged care	10/93 (10.8%)
No funding	4/93 (4.3%)
Others	7/93 (7.6%)

obstacles and difficulty accessing health services and the pattern of care transitions. By elucidating the diversity of transitions and health service use, this study provides a valuable starting point to reflect on the complexity of care transitions for people with ABI and SCI, but more importantly the potential treatment burden [49] that they experience due to interactions with multiple systems and services.

The study findings highlight that while there were six major categories of care transition patterns that people with SCI and ABI experience during the first 12 months postdischarge, and within those broad categories, participants experienced considerable diversity and complexity in the frequency, direction, and sequence of transitions between the primary, specialist, and emergency care levels. This finding aligns with previous research reporting highly varied care transition patterns among people with complex needs [15, 50], including people with ABI during the first 6 months after injury [51]. Although multiple transitions may be indicative of the heterogeneity of needs associated with neurological disability [52, 53], nonetheless, this picture warrants further consideration of the nature of transitions and how these might affect recovery and outcomes. For example, more transitions can increase the likelihood of
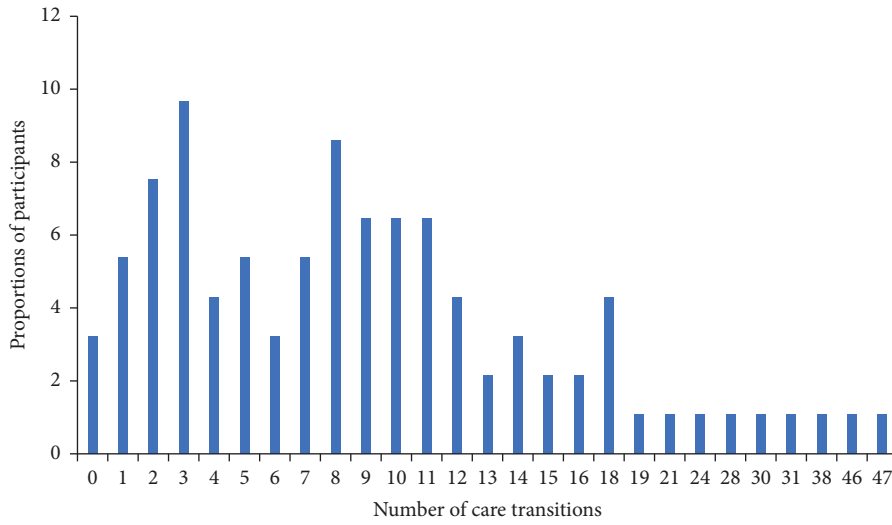
FIGURE 3: Proportions of participants by the frequency of care transitions in the first 12 months postdischarge.
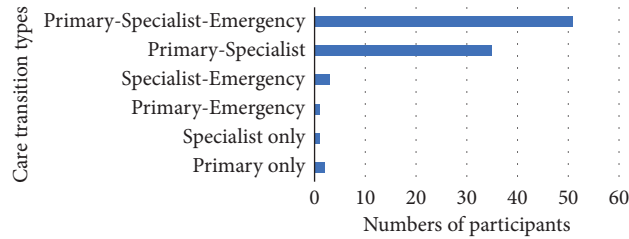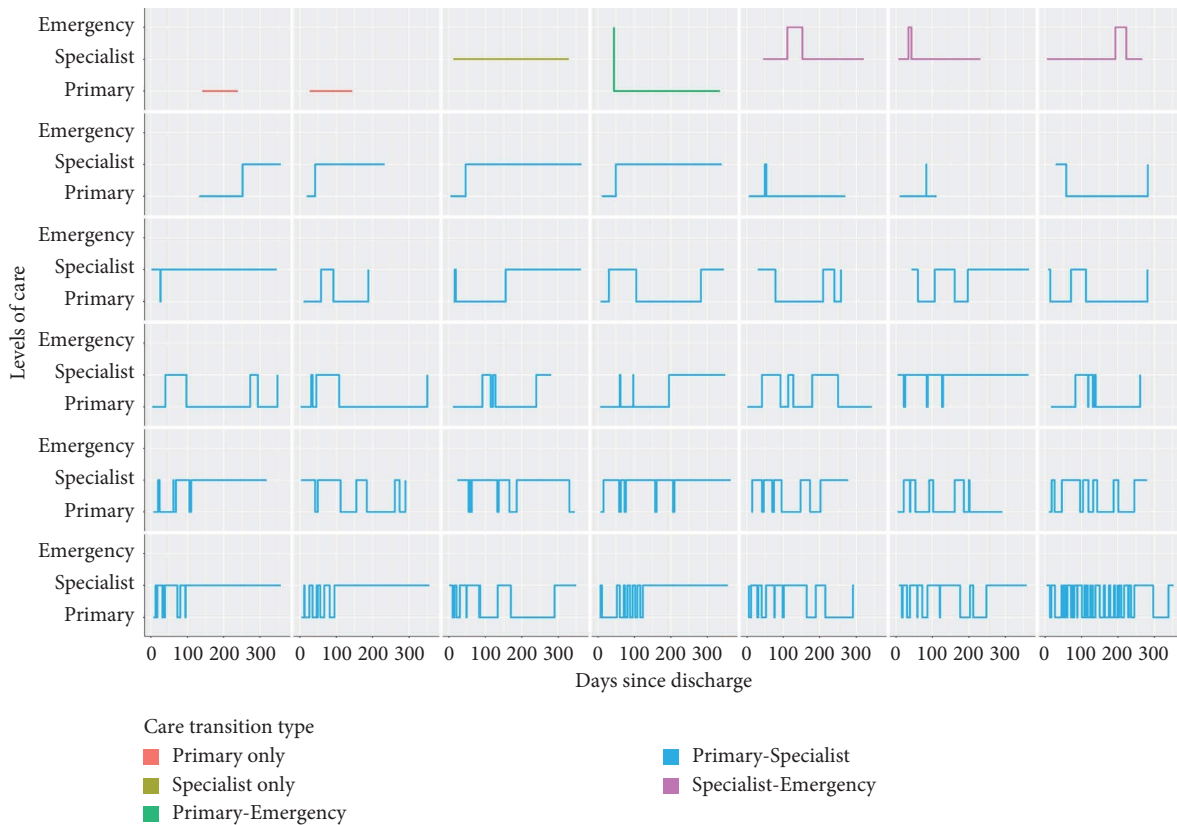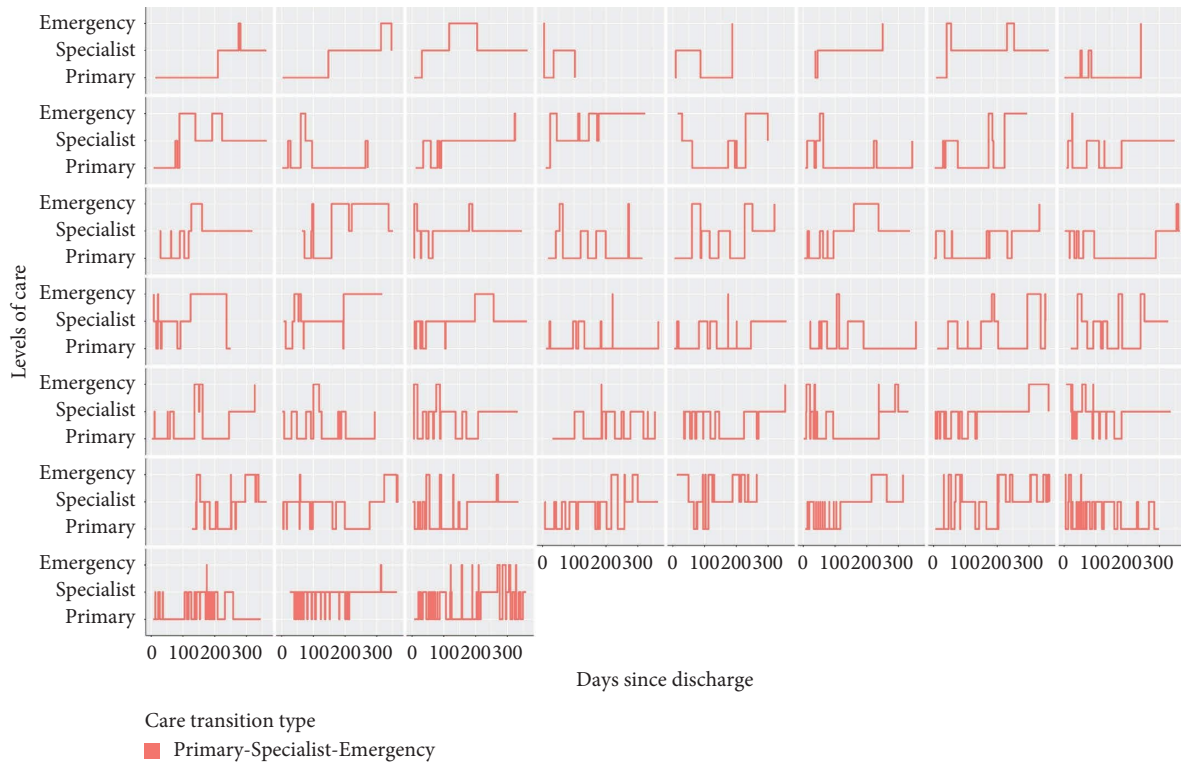

