BMJ Open

Cohort Profile: The Acquired Brain Injury Community Rehabilitation and Support Services OuTcomes CohoRT (ABI-RESTaRT) Study, Western Australia, 1991-2020

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052728
Article Type:	Cohort profile
Date Submitted by the Author:	24-Apr-2021
Complete List of Authors:	Mann, Georgina; Brightwater Care Group, Brightwater Research Centre Troeung, Lakkhina; Brightwater Care Group, Brightwater Research Centre Wagland, Janet; Brightwater Care Group, Community and Disability Services Martini, Angelita; Brightwater Care Group, Brightwater Research Centre
Keywords:	REHABILITATION MEDICINE, Stroke < NEUROLOGY, Neurological injury < NEUROLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Cohort Profile: The Acquired Brain Injury Community Rehabilitation and Support Services OuTcomes CohoRT (ABI-RESTaRT) Study, Western Australia, 1991-2020

Georgina MANN, PhD[1], Lakkhina TROEUNG, PhD[1], Janet WAGLAND, BSc[2], Angelita MARTINI, PhD[1]

[1]Brightwater Research Centre, Brightwater Care Group, Perth, Australia

[2]Community and Disability Services, Brightwater Care Group, Perth, Australia

Correspondence to: Dr. Georgina Mann

Research Officer, Brightwater Research Centre

355 Scarborough Beach Rd, Osborne Park WA 6017 Australia

+ 61 8 9202 3561

Georgina.Mann@brightwatergroup.com

Word count: 3,084

Abstract

Purpose: Transition into the community following acute management of acquired brain injury (ABI) is a critical part of recovery. Post-acute rehabilitation and transitional care can significantly improve outcomes. The **A**cquired **B**rain **I**njury Community **RE**habilitation and Support Services Ou**T**comes Coho**RT** (ABI-RESTaRT) is a novel whole-population cohort formed to better understand the needs of individuals with ABI receiving post-acute rehabilitation and disability services in Western Australia (WA), and to improve their outcomes. To do this a unique combination of i) internal clinical/rehabilitation data, and ii) externally linked health data from the WA Data Linkage System was used, including hospitalisations, emergency department presentations, mental health service use, and death records, to measure longitudinal needs and outcomes of individuals with ABI over 29 years, making this the largest, most diverse post-acute ABI cohort in Australia to date.

Participants: Whole-population cohort of individuals (n =1,011) with an ABI who received post-acute community-based neurorehabilitation or disability support services through Brightwater Care Group from 1991-2020.

Findings to date: Comprehensive baseline demographic, clinical and rehabilitation data, outcome measures and linked health data have been collected and analysed. Non-traumatic brain injury (e.g. stroke, hypoxia) was the main diagnostic group (54.9%, *n*=555), followed by traumatic brain injury (34.9%, *n*=353) and eligible neurologic conditions (10.2%, *n*=103). Mean age at admission was 45.4 years, and 67.5% were male (*n*=682). The cohort demonstrated significant heterogeneity, socially and clinically, with differences between ABI groups across a number of domains.

Future plans: ABI-RESTaRT is a dynamic whole-population cohort that will be updated over time as individuals enrol in the service. Future analyses will assess longitudinal brain injury outcomes, the changing health and social needs of individuals with ABI, and evaluate and inform post-acute services to best support these individuals.

Registration: This cohort is not linked to a clinical trial, and is not registered.

Article Summary

- ABI-RESTaRT is the largest Australian post-acute neurorehabilitation and disability support cohort to date with a 29 year follow-up period.
- The combined use of internal clinical and rehabilitation data and linked health data provides a detailed picture of ABI that could not be derived from a single data source, with key measures including functional independence, health status and comorbidities, goal attainment, mental health and well-being, quality of life, and mortality, offering a unique, holistic understanding of the needs and outcomes of individuals with ABI
- The cohort represents a diverse and complex population including individuals with non-traumatic brain injury, traumatic brain injury, and eligible neurologic conditions, providing a diverse range of brain injury experiences.
- The unique study framework follows each cohort member from pre-injury to long-term follow-up after discharge from post-acute services, with a minimum 10-year lookback period (starting from 1981) and a mean follow-up time of 8.4 years following discharge.
- A state-based data linkage register was used, so pre-admission or post-discharge follow-up data for cohort members based interstate or overseas will not be captured, and all clients were accessing services at a single organisation which may reduce the generalisability of findings.

Introduction

Acquired brain injury (ABI) is one of the leading causes of death and disability in Australia[1]. Defined as any damage to the brain occurring after birth, ABI can be traumatic (caused by extrinsic forces to the head) or non-traumatic (e.g. stroke, drug misuse, tumour, hypoxia/anoxia). Estimates suggest 2% of the population of Western Australia (WA) are living with an ABI[2]. The consequences of ABI are complex and difficult to predict, but often lead to a range of impairments in cognitive, physical and psychosocial functioning[1–4]. Up to 75% of brain injuries occur in adults under 65 years of age[3], resulting in difficulties that can impact working ability, social engagement and community integration[5–7].

Regaining independence and/or meaningful participation in life following an ABI is achievable. Transition back into the community following acute management of ABI in hospital is a critical phase of recovery, and adjustment during transition predicts longer-term outcomes and overall recovery from brain injury[8,9]. Post-acute care is important throughout this often difficult and stressful transition period[9]. Individuals with inadequate supports risk poorer outcomes including development of a depressive disorder[8], re-hospitalisation or institutionalisation[9] and reduced likelihood of returning to work[5].

Despite the importance of post-acute care for individuals with an ABI, little empirical evidence is available to enable service planning and policy development for this poorly-understood cohort. A number of community-based neurorehabilitation cohort studies examining the outcomes of individuals with ABI after rehabilitation exist in Australia[10–13]. While this research has demonstrated the value of community-based rehabilitation, these cohort studies have small samples (<200), and short follow-up times (<3years). Long-term research examining the experiences of individuals accessing post-acute ABI services and the effectiveness of different types of post-acute care is required to ensure the best outcomes for individuals.

The Acquired Brain Injury Community REhabilitation and Support Services OuTcomes CohoRT (ABI-RESTaRT) study is the largest in Australia to date. This cohort includes 1,011 people with ABI who received post-acute rehabilitation or support services at Brightwater Care Group in WA from 1991-2020. Brightwater has been a main provider of post-acute community-based disability services for people with acquired brain injury in WA since 1991[14], with the goal to support people to meaningfully *'restart'* their lives in the community after ABI.

The ABI-RESTaRT research program uses a unique combination of internal clinical and rehabilitation data and externally linked hospital, emergency department, mental health and mortality data from the West Australian Data Linkage System[15]. This enables longitudinal examination of the needs and outcomes of individuals with ABI over 29 years, making this the longest follow-up of individuals with ABI undergoing post-acute care in Australia to date[10–12]. This novel framework follows each cohort member from pre-injury, through acute injury, to long-term community-based follow-up after discharge from post-acute services. The aim of the ABI-RESTaRT research program will focus on understanding the complex health and social needs of people with ABI during post-acute care, and identify predictors of short- and long-term outcomes to facilitate effective service planning and delivery.

This cohort profile paper: 1) describes the background and formation of ABI-RESTaRT, 2) outlines data sources, key variables and outcomes, 3) presents baseline sociodemographic and clinical characteristics, and 4) outlines planned research for the cohort.

Cohort Description

Cohort Design and Eligibility

ABI-RESTaRT is a retrospective whole-population cohort comprising all clients of Brightwater Care Group's ABI programs and services (excluding respite) from inception on March 15, 1991 to December 31, 2020 (*n*=1,011). Each individual's entry date into the cohort represents the date of their index admission to Brightwater's community-based ABI services. The study cohort will be periodically updated with new admissions to allow a dynamic cohort of individuals to be followed through changing services over time, a unique possibility not seen in previous cohorts.

The cohort consists of individuals with diverse brain injuries, including traumatic brain injuries (TBI), non-traumatic brain injuries (NTBI) and eligible neurologic conditions, defined by the Australian Rehabilitation Outcomes Centre (AROC) impairment codes[16]. Each individual's AROC diagnosis represents their primary brain injury diagnosis at entry to Brightwater, and not necessarily their index brain injury, meaning that individuals may have had prior brain injuries. Table S1 displays the AROC diagnoses eligible for Brightwater admission. Individuals with congenital neurologic conditions (e.g. cerebral palsy, spina bifida) or intellectual disabilities are eligible for services at Brightwater, but were excluded from the cohort. Admissions are accepted any time since injury, most often in the sub-acute (3-12 months post-injury) or chronic phases (>12 months post-injury)[17,18].

Cohorts, Setting and Programs

The overall cohort is comprised of four sub-cohorts based on year of admission to services: 1991-2002, 2003-2007, 2008-2013, and 2014-2020. These sub-cohorts reflect periods of service delivery change across the different programs. The five different community-based programs are summarized below, ranging from full-time residential neurorehabilitation to casual home-based supports.

Transitional Rehabilitation Program

The *Oats Street* rehabilitation centre is a purpose-built community-based residential facility providing evidence-based post-acute transitional rehabilitation services for individuals with ABI and/or eligible neurologic conditions. The program is funded by the West Australian Department of Health and can support up to 43 live-in residents aged 18-65, across 8 group houses and 8 independent living units, plus 10 additional home-based clients. The Transitional Rehabilitation Program has a typical duration of 12-24 months, and aims to enable clients to regain the skills to live independently in the community. Clients participate in person-centred rehabilitation tailored to their individual goals, and are supported by an integrated multidisciplinary team of medical and allied health professionals.

The Transitional Rehabilitation Program is based on a novel model of care: Staged Community-Based Brain Injury Rehabilitation. Post-acute therapy and care services are provided in a stage-based approach to support a client's continued recovery from ABI over time[19–21]. On admission, clients are allocated to a house with levels of assistance appropriate for their needs, from 24 hour continuous care to full independence, and graduate through stages with decreasing levels of support as their independence and functional abilities improve[21]. The program is able to support all stages of brain injury rehabilitation, from profound physical disability (including those minimally conscious) to higher-level cognitive rehabilitation.

Transitional Accommodation Program

The Transitional Accommodation Program is funded by the West Australian Department of Health and provides short-term support for individuals with ABI who are medically stable following hospital discharge. Referrals must come from a Perth metropolitan public hospital, and clients receive transitional care and short-term accommodation while

they are supported to seek longer-term accommodation or make adjustments to existing homes[22].

Supported Independent Living

Supported Independent Living is a supported accommodation program for individuals with ABI, with the Australian Government's National Disability Insurance Scheme (NDIS)[23] or private funding, who require additional supports but do not seek neurorehabilitation[24]. Individuals in this program live across 8 shared houses for people with disability throughout the Perth metropolitan area and access supports appropriate for their lifestyle and goals.

Capacity Building

Capacity Building offers home-based supports to individuals with ABI with NDIS funding. Supports include specialist neurorehabilitation therapy services, support coordination, equipment and assistive technology, and behavioural assessment and support. Capacity Building clients have individually tailored rehabilitation or lifestyle goals that are achieved while living off-site.

Home and Community Care Social Skills

The Home and Community Care Social Skills program provides support, privately or with NDIS funding, for social engagement and activities as well as in-home care as required. This program is for individuals with ABI who are at risk of social isolation or need support around the home to maintain their independence.

Data Sources and Follow-Up Time

Figure 1a summarizes the data sources for ABI-RESTaRT. The study uses a unique combination of internal clinical and rehabilitation data, and externally linked data collections from the WA Department of Health. Internal electronic medical records for each cohort

member were probabilistically linked through the WA Data Linkage System[15] to four external health data collections. We obtained data on hospitalizations (hospital morbidity data collection; 1981-2020), emergency department (ED) presentations (ED data collection; 2002-2020), deaths (mortality register, 1991-2020) and mental health (mental health information system; 1981-2020). The combination of internal and external data sources allows triangulation of information to ensure higher accuracy, continuity, and completeness than could be derived from a single source.

Figure 1b summarizes the ABI-RESTaRT study design and follow-up time. The unique study framework follows each cohort member from pre-injury, acute care, post-acute care and long-term follow-up after discharge from post-acute services. For all cohort members, a minimum 10-year pre-admission lookback period is available to examine pre-injury morbidity patterns and acute care details. Linked data are obtained up to December 31, 2020, with a mean follow-up time of 8.4 years (range 0y-29.2y) following discharge from community-based services for each cohort member. The study cohort and data linkage will be periodically updated with new admissions to allow cohort growth and dynamic follow-up.

Key Measures, Variables and Outcomes

Key measures and variables available for the ABI-RESTaRT study are summarized in Table 1. Variables are primarily derived from clinical and administrative data collected as part of routine service provision. Key variables span five categories (Admissions, Demographics, Clinical, Rehabilitation, and Psychosocial), offering a unique, holistic understanding of the needs and outcomes of individuals with ABI. Outcomes for each cohort member include functional independence, health status and comorbidities, goal attainment, mental health and well-being, quality of life, and mortality, the most comprehensive set of measures available for a cohort of this kind to date.

Ethics

Clients provided consent for their de-identified information to be used for research purposes as part of the conditions of service upon admission. Ethics approval for this study was granted by the University of Western Australia Human Research Ethics Committee (RA/4/1/9232) and the West Australian Department of Health Human Research Ethics Committee (RGS0000002894).

Statistical Analysis

Extraction and analysis of baseline data was completed in February 2021. Baseline data were analysed using STATA 16.0[25]. Primary analyses were tested against an alpha level of 0.05 (uncorrected, two-tailed). Descriptive statistics were calculated and presented as mean ± standard deviation, or count (percentage). Independent samples t-tests, two-way ANOVAs and χ^2 analyses were used to compare differences in continuous and categorical outcomes, respectively. Bonferroni correction was used for multiple comparisons.

Patient and public involvement

Patients or public were not involved in the development of the research question and study design or conducting the present study.

Findings to date

Sociodemographic Characteristics

Table 2 summarizes the baseline sociodemographic characteristics of ABI-RESTaRT. Mean age at admission was 45.4 ± 15.5 years (range: 14.9y–93.2y), with 6.2% aged over 65 (n=63). Male clients (67.5%) outnumbered female clients (32.5%). The relatively young age and predominantly male cohort is consistent with other profiles of individuals seeking ABI services[10–12]. The majority of the cohort was born in Australia (64.7%), with 3.4% of clients of Indigenous and/or Torres Strait Islander background. Most of the cohort lived in a major

city (84.3%) and were between *average disadvantage* and *least disadvantaged* levels of the IRSD before admission (76.5%).