FIGURE 4: Types of care transitions in the first 12 months postdischarge.

(a)

FIGURE 5: Continued.

(b)

FIGURE 5: (a) Plots of care transitions, grouped by transition pattern category, in the first 12 months postdischarge. (b) Plots of the primary-specialist-emergency care transition pattern in the first 12 months postdischarge.

adverse events [54, 55], contribute to suboptimal or fragmented care [56], and undermine person-centred pathways. These impacts may be exacerbated if systems themselves are segmented and convoluted as the Australian health care system arguably is. It operates on a complicated mix of public and private funding and discrete programs, with responsibilities for hospital, primary, and community care divided between different levels of government, all of which contribute to fragmented systems of care [57]. Consequently, lack of coordination between various systems is commonplace for people with complex needs, particularly regarding referral and transitions, and can contribute to failures in access [58]. In this context, the diversity and complexity of care transitions for people with ABI and SCI identified in this study may indicate a need to design more seamless, personalised pathways that optimise rehabilitation and recovery trajectories.

The study also found that early perceptions of transportation being an obstacle to accessing health services may be a factor contributing to more care transitions over the 12 months postdischarge. Transportation is a well-known determinant of access and transport obstacles are common in people with complex needs [59]. Only 14% of participants in this study were able to drive independently 3 months after discharge from inpatient rehabilitation, which is consistent with previous research [35]. These people may also vary in their level of caregiver support regarding transport [60]. Transportation barriers are known to contribute to increased

difficulty with health service access [61] and may result in missed opportunities for early management of secondary conditions [62] or delayed progression of rehabilitation programs within the first 3 months postdischarge, which in turn may result in more care transitions being required by the end of the first 12 months postdischarge for people with ABI or SCI. However, it is important to note that transportation obstacles was measured by a single item and the association between early perception of transportation obstacles and increased care transitions was only marginally significant in the multivariate regression analysis. Hence, caution is needed in interpreting this finding, particularly given the modest sample size. In addition, due to the diversity of the population studied and because transportation and other obstacles and their impacts are likely to be highly individual, further research is required to understand the nature of transportation obstacles and how they might influence transitions.

Our findings also provide insight into the possible systemic burden of treatment experienced by people with acquired neurological disability. Burden of treatment is the workload of healthcare and its effect on patient functioning and wellbeing. While the systemic burden of the disabling or chronic condition itself is often a focus of research, limited attention has been paid to the associated systemic treatment burden [63]. Although treatment burden was not directly measured in this study, the number of care transitions experienced and health services used by participants in the first

TABLE 3: Primary, specialist, and emergency health care use during the first 12 months postdischarge.

Level	Participants who used service (n = 93) N (%)	Service contacts[A]		
		Median	Interquartile range	Range
Primary health care	89 (96%)	9	5–14	1–45
General practitioners	88 (95%)	7.5	5–13	1–37
Nursing	14 (15%)	2.5	1–3	1–5
Allied health	44 (47%)	2	1–3	1–26
Specialist health care	90 (97%)	13	7–24	1–144
Medical specialist-day admission	31 (33%)	2	1–5	1–140
Medical consultation-outpatient	89 (96%)	5	3–8	1–26
Planned hospitalisation	12 (13%)	1	1–1.25	1–3
Allied health-outpatient	71 (76%)	6	3–11.5	1–126
Care coordination	9 (10%)	5	4–9	2–14
Other-outpatient[B]	25 (27%)	2	1–3	1–18
Emergency health care	55 (59%)	2	1–4	1–30
Seen and discharged	39 (42%)	1	1-2	1–22
Short stay (4–24 hours)	28 (30%)	1	1-2	1–8
Unplanned hospitalised[C] (>24 hours)	24 (26%)	1	1-2	1–6

Note. [A]Data reported for people who used services and does not include those who did not use services. [B]Other includes aids and appliances, midwifery and maternity, wound management, postacute care, telehealth consultations, and respiratory. [C]Hospital presentations include public and private hospitals.

TABLE 4: Spearman correlation coefficients between potential continuous covariate variables (age, functional independence measure (FIM) at discharge) and independent variables (care access and service obstacles at 3 months).

	Age	FIM score	Care access	Transportation obstacles	Finance obstacles
FIM score	−0.140				
Care access	−0.221	0.105			
Transportation obstacles	−0.028	−0.198	−0.061		
Finance obstacles	0.087	0.033	0.150	0.362**	
Satisfaction with treatment resources	0.028	−0.114	0.181	0.160	0.437**

Note. ** $p < 0.001$.

TABLE 5: Univariate regressions between sociodemographic, injury, and discharge-related factors (potential covariates), care access, and service obstacles at 3 months (dependent variables) and the frequency and pattern of care transitions that included emergency care (use of emergency care) (dependent variables) in the first 12 months postdischarge.

	Univariate negative binomial regression Number of care transitions	Univariate logistic regression Use of emergency care
Age	**B = 0.119, p = 0.018**	OR = 0.991, p = 0.527
Sex (ref: male)		
Female	B = −2.226, p = 0.190	OR = 1.144, p = 0.766
Relationship status (ref: have a partner)		
Single	B = −0.084, p = 0.962	OR = 1.538, p = 0.325
Education (ref: high school or lower)		
Tertiary education	B = 0.026, p = 0.998	OR = 0.976, p = 0.955
Diagnosis (ref: ABI)		
SCI	B = 1.427, p = 0.404	**OR = 2.162, p = 0.073**
Traumatic injury (ref: yes)		
No	B = −1.035, p = 0.548	OR = 0.964, p = 0.931
FIM scores at discharge	B = −0.016, p = 0.742	**OR = 0.973, p = 0.027**
Discharge after COVID-19-related service closures (ref: no)		
Yes	**B = −4.645, p = 0.003**	OR = 1.144, p = 0.766
Having National Disability Insurance Scheme funding (ref: no)		
Yes	**B = 1.194, p = 0.489**	OR = 2.235, p = 0.065
Having National Injury Insurance Scheme in Queensland funding (ref: no)		
Yes	**B = −2.787, p = 0.148**	OR = 0.754, p = 0.618
Care access	B = 0.940, p = 0.680	OR = 1.335, p = 0.559
Transportation obstacles	**B = 1.254, p = 0.008**	**OR = 1.283, p = 0.041**
Finance obstacles	**B = 1.184, p = 0.029**	OR = 1.096, p = 0.449
Satisfaction with treatment resources	**B = 0.518, p = 0.019**	OR = 1.045, p = 0.377

Note. Bold values represent variables with p value <0.25. Ref, reference; FIM, functional independence measure; B, unstandardized coefficient; OR, odd ratio.