Brain Injury Characteristics

Table 3 summarizes AROC diagnostic categories for the cohort. The majority had an NTBI (54.9%; 555 of 1,011) with stroke (52.6%; 292 of 555) comprising over half of NTBI diagnoses. TBI accounted for 34.9% of the cohort (353 of 1,011).

Table 4 summarizes brain injury characteristics for the cohort. There were significant differences in gender composition of the diagnostic groups ($p<0.001$), with more male than female clients with TBI and stroke. Gender differences were smaller in the other NTBI and neurologic groups.

There were significant differences in age at admission and ABI type ($p<.001$). Clients with TBI were significantly younger than those in all other ABI groups at admission (largest corrected $p<0.001$). Consistent with prior literature, TBI clients were more likely to be male and significantly younger than those with other ABIs[26,27]. Those presenting with stroke and neurological conditions were significantly older than those with other NTBI (largest corrected $p<.006$), likely reflecting increasing age-related stroke risk[28,29].

Clients with neurologic conditions or TBI primarily entered post-acute rehabilitation in the chronic injury phase, whereas most clients with stroke entered services during the sub-acute phase. This may be related to longer hospital admissions for TBI clients, but may also demonstrate the benefits of specialized stroke services in managing acute stroke[30], quickly directing people to rehabilitation. Bilateral injuries (58.9%) were the most common overall, and for TBI (62.3%), other NTBI (80.2%) and neurologic condition groups (97.1%). The majority of strokes were unilateral (72.9%), with left hemispheric more common than right hemispheric stroke. Seventy-six clients had another brain injury prior to their admission

injury (7.5%). Individuals with a stroke diagnosis represented 54.0% of those clients (41 of 76). The presence of these individuals with prior injuries is consistent with evidence that recurrent TBI is associated with increased disability[31], and prior stroke is a significant risk factor of recurrent stroke[32].

The median length of acute hospital stay for the cohort was 5.0 months (IQR 2.8mo-8.0mo), with TBI clients having significantly longer acute stays (largest corrected $p<0.001$). Although it is not clear why this was the case, evidence suggests that accompanying injuries and complications are associated with longer hospital stays for patients with TBI[33]. Fortunately, rehabilitation appears to be effective in improving independence despite longer periods between injury and rehabilitation admission[34].

External causes of injury – defined as environmental events, circumstances or conditions that are external to the body – are shown in Table 5. Internal causes (e.g. medical conditions) are not included. Half of the cohort sustained their ABI due to an external cause (50.6%, 512 of 1,011). Accidents were the leading external cause of injury (60.2%; 308 of 512), with motor vehicle accidents (MVA; 33.6%) the most common accident type. Clients aged below 30 were most likely to have sustained an ABI due to motor vehicle accidents (77 of 172, 44.8%), with a median age of 23.7 years (IQR 19.1y-37.7y), whereas clients aged from 40-60 were most likely to have been injured in accidental falls (35 of 61, 57.4%), corrected $p<0.001$. Abnormal reaction during surgical or medical procedure was the leading external cause of stroke (82.4%), while poisoning and toxic effect of substances was the leading external cause of other NTBI (48.6%).

Admission Characteristics

The majority of TBI (65.4%), stroke (63.7%) and other NTBI (54.8%) clients were admitted for post-acute transitional rehabilitation. The majority of neurologic clients were admitted to Supported Independent Living (43.7%).

Median time from injury to admission to community-based services was 10.5 months (IQR 5.7mo-27.1mo). Clients with neurologic conditions took significantly longer to access services than other ABI groups (largest corrected $p<0.001$). Those in the stroke group accessed services significantly faster than the TBI group ($p<0.001$) but did not differ from the other NTBI group ($p=0.40$).

Similar numbers of clients were admitted from hospital and home. There were significant differences in ABI group and admission source ($p=0.001$), with 71.1% of individuals with neurologic conditions admitted from home, 52.9% of the TBI group, 45.3% of the stroke group, and 39.8% of the other NTBI group. The overrepresentation of individuals with neurological injury in admissions from home is likely the result of slow onset of neurological injuries relative to acute injuries like stroke or TBI.

Future Directions

The main focus of the ABI-RESTaRT research program is to measure the short- and long-term outcomes of cohort members following discharge from post-acute services. The heterogeneity of the cohort, and the scope and quantity of longitudinal health data available provides a unique opportunity to identify the predictors of outcomes. Findings will enable greater understanding of personal and structural factors influencing outcomes, providing valuable evidence for clinicians to generate effective, personalized post-acute programs.

Health comorbidities of the cohort will also be examined to understand the complex needs of people with ABI and facilitate effective person-centred care. Comorbidities–i.e. chronic condition(s) co-existing with an index disease[35]–are common following ABI.

Complex or mismanaged comorbidity can affect the course and outcome of rehabilitation and result in poorer functional outcomes, longer stay, and higher use and costs of healthcare services[36–38]. Better understanding of comorbidities can support a focus on the whole person, not only neurologic recovery, which is critical for effective community re-integration.

Mental health disorders are common for those with ABI[27,38]. Individuals with mental health comorbidities present before or after ABI have poorer outcomes than those without[38,39]. Research using 263 ABI-RESTaRT members found that mental health comorbidities were present in 55.8% of the sample (*n*=106), representing the most common comorbidity[26].The ABI-RESTaRT study provides the opportunity to examine the prevalence of mental illness, specific mental health needs, and its impact on rehabilitation outcomes to inform policy and services for mental health and ABI.

Strengths and Limitations

ABI-RESTaRT is the largest post-acute community-based ABI cohort study in Australia. The unique design provides novel opportunities to examine the longitudinal needs of people living with ABI, and to evaluate the efficacy of post-acute rehabilitation and support programs offered. The cohort was formed over 29 years, allowing the effects of policy and treatment changes over time to be examined. The use of both internal clinical data and linked health data produces a detailed picture of brain injury that is more complex than could be derived from a single source, allowing complex questions around the nature of ABI and the individualized client requirements to be examined.

As ABI-RESTaRT is comprised of individuals from a single organization, this population differs from the ABI population in Western Australia in some ways. The cohort is relatively young, with only 6.2% of clients aged 65 years or above. This underrepresentation reduces the conclusions that can be drawn from this cohort around older adults. Similarly,

only 3.4% of the study cohort were of Aboriginal or Torres Strait Islander background despite Indigenous Australians being overrepresented in TBI cases in Western Australia[2,40] and having elevated stroke risk relative to non-Indigenous Australians[41,42]. Research is needed to examine the factors impacting the engagement of Indigenous Australians with post-acute services. Finally, the use of a State-based data linkage register is limited, as pre-admission or post-discharge follow-up data for cohort members based interstate or overseas will not be captured in the WA Data Linkage System data collections.

Collaboration

Researchers interested in collaborating on cohort analyses should contact the corresponding author to express their interest. Initial planned data analyses and publications will be conducted by the primary ABI-RESTaRT study investigators; however the research team is open to potential collaboration on future analyses. Access to the data is only possible with express permission of the University of Western Australia and West Australian Department of Health Human Research Ethics Committees and data custodians, and may require a data sharing agreement. Analysis of linked data is currently authorised to occur at only one location in Perth, Western Australia, owing to ethical considerations.

Funding declaration

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests

None declared.

Acknowledgements

The authors gratefully acknowledge all the clients and families at Brightwater Care Group who participated in this study and all the staff who contributed to the data collection.

Author Contribution

GM performed the data collection, wrote the statistical analysis plan, analysed the data and drafted and revised the paper. **LT** designed and supervised the study, provided analytical input, and drafted and revised the paper. **JW** provided clinical and service input, and revised the draft paper. **AM** designed and led the study, obtained linked data, obtained funding for the study and revised the draft paper.

Data sharing statement

Data may be made available upon reasonable request. Access to the data is only possible with express permission of the WA Department of Health Human Research Ethics Committees and data custodians, and may require a data sharing agreement. Analysis of linked data is currently authorised to occur at only one location in Perth, Western Australia, owing to ethical considerations.

References

1. Rushworth N. *Brain Injury Australia: Submission to the Australian Government's National Mental Health and Disability Employment Strategy*.; 2008. https://www.braininjuryaustralia.org.au/wp-content/uploads//BRAININJURYAUSTRALIAsubmissionEMPLOYMENTSTRATEGYfinal.pdf

2. Fortune N, Wen X. *The Definition, Incidence and Prevalence of Acquired Brain Injury in Australia*. Australian Institute of Health and Welfare; 1999.

3. Brain Injury Australia. About brain injury. Published 2016. https://www.braininjuryaustralia.org.au/

4. Fleminger S, Ponsford J. Long term outcome after traumatic brain injury. *Br Med J*. 2005;331(7530):1419-1420. doi:10.1136/bmj.331.7530.1419

5. van Velzen JM, van Bennekom CAM, Edelaar MJA, Sluiter JK, Frings-Dresen MHW. How many people return to work after acquired brain injury?: A systematic review. *Brain Inj*. 2009;23(6):473-488. doi:10.1080/02699050902970737

6. McCabe P, Lippert C, Weiser M, Hilditch M, Hartridge C, Villamere J. Community reintegration following acquired brain injury. *Brain Inj*. 2007;21(2):231-257. doi:10.1080/02699050701201631

7. Wise EK, Mathews-Dalton C, Dikmen S, et al. Impact of traumatic brain injury on participation in leisure activities. *Arch Phys Med Rehabil*. 2010;91(9):1357-1362. doi:10.1016/j.apmr.2010.06.009

8. Ownsworth T, Fleming J, Haines T, et al. Development of depressive symptoms during early community reintegration after traumatic brain injury. *J Int Neuropsychol*

Soc. 2011;17(1):112-119. doi:10.1017/S1355617710001311

9. Turner BJ, Fleming JM, Ownsworth TL, Cornwell PL. The transition from hospital to home for individuals with acquired brain injury: A literature review and research recommendations. *Disabil Rehabil*. 2008;30(16):1153-1176. doi:10.1080/09638280701532854

10. Curran C, Dorstyn D, Polychronis C, Denson L. Functional outcomes of community-based brain injury rehabilitation clients. *Brain Inj*. 2015;29(1):25-32. doi:10.3109/02699052.2014.948067

11. Borg DN, Nielsen M, Kennedy A, et al. The effect of access to a designated interdisciplinary post-acute rehabilitation service on participant outcomes after brain injury. *Brain Inj*. 2020;34(10):1358-1366. doi:10.1080/02699052.2020.1802660

12. Christie L, Egan C, Wyborn J, Simpson GK. Evaluating client experience of rehabilitation following acquired brain injury: a cross-sectional study. *Brain Inj*. 2021;35(2):215-225. doi:10.1080/02699052.2020.1867768

13. Williams E, Jackson H, Wagland J, Martini A. Community Rehabilitation Outcomes for Different Stroke Diagnoses: An Observational Cohort Study. *Arch Rehabil Res Clin Transl*. 2020;2(2):100047. doi:10.1016/j.arrct.2020.100047

14. Brightwater Care Group. Brain injury rehabilitation. Published 2020. https://brightwatergroup.com/disability/brain-injury-rehabilitation/

15. Department of Health Government of Western Australia. Data Linkage Western Australia. Published 2020. https://www.datalinkage-wa.org.au/

16. Australian Rehabilitation Outcomes Centre. *AROC Impairment Coding Guidelines*.; 2013. https://documents.uow.edu.au/content/groups/public/@web/@chsd/@aroc/documents/doc/uow125260.pdf

17. Tsai Y-C, Liu C-J, Huang H-C, et al. A Meta-analysis of Dynamic Prevalence of Cognitive Deficits in the Acute, Subacute, and Chronic Phases After Traumatic Brain Injury. *J Neurosci Nurs*. 2021;53(2):63-68. doi:10.1097/JNN.0000000000000570

18. Echlin F. Traumatic Subdural Hematoma—Acute, Subacute and Chronic. *J Neurosurg*. 1949;6(4):294-303. doi:10.3171/jns.1949.6.4.0294

19. Cicerone KD, Mott T, Azulay J, et al. A Randomized Controlled Trial of Holistic Neuropsychologic Rehabilitation After Traumatic Brain Injury. *Arch Phys Med Rehabil*. 2008;89(12):2239-2249. doi:10.1016/j.apmr.2008.06.017

20. Piccenna L, Knox L, Douglas L. *Slow Stream Rehabilitation: An Overview*.; 2016. https://www.summerfoundation.org.au/wp-content/uploads/ssr-briefing-paper-7-june-2016-final.pdf

21. Jackson D, Seaman K, Sharp K, Singer R, Wagland J, Turner-Stokes L. Staged residential post-acute rehabilitation for adults following acquired brain injury: A comparison of functional gains rated on the UK Functional Assessment Measure (UK FIM+FAM) and the Mayo-Portland Adaptability Inventory (MPAI-4). *Brain Inj*. 2017;31(11):1405-1413. doi:10.1080/02699052.2017.1350998

22. Brightwater Care Group. Transitional support. Published 2020. https://brightwatergroup.com/disability/transitional-support/

23. National Disability Insurance Agency. What is the NDIS? Published 2020. https://www.ndis.gov.au/understanding/what-ndis

24. Brightwater Care Group. Supported Independent Living. https://brightwatergroup.com/disability/supported-independent-living/

25. StataCorp. Stata statistical software: Release 16. Published online 2019.

26. Jackson HM, Troeung L, Martini A. Prevalence, Patterns, and Predictors of Multimorbidity in Adults With Acquired Brain Injury at Admission to Staged

Community-Based Rehabilitation. *Arch Rehabil Res Clin Transl*. 2020;2(4):100089. doi:10.1016/j.arrct.2020.100089

27. Colantonio A, Gerber G, Bayley M, Deber R, Yin J, Kim H. Differential profiles for patients with traumatic and nontraumatic brain injury. *J Rehabil Med*. 2011;43(4):311-315. doi:10.2340/16501977-0783

28. Simons LA, McCallum J, Friedlander Y, Simons J. Risk factors for ischemic stroke: Dubbo study of the elderly. *Stroke*. 1998;29(7):1341-1346. doi:10.1161/01.STR.29.7.1341

29. Kelly-Hayes M. Influence of age and health behaviors on stroke risk: Lessons from longitudinal studies. *J Am Geriatr Soc*. 2010;58(SUPPL. 2):325-328. doi:10.1111/j.1532-5415.2010.02915.x

30. Langhorne P, Ramachandra S. Organised inpatient (stroke unit) care for stroke: network meta-analysis. *Cochrane Database Syst Rev*. Published online April 23, 2020. doi:10.1002/14651858.CD000197.pub4

31. Gavett BE, Stern RA, McKee AC. Chronic Traumatic Encephalopathy: A Potential Late Effect of Sport-Related Concussive and Subconcussive Head Trauma. *Clin Sports Med*. 2011;30(1):179-188. doi:10.1016/j.csm.2010.09.007

32. Burn J, Dennis M, Bamford J, Sandercock P, Wade D, Warlow C. Long-term risk of recurrent stroke after a first-ever stroke. The Oxfordshire Community Stroke Project. *Stroke*. 1994;25(2):333-337. doi:10.1161/01.STR.25.2.333

33. Tardif PA, Moore L, Boutin A, et al. Hospital length of stay following admission for traumatic brain injury in a Canadian integrated trauma system: A retrospective multicenter cohort study. *Injury*. 2017;48(1):94-100. doi:10.1016/j.injury.2016.10.042

34. Williams E, Martini A, Jackson H, Wagland J, Turner-Stokes L. Time between acquired brain injury and admission to community-based rehabilitation: differences in

cognitive and functional gains. *Brain Inj*. 2020;34(6):713-722. doi:10.1080/02699052.2020.1740943

35. Royal Australian College of General Practitioners (RACGP). Part A: Multimorbidity. In: *RACGP Aged Care Clinical Guide (Silver Book)*. 5th ed. Royal Australian College of General Practitioners; 2019.

36. Giaquinto S. Comorbidity in post-stroke rehabilitation. *Eur J Neurol*. 2003;10(3):235-238. doi:10.1046/j.1468-1331.2003.00563.x

37. Stineman MG, Ross RN, Williams S V., Goin JE, Granger C V. A functional diagnostic complexity index for rehabilitation medicine: Measuring the influence of many diagnoses on functional independence and resource use. *Arch Phys Med Rehabil*. 2000;81(5):549-557. doi:10.1053/mr.2000.5977

38. Hart T, Brenner L, Clark AN, et al. Major and minor depression after traumatic brain injury. *Arch Phys Med Rehabil*. 2011;92(8):1211-1219. doi:10.1016/j.apmr.2011.03.005

39. Williams LS, Ghose SS, Swindle RW. Depression and other mental health diagnoses increase mortality risk after ischemic stroke. *Am J Psychiatry*. 2004;161(6):1090-1095. doi:10.1176/appi.ajp.161.6.1090

40. Katzenellenbogen JM, Atkins E, Thompson SC, et al. Missing voices: Profile, extent, and 12-month outcomes of nonfatal traumatic brain injury in Aboriginal and non-Aboriginal adults in Western Australia using linked administrative records. *J Head Trauma Rehabil*. 2018;33(6):412-423. doi:10.1097/HTR.0000000000000371

41. Kilkenny MF, Harris DM, Ritchie EA, Price C, Cadilhac DA. Hospital management and outcomes of stroke in Indigenous Australians: Evidence from the 2009 Acute Care National Stroke Audit. *Int J Stroke*. 2013;8(3):164-171. doi:10.1111/j.1747-4949.2011.00717.x

42. Katzenellenbogen JM, Vos T, Somerford P, Begg S, Semmens JB, Codde JP. Burden of stroke in Indigenous Western Australians: A study using data linkage. *Stroke*. 2011;42(6):1515-1521. doi:10.1161/STROKEAHA.110.601799

43. Australian Bureau of Statistics. Socio-Economic Indexes for Areas. Published 2018. https://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa

44. Australian Bureau of Statistics. The Australian statistical geography standard (ASGS) remoteness structure. Published 2018. https://www.abs.gov.au/websitedbs/D3310114.nsf/home/remoteness+structure

45. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. *Lancet*. 1974;304(7872):81-84. doi:10.1016/S0140-6736(74)91639-0

46. Turner-Stokes L, Nyein K, Turner-Stokes T, Gatehouse C. The UK FIM+FAM: development and evaluation. *Clin Rehabil*. 1999;13(4):277-287. doi:10.1191/026921599676896799

47. Malec J, Lezak M. MPAI-4 Manual. 2003;(April 2003):1-84.

48. Kiresuk TJ, Sherman RE. Goal attainment scaling: A general method for evaluating comprehensive community mental health programs. *Community Ment Health J*. 1968;4(6):443-453. doi:10.1007/BF01530764

49. Von Steinbuechel N, Petersen C, Bullinger M, the QOLIBRI Group. Assessment of health-related quality of life in persons after traumatic brain injury - Development of the Qolibri, a specific measure. *Acta Neurochir Suppl*. 2005;(93):43-49. doi:10.1007/3-211-27577-0_6

50. von Steinbüchel N, Wilson L, Gibbons H, et al. Quality of Life after Brain Injury (QOLIBRI): Scale Validity and Correlates of Quality of Life. *J Neurotrauma*. 2010;27(7):1157-1165. doi:10.1089/neu.2009.1077

51. Turner-Stokes L, Shaw A, Law J, Rose H. Development and initial validation of the

Northwick Park Therapy Dependency Assessment. *Clin Rehabil*. 2009;23(10):922-937. doi:10.1177/0269215509337447

52. Zigmond AS, Snaith RP. The Hospital Anxiety and Depression Scale. *Acta Psychiatr Scand*. 1983;67(6):361-370. doi:10.1111/j.1600-0447.1983.tb09716.x

Table 1. Data sources, key measures and variables available for the ABI-RESTaRT study

	Date	Data Source/Type	Description	Key Variables
	1991 - 2020	Admissions	▪ Admission & discharge date ▪ Facility ▪ Programs ▪ Referral source	▪ Time since injury to admission ▪ Admission source ▪ Admission program ▪ Admission and discharge dates ▪ Age at admission
	1991 - 2020	Demographics	▪ Demographics ▪ Social background	▪ Age at injury ▪ Gender ▪ Indigenous status ▪ Country of birth ▪ Usual occupation ▪ SEIFA IRSD[43] ▪ ASGS Remoteness Area[44]
	1991 - 2020	Clinical	▪ Diagnoses ▪ Vital signs / observations ▪ Medications ▪ Investigations (pathology, radiology) ▪ Medical & allied health consultation notes ▪ Medical correspondence and referrals	▪ ABI type (TBI, NTBI, neurologic) ▪ Injury location (unilateral, bilateral) ▪ Cause of injury ▪ Severity (Glasgow Coma Scale [45], post-traumatic amnesia, loss of consciousness) ▪ Injury phase (acute, subacute, chronic)
	1991 - 2020	Rehabilitation	▪ Australasian Rehabilitation Outcomes Centre (AROC) Impairment Code ▪ Outcome measures	▪ FIM+FAM[46] ▪ MPAI-4[47] ▪ GAS[48]
	1991 - 2020	Psychosocial	▪ Mental health ▪ Quality of life ▪ Behavioural ▪ Well-being	▪ QOLIBRI[49,50] ▪ NPTDA[51] ▪ HADS[52]
EXTERNAL	1981 - 2020	Hospital (HMDC)	▪ Hospital admissions and separations for all public and private hospitals in WA	▪ Comorbidities ▪ Comorbidity severity ▪ Surgical procedures ▪ Health service use patterns
	2002 - 2020	Emergency department (EDDC)	▪ ED presentations at all public and private hospitals in WA	
	1981 - 2020	Mental health (MHIS)	▪ Inpatient and outpatient community mental health presentations	
	1991 - 2020	Deaths	▪ All deaths occurring in WA	▪ Cause of death ▪ Time to death

Note: SEIFA IRSD = Socio-Economic Indexes for Areas Index of Relative Socioeconomic Disadvantage; ASGS = Australian Statistical Geography Standard; FIM+FAM = Functional Independence Measure + Functional Assessment Measure; MPAI-4 = Mayo-Portland Adaptability Inventory; GAS = Goal Attainment Scale; QOLIBRI = Quality of Life After Brain Injury; NPTDA = Northwick Park Therapy Dependency Assessment; HADS = Hospital Anxiety and Depression Scale.

Table 2. Sociodemographic characteristics for the ABI-RESTaRT cohort at admission to post-acute community-based brain injury support programs, 1991-2020 (n=1,011)

Characteristics	Total, n=1,011	1991-2002, n=231	2003-2007, n=145	2008-2013, n=220	2014-2020, n=415
Sex, n (%)					
Male	682 (67.5)	150 (64.9)	108 (74.5)	156 (70.9)	268 (64.6)
Female	329 (32.5)	81 (35.1)	37 (25.5)	64 (29.1)	147 (35.4)
Age at admission, mean ± SD					
Total	45.4 ± 15.5	44.1 ± 21.5	39.5 ± 12.5	44.2 ± 12.8	48.8 ± 12.9
Male	44.2 ± 14.6	39.8 ± 18.0	39.9 ± 12.8	44.7 ± 12.3	48.0 ± 13.3
Female	47.9 ± 17.1	51.9 ± 25.0	38.3 ± 11.6	43.0 ± 13.9	50.2 ± 12.1
Age category at admission, n (%)					
<18 years	15 (1.5)	8 (3.5)	3 (2.1)	-	4 (1.0)
18-29	190 (18.8)	66 (28.6)	36 (24.8)	40 (18.2)	48 (11.6)
30-39	161 (15.9)	46 (19.9)	32 (22.1)	34 (15.5)	49 (11.8)
40-49	223 (22.1)	43 (18.6)	43 (29.7)	54 (24.6)	83 (20.0)
50-59	274 (27.1)	19 (8.2)	26 (17.9)	78 (35.5)	151 (36.4)
60-69	102 (10.1)	7 (3.0)	5 (3.5)	14 (6.4)	76 (18.3)
≥70 years	46 (4.6)	42 (18.2)	-	-	4 (1.0)
Indigenous, n (%)					
Total	34 (3.4)	2 (0.9)	-	13 (5.9)	19 (4.6)
Male	24 (70.6)	1 (0.5)	-	11 (84.6)	12 (63.2)
Female	10 (29.4)	1 (0.5)	-	2 (15.4)	7 (36.8)
Mean age ± SD	38.8 ± 13.6	31.0 ± 0.8	-	40.0 ± 15.2	38.8 ± 13.4
Marital Status, n (%)					
Single	444 (43.9)	101 (43.7)	76 (52.4)	99 (45.0)	168 (40.5)
De Facto	38 (3.8)	3 (1.3)	2 (1.4)	12 (5.5)	21 (5.1)
Married	253 (25.0)	73 (31.6)	30 (20.7)	50 (22.7)	100 (24.1)
Separated	59 (5.8)	13 (5.6)	10 (6.9)	12 (5.5)	24 (5.8)
Divorced	133 (13.2)	14 (6.1)	20 (13.8)	35 (15.9)	64 (15.4)
Widowed	30 (3.0)	16 (6.9)	1 (0.7)	3 (1.4)	10 (2.4)
Unknown	54 (5.3)	11 (4.8)	6 (4.1)	9 (4.1)	28 (6.8)
Country of Birth, n (%)					
Australia (and external territories)	654 (64.7)	162 (70.1)	98 (67.6)	120 (54.6)	274 (66.0)
New Zealand	31 (3.1)	9 (3.9)	5 (3.5)	5 (2.3)	12 (2.9)
Maritime South-East Asia	27 (2.7)	3 (1.3)	1 (0.7)	6 (2.7)	17 (4.1)
Mainland South-East Asia	13 (1.3)	3 (1.3)	2 (1.4)	2 (0.9)	6 (1.5)
Southern Asia	11 (1.1)	-	-	3 (1.4)	8 (1.9)
Chinese Asia	9 (0.9)	2 (0.9)	-	2 (0.9)	5 (1.2)
Southern and East Africa	18 (1.8)	-	2 (1.4)	3 (1.4)	13 (3.1)
The United Kingdom	84 (8.3)	28 (12.1)	12 (8.3)	14 (6.4)	30 (7.2)
Western Europe	11 (1.1)	2 (0.9)	1 (0.7)	4 (1.8)	4 (1.0)

Southern Europe	11 (1.1)	2 (0.9)	-	3 (1.4)	6 (1.5)
Other	44 (4.4)	7 (3.0)	4 (2.8)	9 (4.1)	24 (5.8)
Unknown	98 (9.7)	13 (5.6)	20 (13.8)	49 (22.3)	16 (3.9)
Usual Occupation, n (%)					
Managers	26 (2.6)	1 (0.4)	4 (2.8)	9 (4.1)	12 (3.0)
Professionals	49 (4.9)	5 (2.2)	3 (2.1)	11 (5.0)	30 (7.2)
Technicians and Trades Workers	80 (7.9)	3 (1.3)	9 (6.2)	24 (10.9)	44 (10.6)
Community and Personal Service Workers	34 (3.4)	2 (0.9)	6 (4.1)	8 (3.6)	18 (4.3)
Clerical or Administrative Workers	20 (2.0)	1 (0.4)	2 (1.4)	5 (2.3)	12 (2.9)
Sales Workers	10 (1.0)	-	1 (0.7)	-	9 (2.2)
Machinery Operators and Drivers	31 (3.1)	4 (1.7)	2 (1.4)	10 (4.6)	15 (3.6)
Labourers	48 (4.8)	5 (2.2)	6 (4.1)	12 (5.5)	25 (6.0)
Not in workforce	206 (20.4)	7 (3.0)	15 (10.3)	42 (19.1)	142 (34.22)
Unknown	507 (50.2)	203 (87.9)	97 (66.9)	99 (45.0)	108 (26.0)
Accommodation Type, n (%)					
Private Residence	318 (31.5)	7 (3.0)	31 (21.4)	74 (33.6)	206 (49.6)
Public Rental	56 (5.5)	4 (1.7)	1 (0.7)	20 (9.1)	31 (7.5)
Family Home	40 (4.0)	3 (1.3)	11 (7.6)	1 (0.5)	11 (2.7)
Supported Accommodation	19 (1.9)	-	-	1 (0.5)	18 (4.3)
Residential Aged Care	9 (0.7)	-	-	1 (0.5)	6 (1.5)
Temporary Housing	15 (1.5)	-	-	1 (0.5)	14 (3.4)
Crisis Accommodation	5 (0.5)	-	-	1 (0.5)	4 (1.0)
Hospital	3 (0.3)	-	-	-	3 (0.7)
Institutional care	2 (0.2)	-	-	-	2 (0.5)
No fixed address	20 (2.0)	-	3 (2.1)	6 (2.7)	11 (2.7)
Unknown	526 (52.0)	217 (94.9)	99 (68.3)	101 (45.9)	109 (26.3)
ASGS – Remoteness Area, n (%)					
Major city	814 (84.3)	179 (77.5)	113 (77.9)	167 (75.9)	355 (85.5)
Inner regional	57 (5.9)	12 (5.2)	10 (6.9)	19 (8.6)	16 (3.9)
Outer regional	45 (4.7)	16 (6.9)	13 (9.0)	9 (4.1)	7 (1.7)
Remote	28 (2.9)	6 (2.6)	1 (0.7)	11 (5.0)	10 (2.4)
Very Remote	14 (1.5)	7 (3.0)	1 (0.7)	1 (0.5)	5 (1.2)
Migratory & Offshore	8 (0.8)	6 (2.6)	2 (1.4)	0	0
Missing	45 (4.5)	5 (2.2)	5 (3.5)	13 (5.9)	22 (5.3)
SEIFA – Index of Relative Social Disadvantage, n (%)					
Q1 – Most disadvantaged	141 (14.0)	61 (26.4)	37 (25.5)	18 (8.2)	25 (6.0)
Q2 – More disadvantaged	83 (8.2)	6 (2.6)	10 (6.9)	25 (11.4)	42 (10.1)
Q3 – Average	216 (21.4)	22 (9.5)	19 (13.1)	68 (30.9)	107 (25.8)