TABLE 6: Results of the negative binomial regression for the frequency of care transitions in the first 12 months postdischarge ($n = 72$).

	Model	B	Std. error	95.0% confidence interval for B		Significance	Exp (B)	95.0% confidence interval for Exp (B)	
				Lower bound	Upper bound			Lower bound	Upper bound
1	(Intercept)	2.604	2.521	-2.337	7.545	0.302	13.520	0.097	1891.500
	Transportation obstacles at 3 months	0.918	0.544	-0.149	1.985	0.092	2.505	0.862	7.282
	Finance obstacles at 3 months	0.322	0.650	-0.953	1.596	0.621	1.380	0.386	4.934
	Satisfaction with treatment resources at 3 months	0.289	0.2504	-0.202	0.780	0.248	1.335	0.817	2.182
2	(Intercept)	-5.482	3.737	-12.806	1.842	1.42	0.004	0.000	6.306
	Age	0.220	0.616	0.100	0.341	<0.001	1.246	1.105	1.406
	Discharge after COVID-19-related service closures	-3.683	1.571	-6.761	-0.604	0.019	0.025	0.001	0.547
	Having National Injury Insurance Scheme in Queensland funding	2.362	2.058	-1.671	6.395	0.251	10.610	0.188	598.545
	Transportation obstacles at 3 months	0.715	0.367	-0.003	1.434	0.051	2.045	0.997	4.194
	Finance obstacles at 3 months	-0.033	0.484	-0.981	0.915	0.946	0.968	0.375	2.498
	Satisfaction with treatment resources at 3 months	0.292	0.207	-0.113	0.697	0.158	1.339	0.893	2.007

TABLE 7: Summary of logistic regression models for the type of care transitions that included emergency care in the first 12 months post-discharge ($n = 71$).

Model	Model Summary		
	−2 Log likelihood	Cox & Snell R square	Nagelkerke R square
1[b]	84.567[a]	0.149	0.201
2[c]	82.771[a]	0.170	0.230

Variables in the equation

	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for Exp (B) Lower	Upper
Model 1[b]								
Diagnosis (spinal cord injury)	0.176	0.550	0.102	1	0.749	1.193	0.406	3.507
FIM at discharge	−0.041	0.017	5.749	1	**0.016**	0.960	0.929	0.993
Having national disability insurance scheme funding	0.881	0.535	2.711	1	0.100	2.413	0.846	6.887
Constant	3.973	1.908	4.336	1	**0.037**	53.136		
Model 2[c]								
Diagnosis type	0.080	0.562	0.020	1	0.887	1.083	0.360	3.257
FIM at discharge	−0.040	0.017	5.455	1	**0.020**	0.961	0.929	0.994
Having national disability insurance scheme funding	0.834	0.543	2.362	1	0.124	2.303	0.795	6.676
Transportation obstacles at 3 months	0.178	0.134	1.761	1	0.185	1.194	0.919	1.553
Constant	3.306	1.959	2.850	1	0.091	27.287		

Note. [a]Estimation terminated at iteration number 5 because parameter estimates changed by less than 0.001. [b]Variable(s) entered on model 1: diagnosis type (spinal cord injury), FIM at discharge, having national disability insurance scheme funding. [c]Variable(s) entered on step 1: diagnosis type (spinal cord injury), FIM at discharge, having national disability insurance scheme funding, and transportation obstacles at 3 months. FIM, functional independence measure; B, unstandardized coefficient; S.E., standard error; df, degree of freedom; sig, significance; Exp (B), odd ratios; C.I., confidence interval. Bold values mean $p < 0.05$