Q4 – Less disadvantaged	291 (28.8)	68 (29.4)	41 (28.3)	53 (24.1)	129 (31.1)
Q5 – Least disadvantaged	224 (22.2)	63 (27.3)	28 (19.3)	43 (19.6)	90 (21.7)
Missing	56 (5.5)	11 (4.8)	10 (6.9)	13 (5.9)	22 (5.3)

Table 3. Brain injury diagnoses and Australasian Rehabilitation Outcomes Centre (AROC) Impairment Codes for the ABI-RESTaRT cohort, 1991-2020

AROC Code, Category and Diagnosis		n (%)
Non-traumatic (Stroke)		292 (28.9)
1.1	Stroke – Haemorrhagic	81 (8.0)
1.2	Stroke – Ischemic	178 (17.6)
1.0	Stroke – Unspecified	33 (3.3)
Non-traumatic (other - excluding stroke)		263 (26.0)
2.11	Subarachnoid haemorrhage	58 (5.7)
2.12	Anoxic brain damage	78 (7.7)
2.13	Encephalitis	18 (1.8)
	Meningitis	6 (0.6)
	Neoplasm/tumour of brain, meninges or cranial nerves	32 (3.2)
	Intracranial abscess	2 (0.2)
	Hydrocephalus	5 (0.5)
	Toxic encephalopathy	35 (3.5)
	Metabolic encephalopathy	7 (0.7)
	Other non-traumatic brain dysfunction	22 (2.2)
Traumatic		353 (34.9)
2.21	Traumatic, open injury	50 (5.0)
2.22	Traumatic, closed injury	280 (27.7)
2.2	Traumatic, unspecified	23 (2.3)
Neurologic		103 (10.2)
3.1	Multiple sclerosis	16 (1.6)
3.2	Parkinsonism	17 (1.7)
3.3	Polyneuropathy	3 (0.3)
3.4	Guillain-Barré Syndrome	1 (0.1)
3.8	Neuromuscular Disorders	13 (1.3)
3.9	Extrapyramidal and abnormal movement disorders	2 (0.2)
	Spinocerebellar disease	3 (0.3)
	Epilepsy	31 (3.1)
	Other neurologic and neurodegenerative disorders	17 (1.7)

Table 4. Brain injury and admission characteristics for the ABI-RESTaRT cohort at admission to community-based brain injury services, 1991-2020 (n=1,011)

Characteristics	Total, n = 1,011	Traumatic, n=353	Non-traumatic		Neurologic, N=103
			Stroke, n=292	Other NTBI, n=263	
Sociodemographic					
Age at injury, mean ± SD (years)	42.3 ± 16.5, n=853	33.4 ± 14.9, n= 303	51.0 ± 13.4, n=265	43.0 ± 15.0, n=226	46.8 ± 18.9, n=59
Gender, n (%)					
Male	682 (67.5)	283 (80.2)	197 (67.5)	142 (54.0)	60 (58.3)
Female	329 (32.5)	70 (19.8)	95 (32.5)	121 (46.0)	43 (41.8)
Indigenous, n (%)					
Total	34 (3.4)	16 (4.5)	10 (3.4)	5 (1.9)	3 (2.9)
Male	24 (3.5)	13 (4.6)	8 (4.1)	2 (1.4)	1 (1.7)
Female	10 (3.0)	3 (4.3)	2 (2.1)	3 (2.5)	2 (4.7)
Clinical					
Injury location, n (%)					
Right	114 (11.3)	24 (6.8)	76 (26.0)	13 (4.9)	1 (1.0)
Left	145 (14.3)	38 (10.8)	97 (33.2)	10 (3.8)	-
Unilateral – side unspecified	101 (10.0)	42 (11.9)	40 (13.7)	19 (7.2)	-
Bilateral	595 (58.9)	220 (62.3)	64 (21.9)	211 (80.2)	100 (97.1)
Unknown	56 (5.5)	29 (8.2)	15 (5.1)	10 (3.8)	2 (1.9)
Length of acute hospital stay, mean ± SD (months)	6.0 ± 4.8, n=740	7.0 ± 5.3, n=273	5.1 ± 3.5, n=236	5.9 ± 4.9, n= 206	4.8 ± 6.7, n= 25
Previous ABI, n (%)	76 (7.5)	15 (4.3)	41 (14.0)	19 (7.2)	1 (1.0)
Injury phase, n (%)					
Acute (>3 months)	56 (6.0)	12 (3.5)	21 (7.5)	20 (8.3)	3 (4.1)
Subacute (3 – 12 months)	410 (43.7)	134 (39.2)	158 (56.2)	109 (45.0)	9 (12.3)
Chronic (> 12 months)	472 (50.3)	196 (57.3)	102 (36.3)	113 (46.7)	61 (83.6)
Admission					
Age at admission, mean ± SD (years)	45.4 ± 15.5	37.8 ± 14.5	52.6 ± 13.2	45.4 ± 14.5	50.9 ± 15.8
Time post-injury, n (%)					
< 1 year	466 (49.7)	146 (42.7)	179 (63.7)	129 (53.3)	12 (16.4)
1 – 2 years	161 (17.2)	68 (19.9)	48 (17.1)	40 (16.5)	5 (6.9)
> 2 years	311 (311)	128 (37.4)	54 (19.2)	73 (30.2)	56 (76.7)
Program, n (%)					
TRP	546 (54.0)	232 (65.7)	168 (57.5)	140 (53.2)	17 (16.5)
TAP	121 (12.0)	36 (10.2)	28 (9.6)	41 (15.6)	16 (15.5)
CAPB	107 (10.6)	32 (9.1)	24 (8.2)	30 (11.4)	21 (20.4)
HACC Social Support	70 (6.9)	25 (7.1)	26 (8.9)	14 (5.3)	5 (4.9)
SIL	167 (16.5)	39 (11.1)	46 (15.8)	38 (14.5)	44 (42.3)
Admitted from, n (%)					
Home	435 (43.0)	165 (46.7)	120 (41.1)	96 (36.5)	54 (52.4)
Hospital	437 (43.2)	139 (39.4)	140 (48.0)	136 (51.7)	22 (21.4)
Other	22 (2.2)	8 (2.3)	5 (1.7)	9 (3.4)	-
Unknown	117 (11.6)	41 (11.6)	27 (9.3)	22 (8.4)	27 (26.2)

Note. TRP = Transitional Rehabilitation Program; TAP = Transitional Accommodation Program; CAPB = Capacity Building; HACC = Home and Community Care; SIL = Supported Independent Living

Table 5. Known external causes of brain injury for the ABI-RESTaRT cohort (n=1,011)

Cause of ABI, n (%)	Total, n=1,011	Traumatic, n = 353	Non-traumatic		Neurologic, n=103
			Stroke, n=292	Other NTBI, n=263	
Individuals with known external causes of injury	512	347	51	111	4
Accidents					
Accidental fall	61 (11.9)	58 (16.7)	1 (2.0)	2 (1.8)	-
Motor vehicle accident (incl. pedestrian)	172 (33.6)	167 (48.1)	-	4 (3.6)	1 (33.3)
Motorbike accident	29 (5.7)	29 (8.4)	-	-	-
Cycling accident	14 (2.7)	13 (3.8)	-	1 (0.9)	-
Quad bike accident	4 (0.8)	4 (1.2)	-	-	-
Railway accident	3 (0.6)	3 (0.9)	-	-	-
Drowning and submersion	3 (0.6)	1 (0.3)	-	2 (1.8)	-
Other accident	12 (2.3)	9 (2.6)	1 (2.0)	2 (1.8)	-
Unspecified accident	10 (1.9)	8 (2.3)	-	2 (1.8)	-
Poisoning and toxic effect of drugs, medicaments, or gases					
Accidental overdose	12 (2.3)	-	1 (2.0)	11 (9.9)	-
Intentional overdose	19 (3.7)	-	1 (2.0)	18 (16.2)	-
Unknown intent	9 (1.8)	-	-	9 (8.1)	-
Complication of chronic substance use	20 (3.9)	-	3 (3.9)	16 (14.4)	1 (33.3)
Intentional self-harm (excl. poisoning)					
Hanging or strangulation	4 (0.8)	-	-	4 (3.6)	-
Jumping from high place, or in front of moving object	7 (1.4)	7 (2.0)	-	-	-
Drowning	1 (0.2)	-	-	1 (0.9)	-
Unspecified suicide	2 (0.4)	1 (0.3)	-	1 (0.9)	-
Complications of medical and surgical care					
Abnormal reaction during surgical or medical procedure	78 (15.2)	2 (0.6)	42 (82.4)	33 (29.7)	1 (33.3)
Adverse effects of drugs, medicaments and biological substances during therapeutic use	2 (0.4)	-	1 (2.0)	1 (0.9)	-
Assault	50 (9.8)	45 (13.0)	1 (2.0)	4 (3.6)	-
Individuals with known internal or unknown causes	499	6	241	152	99

Note. Percentages for each group were calculated using the number of individuals with known external causes of injury recorded as the denominator. Individuals with known internal or unknown causes were not included in the count.

Figure 1. Data Sources and Study Design for the ABI-RESTaRT Study, 1991-2020. (a) Internal and External Data Sources and, (b) Study Design

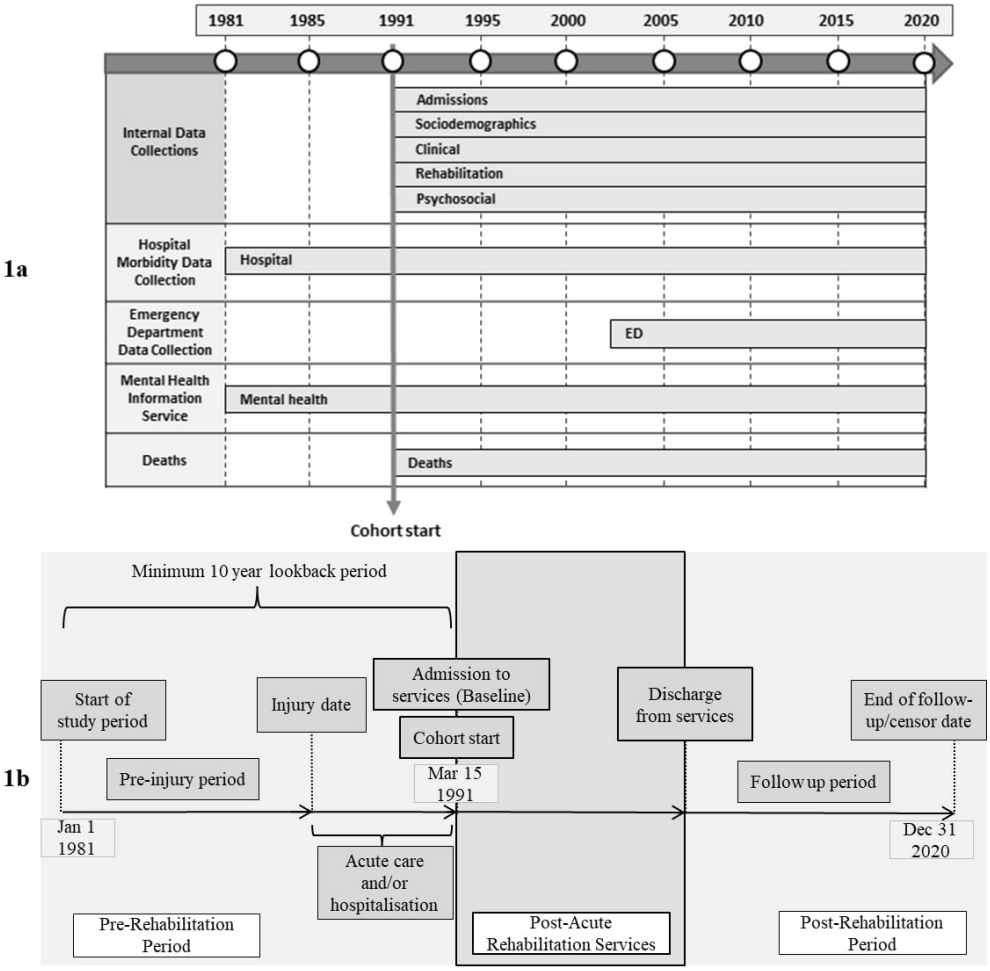

Figure 1. Data Sources and Study Design for the ABI-RESTaRT Study, 1991-2020. (a) Internal and External Data Sources and, (b) Study Design

401x391mm (72 x 72 DPI)

Table S 1. AROC codes and diagnoses eligible for admission to Brightwater services.

AROC Impairment Group	AROC Impairment Group Code
Haemorrhagic Stroke	1.11 Left Body Involvement (Right Brain)
	1.12 Right Body Involvement (Left Brain)
	1.13 Bilateral Involvement
	1.14 No Paresis
	1.19 Other Stroke
Ischemic Stroke	1.21 Left Body Involvement (Right Brain)
	1.22 Right Body Involvement (Left Brain)
	1.23 Bilateral Involvement
	1.24 No Paresis
	1.29 Other Stroke
Brain Dysfunction	2.11 Non-traumatic Subarachnoid Haemorrhage
	2.12 Anoxic Brain Damage
	2.13 Other Non-traumatic Brain Dysfunction Encephalitis Meningitis Neoplasm/tumour of brain of meninges – malignant or benign (includes secondary tumours Neoplasm/tumour of cranial nerves Intracranial abscess Hydrocephalus Toxic encephalopathy *Metabolic encephalopathy**
	2.21 Traumatic, Open Injury
	2.22 Traumatic, Closed Injury
Neurologic Conditions	3.1 Multiple Sclerosis
	3.2 Parkinsonism
	3.3 Polyneuropathy
	3.4 Guillain-Barré Syndrome
	3.8 Neuromuscular Disorders Post poliomyelitis/post-polio syndrome Motor neurone disease Muscular dystrophies and other myopathies
	3.9 Other Neurologic Disorders Other extrapyramidal disease and abnormal movement disorders Spinocerebellar disease Disorders of the autonomic nervous system *Epilepsy** Other demyelinating diseases of the central nervous system

Note. * indicates a diagnosis included in the cohort that was not taken from the AROC code

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8,9
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Table 1
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9,10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-13
		(b) Indicate number of participants with missing data for each variable of interest	Tables 2,4,5
		(c) Summarise follow-up time (eg, average and total amount)	9
Outcome data	15*	Report numbers of outcome events or summary measures over time	n/a

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a Table 4 n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	n/a
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	n/a
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Cohort Profile: The Acquired Brain Injury Community Rehabilitation and Support Services OuTcomes CohoRT (ABI-RESTaRT), Western Australia, 1991-2020

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052728.R1
Article Type:	Cohort profile
Date Submitted by the Author:	22-Jun-2021
Complete List of Authors:	Mann, Georgina; Brightwater Care Group, Brightwater Research Centre Troeung, Lakkhina; Brightwater Care Group, Brightwater Research Centre Wagland, Janet; Brightwater Care Group, Disability Services Martini, Angelita; Brightwater Care Group, Brightwater Research Centre; The University of Western Australia
Primary Subject Heading:	Neurology
Secondary Subject Heading:	Neurology, Health services research
Keywords:	REHABILITATION MEDICINE, Stroke < NEUROLOGY, Neurological injury < NEUROLOGY

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Cohort Profile: The Acquired Brain Injury Community REhabilitation and Support Services OuTcomes CohoRT (ABI-RESTaRT), Western Australia, 1991-2020

Georgina MANN, PhD[1], Lakkhina TROEUNG, PhD[1], Janet WAGLAND, BSc[2], Angelita MARTINI, PhD[1,3]

[1]Brightwater Research Centre, Brightwater Care Group, Perth, Australia

[2]Disability Services, Brightwater Care Group, Perth, Australia

[3]The University of Western Australia, Perth, Australia

Correspondence to: Dr. Georgina Mann

Research Officer, Brightwater Research Centre

355 Scarborough Beach Rd, Osborne Park WA 6017 Australia

+ 61 8 9202 3561

Georgina.Mann@brightwatergroup.com

Word count: 3,849

Abstract

Purpose: Transition into the community following acute management of acquired brain injury (ABI) is a critical part of recovery. Post-acute rehabilitation and transitional care can significantly improve outcomes. The **A**cquired **B**rain **I**njury Community **RE**habilitation and Support Services Ou**T**comes Coho**RT** (ABI-RESTaRT) is a novel whole-population cohort formed to better understand the needs of individuals with ABI receiving post-acute rehabilitation and disability services in Western Australia (WA), and to improve their outcomes. To do this a unique combination of i) internal clinical/rehabilitation data, and ii) externally linked health data from the WA Data Linkage System was used, including hospitalisations, emergency department presentations, mental health service use, and death records, to measure longitudinal needs and outcomes of individuals with ABI over 29 years, making this the largest, most diverse post-acute ABI cohort in Australia to date.

Participants: Whole-population cohort of individuals (n =1,011) with an ABI who received post-acute community-based neurorehabilitation or disability support services through Brightwater Care Group from 1991-2020.

Findings to date: Comprehensive baseline demographic, clinical and rehabilitation data, outcome measures and linked health data have been collected and analysed. Non-traumatic brain injury (e.g. stroke, hypoxia) was the main diagnostic group (54.9%, *n*=555), followed by traumatic brain injury (34.9%, *n*=353) and eligible neurologic conditions (10.2%, *n*=103). Mean age at admission was 45.4 years, and 67.5% were male (*n*=682). The cohort demonstrated significant heterogeneity, socially and clinically, with differences between ABI groups across a number of domains.

Future plans: ABI-RESTaRT is a dynamic whole-population cohort that will be updated over time as individuals enrol in the service. Future analyses will assess longitudinal brain injury outcomes, the changing health and social needs of individuals with ABI, and evaluate and inform post-acute services to best support these individuals.

Registration: This cohort is not linked to a clinical trial, and is not registered.

Strengths and Limitations

- ABI-RESTaRT is the largest Australian post-acute neurorehabilitation and disability support cohort to date with a 29 year follow-up period.
- The combined use of internal clinical and rehabilitation data and linked health data provides a detailed picture of ABI that could not be derived from a single data source, with key measures including functional independence, health status and comorbidities, goal attainment, mental health and well-being, quality of life, and mortality, offering a unique, holistic understanding of the needs and outcomes of individuals with ABI
- The cohort represents a diverse and complex population including individuals with non-traumatic brain injury, traumatic brain injury, and eligible neurologic conditions, providing a diverse range of brain injury experiences.
- The study framework follows each cohort member from pre-injury to long-term follow-up after discharge from post-acute services, with a minimum 10-year lookback period (starting from 1981) and a mean follow-up time of 8.4 years following discharge.
- A state-based data linkage register was used, so pre-admission or post-discharge follow-up data for cohort members based interstate or overseas will not be captured, and all clients were accessing services at a single organisation which may reduce the generalisability of findings.

Introduction

Acquired brain injury (ABI) is one of the leading causes of death and disability in Australia[1]. Defined as any damage to the brain occurring after birth, ABI can be traumatic (caused by extrinsic forces to the head) or non-traumatic (e.g. stroke, drug misuse, tumour, hypoxia/anoxia). Estimates suggest 2% of the population of Western Australia (WA) are living with an ABI[2]. The consequences of ABI are complex and difficult to predict, but often lead to a range of impairments in cognitive, physical and psychosocial functioning[1–4]. ABI can cause long-term physical disability and complex neuro-behavioural effects. These can include neurological impairment (e.g. motor function, sensory loss), medical complications (e.g. spasticity, epilepsy), cognitive impairment (e.g. memory deficits, language impairments, reduced consciousness), personality and behavioural changes (e.g. impaired social skills) and lifestyle consequences (e.g. loss of independence, reduced quality of life)[5]. Up to 75% of brain injuries in Australia occur in adults under 65 years of age[3], resulting in difficulties that can impact working ability, social engagement and community integration[6–8].

Regaining independence and/or meaningful participation in life following an ABI is achievable. Transition back into the community following acute management of ABI in hospital is a critical phase of recovery, and adjustment to the cognitive, physical and behavioural impairments associated with ABI during transition predicts longer-term outcomes and overall recovery from brain injury[9,10]. Post-acute care is important throughout the transition from acute services, such as hospitalisation, to home or community care , with clients and families often reporting the transition to be difficult and stressful[10]. Individuals with inadequate supports risk poorer outcomes including development of a depressive disorder[9], re-hospitalisation or institutionalisation[10] and reduced likelihood of returning to work[6].

Post-acute care is defined as care occurring after the acute care period, with individuals who have achieved acute recovery, are medically stable, and no longer requiring hospitalisation[11]. Post-acute care may occur immediately following discharge from hospital or at any time after the individual has achieved medical stability[12]. The focus of post-acute care is on functional improvement and/or to support individuals to achieve meaningful participation in life, as distinct from physiological recovery.

Despite the importance of post-acute care for individuals with an ABI, little empirical evidence is available to enable service planning and policy development for this cohort. A number of community-based neurorehabilitation cohort studies examining the outcomes of individuals with ABI after rehabilitation exist in Australia[13–16]. Two of these studies involved retrospective analysis of client data at discharge from community-based brain injury services in which individualized rehabilitation care was provided. The first study showed that ABI clients (n=63) who received rehabilitation services in Queensland between 2017-2018 had significantly improved physical outcomes compared with a historical ABI cohort who did not receive rehabilitation services between 2007–2009 (n=124)[14]. The second study, conducted with 47 ABI clients in South Australia from 2010–2013, demonstrated that outpatient rehabilitation significantly and immediately improved physical and psychosocial outcomes, although social wellbeing declined in the follow-up period[13]. Client experiences of community-based rehabilitation have also been examined, with one study surveying clients (n = 79) and their families (n = 39) experiences following attendance to a brain injury rehabilitation unit in New South Wales from 2015–2017. This study indicated that person-centred care was critical to an individuals' experience of care across a number of post-acute services[15].While this research has demonstrated the value of community-based rehabilitation, these cohort studies have small sample sizes (<200), and short follow-up times (<3years). Longer-term research examining the experiences of individuals accessing post-acute ABI

services and the effectiveness of different types of post-acute care is required to ensure the best outcomes for individuals.

ABI-RESTaRT

The Acquired Brain Injury Community REhabilitation and Support Services OuTcomes CohoRT (ABI-RESTaRT) is the largest research cohort of people with ABI who received post-acute rehabilitation or support services in Australia to date. The cohort is a whole-population cohort comprising of all individuals who received brain injury services through Brightwater Care Group in WA, from 1991-2020. Brightwater has been a main provider of post-acute community-based disability services for people with acquired brain injury in WA since 1991[17], with the goal to support people to meaningfully *'restart'* their lives in the community after ABI.

The ABI-RESTaRT research program uses a unique combination of internal clinical and rehabilitation data and external linked health data collections from the WA Data Linkage System[18]. This enables longitudinal examination of the needs and outcomes of individuals with ABI over 29 years, making this the longest follow-up of individuals with ABI undergoing post-acute care in Australia to date[13–15]. The aim of the ABI-RESTaRT research program will focus on understanding the complex health and social needs of people with ABI during post-acute care, and identify predictors of short- and long-term outcomes to facilitate effective service planning and delivery.

Aims

This cohort profile paper aims to: 1) describe the background and formation of ABI-RESTaRT, 2) outline data sources and , key variables, 3) present baseline sociodemographic and clinical characteristics, and 4) outline planned research for the cohort. Future publications will examine the specific outcomes of the cohort.

Cohort Description

Cohort Design and Eligibility

ABI-RESTaRT is a retrospective whole-population cohort comprising all clients of Brightwater Care Group's post-acute brain injury programs and services (excluding respite) from inception on March 15, 1991 to December 31, 2020 (*n*=1,011). Each individual's entry date into the cohort represents the date of their index admission (first episode of care) to Brightwater's community-based brain injury services.

The cohort consists of individuals with diverse brain injuries, including traumatic brain injuries (TBI), non-traumatic brain injuries (NTBI) and eligible neurologic conditions, defined by the Australian Rehabilitation Outcomes Centre (AROC) impairment codes[19]. Table 1 summarises AROC diagnostic categories for the cohort. NTBI were the leading diagnostic category in the cohort (54.9%; 555 of 1,011) with stroke (52.6%; 292 of 555) comprising over half of NTBI diagnoses. TBI accounted for 34.9% of the cohort (353 of 1,011).

Table 1. Brain injury diagnoses and Australasian Rehabilitation Outcomes Centre (AROC) Impairment Codes for the ABI-RESTaRT cohort, 1991-2020

AROC Code, Category and Diagnosis		n (%)
Non-traumatic (Stroke)		292 (28.9)
1.1	Stroke – Haemorrhagic	81 (8.0)
1.2	Stroke – Ischemic	178 (17.6)
1.0	Stroke – Unspecified	33 (3.3)
Non-traumatic (other - excluding stroke)		263 (26.0)
2.11	Subarachnoid haemorrhage	58 (5.7)
2.12	Anoxic brain damage	78 (7.7)
2.13	Encephalitis	18 (1.8)
	Meningitis	6 (0.6)
	Neoplasm/tumour of brain, meninges or cranial nerves	32 (3.2)
	Intracranial abscess	2 (0.2)
	Hydrocephalus	5 (0.5)
	Toxic encephalopathy	35 (3.5)
	Metabolic encephalopathy	7 (0.7)

	Other non-traumatic brain dysfunction	22 (2.2)
Traumatic		353 (34.9)
2.21	Traumatic, open injury	50 (5.0)
2.22	Traumatic, closed injury	280 (27.7)
2.2	Traumatic, unspecified	23 (2.3)
Neurologic		103 (10.2)
3.1	Multiple sclerosis	16 (1.6)
3.2	Parkinsonism	17 (1.7)
3.3	Polyneuropathy	3 (0.3)
3.4	Guillain-Barré Syndrome	1 (0.1)
3.8	Neuromuscular Disorders	13 (1.3)
3.9	Extrapyramidal and abnormal movement disorders	2 (0.2)
	Spinocerebellar disease	3 (0.3)
	Epilepsy	31 (3.1)
	Other neurologic and neurodegenerative disorders	17 (1.7)

Each individual's AROC diagnosis represents their primary brain injury diagnosis at index admission to Brightwater, but not necessarily their index brain injury. It is possible for individuals to have had prior brain injuries for which they did not access Brightwater services. Individuals with congenital neurologic conditions (e.g. cerebral palsy, spina bifida) or intellectual disabilities are eligible for services at Brightwater, but were excluded from the cohort. Admissions are accepted any time since injury, most often in the sub-acute (3-12 months post-injury) or chronic phases (>12 months post-injury)[20,21].

Cohorts, Setting and Programs

The overall cohort is comprised of four service delivery periods based on year of index admission to services: 1991-2002, 2003-2007, 2008-2013, and 2014-2020. These periods reflect significant change to service delivery programs. Key changes are specified in Table 2.

Table 2. Key changes to programs across four service delivery periods.

Service Period	Program (start date)	Service Changes
1991-2002	**TRP (1991)**	1) Commencement of the Transitional Rehabilitation Program on the Oats Street site (24 beds). 2) Inclusion for TRP: a. No more than 1 support worker; b. At least 1 personally-relevant goal; c. Some supportive social network; d. No interfering comorbid health conditions; e. Able to independently complete basic self-care.
	SIL (1998)	3) Commencement of long-stay brain injury accommodation.
2003-2007	**TRP**	1) Increase in number of TRP beds **and** program expands to two sites (Oats Street and Marangaroo). 2) Introduction of staged approach to ability-based graduation through houses at Oats Street.
2008-2013	**TRP**	1) Increase in number of beds to include on-site independent living units for more independent clients. 2) Change in inclusion criteria: a. Reduced restrictions around comorbid health conditions; b. No requirement for self-care ability; c. More than 1 support worker permitted (inclusion of minimally conscious clients).
	TAP (2008)	3) Transitional Accommodation Program introduced.
	HACC SS (2009)	4) HACC Social Support Program introduced.
2014-2020	**TRP**	1) Increase in number of beds to 43. 2) Transitional Rehabilitation Program reduced to a single site (Oats Street).
	CAPB (2016)	**3)** Capacity Building Program introduced.
	HACC SS	4) HACC SS clients began transitioning into CAPB program and HACC program closed down.