12 months after discharge reveal something of the early workload associated with the rehabilitation and recovery trajectory for people with ABI and SCI. Furthermore, previous research [64] supports the finding that obstacles such as transport may contribute to greater care transitions, potentially increasing the systemic treatment burden for participants. As such, these findings provide a springboard to better understand and measure the burden imposed by treatment regimens and systems on people with complex needs as a measure of quality of care [65]. More could be learnt through future research combining qualitative accounts of personal experiences with more detailed mapping of transitions.

The finding of many varied and complex care transitions may have implications when considering the development of future care transition interventions for people with acquired neurological disability. Future strategies could entail more comprehensive, personalised approaches to assist people navigating care transitions and overcoming obstacles to access. Furthermore, given the ongoing health and support needs of people with neurological disability, coordination between health and disability services could be strengthened, for example, by providing designated support coordination within the health system or through the NDIS for those who are eligible [66].

Person-centred care approaches, tailoring treatment to individual needs and providing personalized monitoring of developing issues and changing goals, are well established as central to effective rehabilitation and are already employed by many rehabilitation services. Approaches which support more comprehensive "personalised rehabilitation pathways" to enhance care transitions include utilisation of case management [67–69], care navigators [70, 71], integrated care models [72, 73], self-management approaches [74, 75], improved resourcing [67, 70], improved communication including (patient controlled) EMR [71, 76], and person and family-engaged approaches [77, 78]. Further studies are needed to examine the best strategies or models for implementing more personalised rehabilitation pathways for people with SCI and ABI.

This study had several limitations. First, an a priori sample size calculation was not conducted as the primary objective of this study was to describe postdischarge care transition pathways. The sample size is relatively modest for multivariate negative binomial or logistic regression analysis. Second, participants with fewer care transitions had more missing data particularly regarding completion of the care access and service obstacles components of the survey at 3 months postdischarge, suggesting lower engagement in the study and potentially limiting generalisability of the results. Third, not all possible types and features of care transitions could be evaluated due to required data not being available as part of the data collection and linkage. This included care transitions to and from the community-based rehabilitation components of the specialist SCI and ABI services and the impact of readmissions to hospital on total number and pattern of care transitions. Fourth,

although care transitions were characterised, it is unclear whether these care transitions were appropriate transitions or not. Assessment of the appropriateness of timing of care transitions may have important implications for future interventions and system improvement [51]. Finally, financial and transportation obstacles were assessed only using a single item, which may not have fully captured all aspects of these barriers.

5. Conclusion

This study found that within six overarching categories, postdischarge system-level care transition patterns were diverse and complex for people with acquired neurological disability. Transport as an obstacle to service access may be contributed to increased transitions in the first 12 months following discharge. While the heterogeneity of post-discharge needs may necessitate diverse care transitions and access to varied health services, the critical issue is to ensure these are personalised to individual need and that systems are performing optimally for the benefit of people with acquired neurological disability. Further research is needed to comprehensively document the characteristics and complications of care transitions for people with SCI and ABI, across the health and social service systems and how these relate to meaningful access and health outcomes.

Data Availability

Data will be shared upon reasonable request.

Additional Points

What Is Known About the Topic? (i) Transitions of care are points of vulnerability for people with acquired neurological disability resulting from acquired brain or spinal cord injury. (ii) Understanding the complexity of care transitions between healthcare settings is needed to develop personalised approaches to improving quality of transitions. *What Does This Paper Add?* (i) The first 12 months postdischarge were characterised by multiple, diverse care transitions between different levels of health care. (ii) Transport obstacles postdischarge were marginally associated with the number of care transitions. (iii) More research studies on the circumstances and patterns of multiple care transitions may help in developing more personalised, coordinated rehabilitation approaches that minimise transition risks for people with complex needs.

Disclosure

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Acknowledgments

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