Note. TRP = Transitional Rehabilitation Program; SIL = Supported Independent Living; TAP = Transitional Accommodation Program; HACC SS = Home and Community Care Social Support; CAPB = Capacity Building

Clients are able to be re-referred to Brightwater programs, or transferred between programs, as their goals and abilities change, and therefore can have multiple episodes of care. However, clients can only be enrolled in a single program at any one time.

All programs accept clients between the ages of 18-65 years, however acceptance to each program is on a case-by-case basis. As such, some individuals outside of those age ranges have been admitted throughout the duration of the programs. The five different community-based programs are summarized below, ranging from full-time residential neurorehabilitation to casual home-based supports.

Transitional Rehabilitation Program

Beginning in 1991, the Transitional Rehabilitation Program was Brightwater's first post-acute service for individuals with ABI and/or eligible neurologic conditions. The program is delivered at the *Oats Street* rehabilitation centre, a purpose-built community-based residential facility. The program is funded by the WA Department of Health and can support up to 43 live-in residents, across 8 group houses and 8 independent living units, plus 10 additional home-based clients.

The Transitional Rehabilitation Program has a typical duration of 12-24 months, and aims to enable clients to regain the skills to live independently in the community. Clients participate in evidence-based, person-centred neurorehabilitation that is tailored to their individual goals, and are supported by an integrated multidisciplinary team of medical and allied health professionals.

The Transitional Rehabilitation Program is based on a novel model of care called Staged Community-Based Brain Injury Rehabilitation, whereby post-acute therapy and care services are provided in a stage-based approach to support a client's continued recovery from ABI over time[22–24]. On admission, clients are allocated to a house with levels of assistance appropriate for their needs, ranging from 24 hour continuous care to full independence, and

graduate through stages with decreasing levels of support as their independence and functional abilities improve[24]. The program is able to support all stages of brain injury rehabilitation, from profound physical disability (including those in a minimally conscious state, in which there is reduced consciousness with evidence of environmental awareness[25]) to higher-level cognitive rehabilitation.

Supported Independent Living

Beginning in 1998, Supported Independent Living is a supported accommodation program for individuals with ABI who are funded by the Australian Governments' National Disability Insurance Scheme[26] (NDIS; from 2016), or Disability Service Commission (DSC; prior to 2016), or with private funding, and who require additional supports to carry out activities of daily living but do not seek neurorehabilitation[27]. Individuals in this program live across 8 shared houses for people with disability throughout the Perth metropolitan area.

Transitional Accommodation Program

The Transitional Accommodation Program commenced in 2008 and is funded by the WA Department of Health as a step down from hospital service[28]. Referrals must come from a Perth metropolitan public hospital, and clients receive transitional care and short-term accommodation while they are supported to seek longer-term accommodation or make adjustments to existing homes. This program operates in a socio-medical model, using short-term therapy, nursing and care supports to keep clients healthy and medically stable to promote natural recovery but does not involve comprehensive active rehabilitation. Clients in the program can utilise NDIS funding to engage in activities and have sustainable discharge options. The Transitional Accommodation Program often involves setting up support structures for people with complex disabilities, including nursing and psychosocial complexity.

Home and Community Care Social Skills

Commencing in 2009, the Home and Community Care Social Skills program provided support, privately, with Commonwealth Department of Health funding, for social engagement and activities as well as in-home care as required. This program was for individuals with ABI who were at risk of social isolation or needed support around the home to maintain their independence. This program began to be phased out in 2016 when the Capacity Building program began, with no new clients accepted into the program after June 2019[29].

Capacity Building

The Capacity Building program was launched in 2016 to replace the Home and Community Care Social Skills program. Capacity Building offers home-based supports to individuals with ABI who have NDIS funding. The supports on offer include specialist neurorehabilitation therapy services, support coordination, equipment and assistive technology, and behavioural assessment and support. Capacity Building clients are able to access services on an ad-hoc basis as determined by the client themselves, and have individually tailored rehabilitation or lifestyle goals that are achieved while living off-site.

Data Sources and Follow-Up Time

Figure 1a summarizes the data sources for ABI-RESTaRT. The research program uses a combination of internal clinical and rehabilitation data, and externally linked data collections from the WA Department of Health. Internal electronic medical records for each cohort member were probabilistically linked through the WA Data Linkage System[18] to four external health data collections. We obtained data on hospitalizations (hospital morbidity data collection; 1981-2020), emergency department (ED) presentations (ED data collection; 2002-2020), deaths (mortality register, 1991-2020) and mental health (mental health information system; 1981-2020). The combination of internal and external data sources allows

triangulation of information to ensure higher accuracy, continuity, and completeness than could be derived from a single source.

Figure 1b summarizes the ABI-RESTaRT design and follow-up time. The study framework follows each cohort member from pre-injury, acute care, post-acute care and long-term follow-up after discharge from post-acute services. For all cohort members, a minimum 10-year pre-admission lookback period is available to examine pre-injury morbidity patterns and acute care details. Linked data are obtained up to December 31, 2020, with a mean follow-up time of 8.4 years (range 0y-29.2y) following discharge from community-based services for each cohort member.

Key Measures, Variables and Outcomes

Key outcome measures and variables available for ABI-RESTaRT are summarized in Table 3. Study variables are primarily derived from clinical and administrative data collected as part of routine service provision. Key variables span five categories (Admissions, Demographics, Clinical, Rehabilitation, and Psychosocial), offering a unique, holistic understanding of the needs and outcomes of individuals with ABI. Outcomes for each cohort member include functional independence, health status and comorbidities, goal attainment, mental health and well-being, quality of life, and mortality.

Table 3. Data sources, key measures and variables available for the ABI-RESTaRT study

	Date	Data Source/Type	Description	Key Variables
	1991 - 2020	Admissions	▪ Admission & discharge date ▪ Facility ▪ Programs ▪ Referral source	▪ Time since injury to admission ▪ Admission source ▪ Admission program ▪ Admission and discharge dates ▪ Age at admission
	1991 - 2020	Demographics	▪ Demographics ▪ Social background	▪ Age at injury ▪ Gender ▪ Indigenous status ▪ Country of birth ▪ Usual occupation ▪ SEIFA IRSD[30] ▪ ASGS Remoteness Area[31]
	1991 - 2020	Clinical	▪ Diagnoses ▪ Vital signs / observations ▪ Medications ▪ Investigations (pathology, radiology) ▪ Medical & allied health consultation notes ▪ Medical correspondence and referrals	▪ ABI type (TBI, NTBI, neurologic) ▪ Injury location (unilateral, bilateral) ▪ Cause of injury ▪ Severity (Glasgow Coma Scale [32], post-traumatic amnesia, loss of consciousness) ▪ Injury phase (acute, subacute, chronic)
	1991 - 2020	Rehabilitation	▪ Australasian Rehabilitation Outcomes Centre (AROC) Impairment Code ▪ Outcome measures	▪ FIM+FAM[33] ▪ MPAI-4[34] ▪ GAS[35] ▪ RCS[36] ▪
	1991 - 2020	Psychosocial	▪ Mental health ▪ Quality of life ▪ Behavioural ▪ Well-being	▪ QOLIBRI[37,38] ▪ NPTDA[39] ▪ NPDS[40] ▪
EXTERNAL	1981 - 2020	Hospital (HMDC)	▪ Hospital admissions and separations for all public and private hospitals in WA	▪ Comorbidities ▪ Comorbidity severity ▪ Surgical procedures ▪ Health service use patterns
	2002 - 2020	Emergency department (EDDC)	▪ ED presentations at all public and private hospitals in WA	
	1981 - 2020	Mental health (MHIS)	▪ Inpatient and outpatient community mental health presentations	
	1991 - 2020	Deaths	▪ All deaths occurring in WA	▪ Cause of death ▪ Time to death

Note: SEIFA IRSD = Socio-Economic Indexes for Areas Index of Relative Socioeconomic Disadvantage; ASGS = Australian Statistical Geography Standard; FIM+FAM = Functional Independence Measure + Functional Assessment Measure; MPAI-4 = Mayo-Portland Adaptability Inventory; GAS = Goal Attainment Scale; RCS = Rehabilitation Complexity Scale; QOLIBRI = Quality of Life After Brain Injury; NPTDA = Northwick Park Therapy Dependency Assessment; NPDS = Northwick Park Dependency Score

Table 4 outlines the availability of key outcome measures data for the cohort. As the cohort is a retrospective pragmatic cohort, available outcome measures data for each client differs depending on the service period, the outcome measures used at the time, and the program the client was admitted to. Comprehensive outcome measures were introduced across services in 2011, therefore, only a subset of the cohort have complete outcome measures.

Table 4. Key ABI-RESTaRT outcome measures and data availability, 1991-2020 (n=1,011)

Key Outcome Measures and Data	Years Available	Clients with data		
		Total number, n	Of total cohort, %	Over years available, %
Internal Data				
Functional Independence Measure and Functional Assessment Measure (FIM+FAM)[33]	2011–2020	383	37.9	57.0
Mayo-Portland Adaptability Inventory-4 (MPAI-4)[34]	2011–2020	468	46.3	69.6
Goal Attainment Scale (GAS)[35]	2011-2020	362	35.8	53.8
Quality of Life After Brain Injury Inventory (QoLIBRI)[38]	2015–2020	94	9.3	19.0
Northwick Park Dependency Score (NPDS)[40]	2011–2020	405	40.1	60.3
Northwick Park Care Needs Assessment (NCPNA)[39]	2011–2020	405	40.1	(60.3
Rehabilitation Complexity Scale (RCS)[36]	2012–2020	354	35.0	56.9
External Data				
Hospital admissions				
Pre-admission	1981–2020	1,011	100	-
Post-discharge (follow-up)	1991–2020	829	81.9	-
Emergency department presentations				-
Pre-admission	2002–2020	692	68.4	-
Post-discharge (follow-up)	2002–2020	342	33.8	-
Mental health information system	1981–2020	TBD	-	-
Death	1991–2020	TBD	-	-

Note. TBD = To be determined. Mental health data not yet received. Updated death data not yet received.

Data Extraction, Storage and Security

Clinical records for active and historic ABI clients are stored within a secure internal clinical application (iCare). This data can only be accessed by users with appropriate security clearance, such as the researchers involved on the project, and relevant clinical and administrative staff. Archived historic client data is retained by the organisation and used for service evaluation and research purposes as needed.

Researchers extracted demographic, clinical and outcome measures data for the ABI-RESTaRT members from the iCare data warehouse using structured query language (SQL). Linked hospital and ED data were used to validate clinical diagnosis details, date of injury and cause of injury. For historic clients, researchers manually extracted admissions, demographic, clinical and outcome measures data from scanned documents (PDF) uploaded into the client's clinical records. Researchers created a master ABI-RESTaRT database specifically for this study. This database is stored on a secure internal network drive which can only be accessed by the study investigators.

Ethics

Clients provided consent for their de-identified information to be used for research purposes as part of the conditions of service upon admission. Ethics approval for this research was granted by the University of Western Australia Human Research Ethics Committee (RA/4/1/9232) and the West Australian Department of Health Human Research Ethics Committee (RGS0000002894).

Statistical Analysis

Extraction and analysis of baseline data was completed in February 2021. Basic demographic and brain injury characteristics at index admission are presented in the current cohort profile. Subsequent research will examine the health status, service use, and outcomes of the cohort in detail.

Baseline data were analysed using STATA 16.0[41]. Primary analyses were tested against an alpha level of 0.05 (uncorrected, two-tailed). Descriptive statistics were calculated and presented as mean ± standard deviation, or count (percentage). Independent samples t-tests, two-way ANOVAs and χ^2 analyses were used to compare differences in continuous and categorical outcomes, respectively. Bonferroni correction was used for multiple comparisons.

Patient and public involvement

Patients or public were not involved in the development of the research question and project design or conducting the present study.

Findings to date

Sociodemographic Characteristics

Table 5 summarizes the baseline sociodemographic characteristics of ABI-RESTaRT. Mean age at admission was 45.4 ± 15.5 years (range: 14.9y–93.2y), with 6.2% aged over 65 (n=63). Male clients (67.5%) outnumbered female clients (32.5%). The relatively young age and predominantly male cohort is consistent with other profiles of individuals seeking ABI services[13–15]. The majority of the cohort was born in Australia (64.7%), with 3.4% of clients of Indigenous and/or Torres Strait Islander background. Most of the cohort lived in a major city (84.3%) and were between *average disadvantage* and *least disadvantaged* levels of the Socio-Economic Index for Areas Index of Relative Socioeconomic Disadvantage (SEIFA IRSD) before admission (76.5%).

Table 5. Sociodemographic characteristics for the ABI-RESTaRT cohort at index admission to post-acute community-based brain injury support programs, 1991-2020 (n=1,011)

Characteristics	Total, n=1,011	1991-2002, n=231	2003-2007, n=145	2008-2013, n=220	2014-2020, n=415
Sex, n (%)					

Male	682 (67.5)	150 (64.9)	108 (74.5)	156 (70.9)	268 (64.6)
Female	329 (32.5)	81 (35.1)	37 (25.5)	64 (29.1)	147 (35.4)
Age at admission, mean ± SD					
Total	45.4 ± 15.5	44.1 ± 21.5	39.5 ± 12.5	44.2 ± 12.8	48.8 ± 12.9
Male	44.2 ± 14.6	39.8 ± 18.0	39.9 ± 12.8	44.7 ± 12.3	48.0 ± 13.3
Female	47.9 ± 17.1	51.9 ± 25.0	38.3 ± 11.6	43.0 ± 13.9	50.2 ± 12.1
Age category at admission, n (%)					
<18 years	15 (1.5)	8 (3.5)	3 (2.1)	-	4 (1.0)
18-29	190 (18.8)	66 (28.6)	36 (24.8)	40 (18.2)	48 (11.6)
30-39	161 (15.9)	46 (19.9)	32 (22.1)	34 (15.5)	49 (11.8)
40-49	223 (22.1)	43 (18.6)	43 (29.7)	54 (24.6)	83 (20.0)
50-59	274 (27.1)	19 (8.2)	26 (17.9)	78 (35.5)	151 (36.4)
60-69	102 (10.1)	7 (3.0)	5 (3.5)	14 (6.4)	76 (18.3)
≥70 years	46 (4.6)	42 (18.2)	-	-	4 (1.0)
Indigenous, n (%)					
Total	34 (3.4)	2 (0.9)	-	13 (5.9)	19 (4.6)
Male	24 (70.6)	1 (0.5)	-	11 (84.6)	12 (63.2)
Female	10 (29.4)	1 (0.5)	-	2 (15.4)	7 (36.8)
Mean age ± SD	38.8 ± 13.6	31.0 ± 0.8	-	40.0 ± 15.2	38.8 ± 13.4
Marital Status, n (%)					
Single	444 (43.9)	101 (43.7)	76 (52.4)	99 (45.0)	168 (40.5)
De Facto	38 (3.8)	3 (1.3)	2 (1.4)	12 (5.5)	21 (5.1)
Married	253 (25.0)	73 (31.6)	30 (20.7)	50 (22.7)	100 (24.1)
Separated	59 (5.8)	13 (5.6)	10 (6.9)	12 (5.5)	24 (5.8)
Divorced	133 (13.2)	14 (6.1)	20 (13.8)	35 (15.9)	64 (15.4)
Widowed	30 (3.0)	16 (6.9)	1 (0.7)	3 (1.4)	10 (2.4)
Unknown	54 (5.3)	11 (4.8)	6 (4.1)	9 (4.1)	28 (6.8)
Country of Birth, n (%)					
Australia (and external territories)	654 (64.7)	162 (70.1)	98 (67.6)	120 (54.6)	274 (66.0)
New Zealand	31 (3.1)	9 (3.9)	5 (3.5)	5 (2.3)	12 (2.9)
Maritime South-East Asia	27 (2.7)	3 (1.3)	1 (0.7)	6 (2.7)	17 (4.1)
Mainland South-East Asia	13 (1.3)	3 (1.3)	2 (1.4)	2 (0.9)	6 (1.5)
Southern Asia	11 (1.1)	-	-	3 (1.4)	8 (1.9)
Chinese Asia	9 (0.9)	2 (0.9)	-	2 (0.9)	5 (1.2)
Southern and East Africa	18 (1.8)	-	2 (1.4)	3 (1.4)	13 (3.1)
The United Kingdom	84 (8.3)	28 (12.1)	12 (8.3)	14 (6.4)	30 (7.2)
Western Europe	11 (1.1)	2 (0.9)	1 (0.7)	4 (1.8)	4 (1.0)
Southern Europe	11 (1.1)	2 (0.9)	-	3 (1.4)	6 (1.5)
Other	44 (4.4)	7 (3.0)	4 (2.8)	9 (4.1)	24 (5.8)
Unknown	98 (9.7)	13 (5.6)	20 (13.8)	49 (22.3)	16 (3.9)
Usual Occupation, n (%)					
Managers	26 (2.6)	1 (0.4)	4 (2.8)	9 (4.1)	12 (3.0)
Professionals	49 (4.9)	5 (2.2)	3 (2.1)	11 (5.0)	30 (7.2)
Technicians and Trades Workers	80 (7.9)	3 (1.3)	9 (6.2)	24 (10.9)	44 (10.6)
Community and Personal Service Workers	34 (3.4)	2 (0.9)	6 (4.1)	8 (3.6)	18 (4.3)
Clerical or Administrative Workers	20 (2.0)	1 (0.4)	2 (1.4)	5 (2.3)	12 (2.9)
Sales Workers	10 (1.0)	-	1 (0.7)	-	9 (2.2)

Machinery Operators and Drivers	31 (3.1)	4 (1.7)	2 (1.4)	10 (4.6)	15 (3.6)
Labourers	48 (4.8)	5 (2.2)	6 (4.1)	12 (5.5)	25 (6.0)
Not in workforce	206 (20.4)	7 (3.0)	15 (10.3)	42 (19.1)	142 (34.22)
Unknown	507 (50.2)	203 (87.9)	97 (66.9)	99 (45.0)	108 (26.0)
Accommodation Type, n (%)					
Private Residence	318 (31.5)	7 (3.0)	31 (21.4)	74 (33.6)	206 (49.6)
Public Rental	56 (5.5)	4 (1.7)	1 (0.7)	20 (9.1)	31 (7.5)
Family Home	40 (4.0)	3 (1.3)	11 (7.6)	1 (0.5)	11 (2.7)
Supported Accommodation	19 (1.9)	-	-	1 (0.5)	18 (4.3)
Residential Aged Care	9 (0.7)	-	-	1 (0.5)	6 (1.5)
Temporary Housing	15 (1.5)	-	-	1 (0.5)	14 (3.4)
Crisis Accommodation	5 (0.5)	-	-	1 (0.5)	4 (1.0)
Hospital	3 (0.3)	-	-	-	3 (0.7)
Institutional care	2 (0.2)	-	-	-	2 (0.5)
No fixed address	20 (2.0)	-	3 (2.1)	6 (2.7)	11 (2.7)
Unknown	526 (52.0)	217 (94.9)	99 (68.3)	101 (45.9)	109 (26.3)
ASGS – Remoteness Area, n (%)					
Major city	814 (84.3)	179 (77.5)	113 (77.9)	167 (75.9)	355 (85.5)
Inner regional	57 (5.9)	12 (5.2)	10 (6.9)	19 (8.6)	16 (3.9)
Outer regional	45 (4.7)	16 (6.9)	13 (9.0)	9 (4.1)	7 (1.7)
Remote	28 (2.9)	6 (2.6)	1 (0.7)	11 (5.0)	10 (2.4)
Very Remote	14 (1.5)	7 (3.0)	1 (0.7)	1 (0.5)	5 (1.2)
Migratory & Offshore	8 (0.8)	6 (2.6)	2 (1.4)	0	0
Missing	45 (4.5)	5 (2.2)	5 (3.5)	13 (5.9)	22 (5.3)
SEIFA – Index of Relative Social Disadvantage, n (%)					
Q1 – Most disadvantaged	141 (14.0)	61 (26.4)	37 (25.5)	18 (8.2)	25 (6.0)
Q2 – More disadvantaged	83 (8.2)	6 (2.6)	10 (6.9)	25 (11.4)	42 (10.1)
Q3 – Average	216 (21.4)	22 (9.5)	19 (13.1)	68 (30.9)	107 (25.8)
Q4 – Less disadvantaged	291 (28.8)	68 (29.4)	41 (28.3)	53 (24.1)	129 (31.1)
Q5 – Least disadvantaged	224 (22.2)	63 (27.3)	28 (19.3)	43 (19.6)	90 (21.7)
Missing	56 (5.5)	11 (4.8)	10 (6.9)	13 (5.9)	22 (5.3)

Note. ASGS = Australian Statistical Geography Standard; SEIFA = Socio-Economic Index for Areas.

Brain Injury Characteristics

Table 6 summarizes brain injury characteristics for the cohort. There were significant differences in gender composition of the diagnostic groups ($p<0.001$), with more male than female clients with TBI and stroke. Gender differences were smaller in the other NTBI and neurologic groups.

Table 6. Brain injury and admission characteristics for the ABI-RESTaRT cohort at index admission to community-based brain injury services, 1991-2020 (n=1,011)

Characteristics	Total, n = 1,011	Traumatic, n=353	Non-traumatic		Neurologic, N=103
			Stroke, n=292	Other NTBI, n=263	
Sociodemographic					
Age at injury, mean ± SD (years)	42.3 ± 16.5, n=853	33.4 ± 14.9, n= 303	51.0 ± 13.4, n=265	43.0 ± 15.0, n=226	46.8 ± 18.9, n=59
Gender, n (%)					
Male	682 (67.5)	283 (80.2)	197 (67.5)	142 (54.0)	60 (58.3)
Female	329 (32.5)	70 (19.8)	95 (32.5)	121 (46.0)	43 (41.8)
Indigenous, n (%)					
Total	34 (3.4)	16 (4.5)	10 (3.4)	5 (1.9)	3 (2.9)
Male	24 (3.5)	13 (4.6)	8 (4.1)	2 (1.4)	1 (1.7)
Female	10 (3.0)	3 (4.3)	2 (2.1)	3 (2.5)	2 (4.7)
Clinical					
Injury location, n (%)					
Right	114 (11.3)	24 (6.8)	76 (26.0)	13 (4.9)	1 (1.0)
Left	145 (14.3)	38 (10.8)	97 (33.2)	10 (3.8)	-
Unilateral – side unspecified	101 (10.0)	42 (11.9)	40 (13.7)	19 (7.2)	-
Bilateral	595 (58.9)	220 (62.3)	64 (21.9)	211 (80.2)	100 (97.1)
Unknown	56 (5.5)	29 (8.2)	15 (5.1)	10 (3.8)	2 (1.9)
Length of acute hospital stay, mean ± SD (months)	6.0 ± 4.8, n=740	7.0 ± 5.3, n=273	5.1 ± 3.5, n=236	5.9 ± 4.9, n= 206	4.8 ± 6.7, n= 25
Previous ABI, n (%)	76 (7.5)	15 (4.3)	41 (14.0)	19 (7.2)	1 (1.0)
Injury phase, n (%)					
Acute (>3 months)	56 (6.0)	12 (3.5)	21 (7.5)	20 (8.3)	3 (4.1)
Subacute (3 – 12 months)	410 (43.7)	134 (39.2)	158 (56.2)	109 (45.0)	9 (12.3)
Chronic (> 12 months)	472 (50.3)	196 (57.3)	102 (36.3)	113 (46.7)	61 (83.6)
Admission					
Age at admission, mean ± SD (years)	45.4 ± 15.5	37.8 ± 14.5	52.6 ± 13.2	45.4 ± 14.5	50.9 ± 15.8
Time post-injury, n (%)					
< 1 year	466 (49.7)	146 (42.7)	179 (63.7)	129 (53.3)	12 (16.4)
1 – 2 years	161 (17.2)	68 (19.9)	48 (17.1)	40 (16.5)	5 (6.9)
> 2 years	311 (311)	128 (37.4)	54 (19.2)	73 (30.2)	56 (76.7)
Program, n (%)					
TRP	546 (54.0)	232 (65.7)	168 (57.5)	140 (53.2)	17 (16.5)
TAP	121 (12.0)	36 (10.2)	28 (9.6)	41 (15.6)	16 (15.5)
CAPB	107 (10.6)	32 (9.1)	24 (8.2)	30 (11.4)	21 (20.4)
HACC Social Support	70 (6.9)	25 (7.1)	26 (8.9)	14 (5.3)	5 (4.9)

SIL	167 (16.5)	39 (11.1)	46 (15.8)	38 (14.5)	44 (42.3)
Admitted from, n (%)					
Home	435 (43.0)	165 (46.7)	120 (41.1)	96 (36.5)	54 (52.4)
Hospital	437 (43.2)	139 (39.4)	140 (48.0)	136 (51.7)	22 (21.4)
Other	22 (2.2)	8 (2.3)	5 (1.7)	9 (3.4)	-
Unknown	117 (11.6)	41 (11.6)	27 (9.3)	22 (8.4)	27 (26.2)

Note. TRP = Transitional Rehabilitation Program; TAP = Transitional Accommodation Program; CAPB = Capacity Building; HACC = Home and Community Care; SIL = Supported Independent Living

Significant differences in age at admission and ABI type (p<.001) were also present. Clients with TBI were significantly younger than those in all other ABI groups at admission (largest corrected $p<0.001$), which is consistent with prior literature. Those presenting with stroke and neurological conditions were significantly older than those with other NTBI (largest corrected $p<.006$), likely reflecting increasing age-related stroke risk[42,43].

Clinical Characteristics

Clients with neurologic conditions or TBI primarily entered post-acute rehabilitation in the chronic injury phase, whereas most clients with stroke entered services during the sub-acute phase. This may be related to longer hospital admissions for TBI clients, but may also demonstrate the benefits of specialized stroke services in managing acute stroke[44], quickly directing people to rehabilitation. Bilateral injuries (58.9%) were the most common overall, and for TBI (62.3%), other NTBI (80.2%) and neurologic condition groups (97.1%). The majority of strokes were unilateral (72.9%), with left hemispheric more common than right hemispheric stroke. Seventy-six clients had another brain injury prior to their admission injury (7.5%). Individuals with a stroke diagnosis represented 54.0% of those clients (41 of 76). The presence of these individuals with prior injuries is consistent with evidence that recurrent TBI is associated with increased disability[45], and prior stroke is a significant risk factor of recurrent stroke[46].

The median length of acute hospital stay for the cohort was 5.0 months (IQR 2.8mo-8.0mo), with TBI clients having significantly longer acute stays (largest corrected $p<0.001$). Although it is not clear why this was the case, evidence suggests that accompanying injuries

and complications are associated with longer hospital stays for patients with TBI[47]. However, rehabilitation appears to be effective in improving independence despite longer periods between injury and rehabilitation admission[48].

Cause of Injury

External causes of injury – defined as environmental events, circumstances or conditions that are external to the body – are shown in Table 7. Internal causes (e.g. medical conditions) are not included. Half of the cohort sustained their ABI due to an external cause (50.6%, 512 of 1,011). Accidents were the leading external cause of injury (60.2%; 308 of 512), with motor vehicle accidents (MVA; 33.6%) the most common accident type. Clients aged below 30 were most likely to have sustained an ABI due to motor vehicle accidents (77 of 172, 44.8%), with a median age of 23.7 years (IQR 19.1y-37.7y), whereas clients aged from 40-60 were most likely to have been injured in accidental falls (35 of 61, 57.4%), corrected $p<0.001$. Abnormal reaction during surgical or medical procedure was the leading external cause of stroke (82.4%), while poisoning and toxic effect of substances was the leading external cause of other NTBI (48.6%).

Table 7. Known external causes of brain injury for the ABI-RESTaRT cohort (n=1,011)

Cause of ABI, n (%)	Total, n=1,011	Traumatic, n = 353	Non-traumatic		Neurologic, n=103
			Stroke, n=292	Other NTBI, n=263	
Individuals with known external causes of injury	512 (50.6)	347 (98.3)	51 (17.5)	111 (42.2)	4 (3.9)
Accidents					
Accidental fall	61 (11.9)	58 (16.7)	1 (2.0)	2 (1.8)	-
Motor vehicle accident (incl. pedestrian)	172 (33.6)	167 (48.1)	-	4 (3.6)	1 (33.3)
Motorbike accident	29 (5.7)	29 (8.4)	-	-	-
Cycling accident	14 (2.7)	13 (3.8)	-	1 (0.9)	-
Quad bike accident	4 (0.8)	4 (1.2)	-	-	-
Railway accident	3 (0.6)	3 (0.9)	-	-	-
Drowning and submersion	3 (0.6)	1 (0.3)	-	2 (1.8)	-
Other accident	12 (2.3)	9 (2.6)	1 (2.0)	2 (1.8)	-
Unspecified accident	10 (1.9)	8 (2.3)	-	2 (1.8)	-
Poisoning and toxic effect of drugs, medicaments, or gases					
Accidental overdose	12 (2.3)	-	1 (2.0)	11 (9.9)	-
Intentional overdose	19 (3.7)	-	1 (2.0)	18 (16.2)	-
Unknown intent	9 (1.8)	-	-	9 (8.1)	-
Complication of chronic substance use	20 (3.9)	-	3 (3.9)	16 (14.4)	1 (33.3)
Intentional self-harm (excl. poisoning)					
Hanging or strangulation	4 (0.8)	-	-	4 (3.6)	-
Jumping from high place, or in front of moving object	7 (1.4)	7 (2.0)	-	-	-
Drowning	1 (0.2)	-	-	1 (0.9)	-
Unspecified suicide	2 (0.4)	1 (0.3)	-	1 (0.9)	-
Complications of medical and surgical care					
Abnormal reaction during surgical or medical procedure	78 (15.2)	2 (0.6)	42 (82.4)	33 (29.7)	1 (33.3)
Adverse effects of drugs, medicaments and biological substances during therapeutic use	2 (0.4)	-	1 (2.0)	1 (0.9)	-
Assault	50 (9.8)	45 (13.0)	1 (2.0)	4 (3.6)	-
Individuals with known internal or unknown causes	499 (49.4)	6 (1.7)	241 (82.5)	152 (57.8)	99 (96.1)

Note. Percentages for each group were calculated using the number of individuals with known external causes of injury recorded as the denominator. Individuals with known internal or unknown causes were not included in the count.

Admission Characteristics

The majority of TBI (65.4%), stroke (63.7%) and other NTBI (54.8%) clients were admitted for post-acute transitional rehabilitation. The majority of neurologic clients were admitted to Supported Independent Living (43.7%).

Median time from injury to admission to community-based services was 10.5 months (IQR 5.7mo-27.1mo). Clients with neurologic conditions took significantly longer to access services than other ABI groups (largest corrected $p<0.001$). Those in the stroke group accessed services significantly faster than the TBI group ($p<0.001$) but did not differ from the other NTBI group ($p=0.40$).

Similar numbers of clients were admitted from hospital and home. There were significant differences in ABI group and admission source ($p=0.001$), with 71.1% of individuals with neurologic conditions admitted from home, 52.9% of the TBI group, 45.3% of the stroke group, and 39.8% of the other NTBI group. The overrepresentation of individuals with neurological injury in admissions from home is likely the result of slow onset of neurological injuries relative to acute injuries like stroke or TBI.

Future Directions

The main focus of the ABI-RESTaRT research program is to measure the short- and long-term outcomes of cohort members following discharge from post-acute services. The heterogeneity of the cohort, and the scope and quantity of longitudinal health data available provides a unique opportunity to identify the predictors of outcomes. Findings will enable greater understanding of personal and structural factors influencing outcomes, providing valuable evidence for clinicians to generate effective, personalized post-acute programs.

To ensure that change over time can be examined into the future, the cohort will be periodically updated with new admissions to allow a dynamic cohort of individuals to be followed through changing services over time, a possibility not seen in previous cohorts of this type.

Health comorbidities of the cohort will also be examined to understand the complex needs of people with ABI and facilitate effective person-centred care. Comorbidities–i.e. chronic condition(s) co-existing

with an index disease[49]–are common following ABI. Complex or mismanaged comorbidity can affect the course and outcome of rehabilitation and result in poorer functional outcomes, longer stay, and higher use and costs of healthcare services[50–52]. Better understanding of comorbidities can support a focus on the whole person, not only neurologic recovery, which is critical for effective community re-integration.

Mental health disorders are common for those with ABI[52,53]. Individuals with mental health comorbidities present before or after ABI have poorer outcomes than those without[52,54]. Prior research using a retrospective convenience sample of 263 ABI-RESTaRT members admitted to the service from 2009 - 2018 found that mental health comorbidities were present in 55.8% of the sample (*n*=106), representing the most common comorbidity[55]. ABI-RESTaRT provides the opportunity to examine the prevalence of mental illness, specific mental health needs, and its impact on rehabilitation outcomes to inform policy and services for mental health and ABI.

Strengths and Limitations

ABI-RESTaRT is the largest post-acute community-based ABI cohort in Australia. The research design provides novel opportunities to examine the longitudinal needs of people living with ABI, and to evaluate the efficacy of post-acute rehabilitation and support programs offered. The demographic and outcomes data at Brightwater has been collected over 29 years, which will allow the effects of policy and treatment changes over time to be examined. The use of both internal clinical data and linked health data produces a detailed picture of brain injury that is more complex than could be derived from a single source, allowing complex questions around the nature of ABI and the individualized client requirements to be examined.

As ABI-RESTaRT is comprised of individuals from a single organization, this population differs from the ABI population in Western Australia in some ways. The cohort is relatively young, with only 6.2% of clients aged 65 years or above. This underrepresentation reduces the conclusions that can be drawn from this cohort around older adults. Similarly, only 3.4% of the cohort were of Aboriginal or Torres Strait

Islander background despite Indigenous Australians being overrepresented in TBI cases in Western Australia[2,56] and having elevated stroke risk relative to non-Indigenous Australians[57,58]. Research is needed to examine the factors impacting the engagement of Indigenous Australians with post-acute services. Finally, the use of a State-based data linkage register has limitations, as pre-admission or post-discharge follow-up data for cohort members based interstate or overseas will not be captured in the WA Data Linkage System data collections, and it is not possible to distinguish these cases from individuals who remained in WA but did not access services captured by data linkage systems.

Collaboration

Researchers interested in collaborating on cohort analyses should contact the corresponding author to express their interest. Initial planned data analyses and publications will be conducted by the primary ABI-RESTaRT study investigators; however the research team is open to potential collaboration on future analyses. Access to the data is only possible with express permission of the University of Western Australia and West Australian Department of Health Human Research Ethics Committees and data custodians, and may require a data sharing agreement. Analysis of linked data is currently authorised to occur at only one location in Perth, Western Australia, owing to ethical considerations.

Funding declaration

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests

None declared.

Acknowledgements

The authors gratefully acknowledge all the clients and families at Brightwater Care Group who participated in this study and all the staff who contributed to the data collection.

Author Contribution

GM performed the data collection, wrote the statistical analysis plan, analysed the data and drafted and revised the paper. **LT** designed and supervised the study, provided analytical input, and drafted and revised the paper. **JW** provided clinical and service input, and revised the draft paper. **AM** designed and led the study, obtained linked data and revised the draft paper.

Data sharing statement

Data may be made available upon reasonable request. Access to the data is only possible with express permission of the WA Department of Health Human Research Ethics Committees and data custodians, and may require a data sharing agreement. Analysis of linked data is currently authorised to occur at only one location in Perth, Western Australia, owing to ethical considerations.

Figure 1. Data Sources and Study Design for the ABI-RESTaRT Study, 1991-2020. (a) Internal and External Data Sources and, (b) Study Design

References

1. Rushworth N. *Brain Injury Australia: Submission to the Australian Government's National Mental Health and Disability Employment Strategy*.; 2008. https://www.braininjuryaustralia.org.au/wp-content/uploads//braininjuryaustraliasubmissionemploymentstrategyfinal.pdf
2. Fortune N, Wen X. *The Definition, Incidence and Prevalence of Acquired Brain Injury in Australia*. Australian Institute of Health and Welfare; 1999.
3. Brain Injury Australia. About brain injury. Published 2016. https://www.braininjuryaustralia.org.au/
4. Fleminger S, Ponsford J. Long term outcome after traumatic brain injury. *Br Med J*. 2005;331(7530):1419-1420. doi:10.1136/bmj.331.7530.1419
5. The Victorian Neurotrauma Initiative. *The Economic Cost of Spinal Cord Injury and Traumatic Brain Injury in Australia Report by Access Economics Pty Limited for The Victorian Neurotrauma Initiative*.; 2009. http://www.spinalcure.org.au/pdf/Economic-cost-of-SCI-and-TBI-in-Au-2009.pdf
6. van Velzen JM, van Bennekom CAM, Edelaar MJA, Sluiter JK, Frings-Dresen MHW. How many people return to work after acquired brain injury?: A systematic review. *Brain Inj*. 2009;23(6):473-488. doi:10.1080/02699050902970737
7. McCabe P, Lippert C, Weiser M, Hilditch M, Hartridge C, Villamere J. Community reintegration following acquired brain injury. *Brain Inj*. 2007;21(2):231-257. doi:10.1080/02699050701201631
8. Wise EK, Mathews-Dalton C, Dikmen S, et al. Impact of traumatic brain injury on participation in leisure activities. *Arch Phys Med Rehabil*. 2010;91(9):1357-1362. doi:10.1016/j.apmr.2010.06.009
9. Ownsworth T, Fleming J, Haines T, et al. Development of depressive symptoms during early community reintegration after traumatic brain injury. *J Int Neuropsychol Soc*. 2011;17(1):112-119. doi:10.1017/S1355617710001311
10. Turner BJ, Fleming JM, Ownsworth TL, Cornwell PL. The transition from hospital to home for individuals with acquired brain injury: A literature review and research recommendations. *Disabil Rehabil*. 2008;30(16):1153-1176. doi:10.1080/09638280701532854

11. Malec JF, Basford JS. Postacute brain injury rehabilitation. *Arch Phys Med Rehabil*. 1996;77(2):198-207. doi:10.1016/S0003-9993(96)90168-9

12. Marquez de la Plata C. Timeliness of postacute brain injury rehabilitation after TBI improves outcome. *Chall*. 2015;9(2):10-12.

13. Curran C, Dorstyn D, Polychronis C, Denson L. Functional outcomes of community-based brain injury rehabilitation clients. *Brain Inj*. 2015;29(1):25-32. doi:10.3109/02699052.2014.948067

14. Borg DN, Nielsen M, Kennedy A, et al. The effect of access to a designated interdisciplinary post-acute rehabilitation service on participant outcomes after brain injury. *Brain Inj*. 2020;34(10):1358-1366. doi:10.1080/02699052.2020.1802660

15. Christie L, Egan C, Wyborn J, Simpson GK. Evaluating client experience of rehabilitation following acquired brain injury: a cross-sectional study. *Brain Inj*. 2021;35(2):215-225. doi:10.1080/02699052.2020.1867768

16. Williams E, Jackson H, Wagland J, Martini A. Community Rehabilitation Outcomes for Different Stroke Diagnoses: An Observational Cohort Study. *Arch Rehabil Res Clin Transl*. 2020;2(2):100047. doi:10.1016/j.arrct.2020.100047

17. Brightwater Care Group. Brain injury rehabilitation. Published 2020. https://brightwatergroup.com/disability/brain-injury-rehabilitation/

18. Department of Health Government of Western Australia. Data Linkage Western Australia. Published 2020. https://www.datalinkage-wa.org.au/

19. Australian Rehabilitation Outcomes Centre. *AROC Impairment Coding Guidelines*.; 2013. https://documents.uow.edu.au/content/groups/public/@web/@chsd/@aroc/documents/doc/uow125260.pdf

20. Tsai Y-C, Liu C-J, Huang H-C, et al. A Meta-analysis of Dynamic Prevalence of Cognitive Deficits in the Acute, Subacute, and Chronic Phases After Traumatic Brain Injury. *J Neurosci Nurs*. 2021;53(2):63-68. doi:10.1097/JNN.0000000000000570

21. Echlin F. Traumatic Subdural Hematoma—Acute, Subacute and Chronic. *J Neurosurg*. 1949;6(4):294-303. doi:10.3171/jns.1949.6.4.0294

22. Cicerone KD, Mott T, Azulay J, et al. A Randomized Controlled Trial of Holistic Neuropsychologic Rehabilitation After Traumatic Brain Injury. *Arch Phys Med Rehabil*. 2008;89(12):2239-2249. doi:10.1016/j.apmr.2008.06.017

23. Piccenna L, Knox L, Douglas L. *Slow Stream Rehabilitation: An Overview*.; 2016. https://www.summerfoundation.org.au/wp-content/uploads/ssr-briefing-paper-7-june-2016-final.pdf

24. Jackson D, Seaman K, Sharp K, Singer R, Wagland J, Turner-Stokes L. Staged residential post-acute rehabilitation for adults following acquired brain injury: A comparison of functional gains rated on the UK Functional Assessment Measure (UK FIM+FAM) and the Mayo-Portland Adaptability Inventory (MPAI-4). *Brain Inj*. 2017;31(11):1405-1413. doi:10.1080/02699052.2017.1350998

25. Giacino JT, Ashwal S, Childs N, et al. The minimally conscious state: Definition and diagnostic criteria. *Neurology*. 2002;58(3):349-353. doi:10.1212/WNL.58.3.349

26. National Disability Insurance Agency. What is the NDIS? Published 2020. https://www.ndis.gov.au/understanding/what-ndis

27. Brightwater Care Group. Supported Independent Living. https://brightwatergroup.com/disability/supported-independent-living/

28. Brightwater Care Group. Transitional support. Published 2020. https://brightwatergroup.com/disability/transitional-support/

29. Department of Health Government of Western Australia. Access to WA Community Care Services. Published 2019. https://ww2.health.wa.gov.au/Articles/F_I/HACC-Home-and-Community-Care-Program/Access-to-WA-Community-Care-Services

30. Australian Bureau of Statistics. Socio-Economic Indexes for Areas. Published 2018. https://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa

31. Australian Bureau of Statistics. The Australian statistical geography standard (ASGS) remoteness

structure. Published 2018. https://www.abs.gov.au/websitedbs/D3310114.nsf/home/remoteness+structure

32. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. *Lancet*. 1974;304(7872):81-84. doi:10.1016/S0140-6736(74)91639-0

33. Turner-Stokes L, Nyein K, Turner-Stokes T, Gatehouse C. The UK FIM+FAM: development and evaluation. *Clin Rehabil*. 1999;13(4):277-287. doi:10.1191/026921599676896799

34. Malec J, Lezak M. MPAI-4 Manual. 2003;(April 2003):1-84.

35. Kiresuk TJ, Sherman RE. Goal attainment scaling: A general method for evaluating comprehensive community mental health programs. *Community Ment Health J*. 1968;4(6):443-453. doi:10.1007/BF01530764

36. Turner-Stokes L, Disler R, Williams H. The Rehabilitation Complexity Scale: a simple, practical tool to identify 'complex specialised' services in neurological rehabilitation. *Clin Med (Northfield Il)*. 2007;7(6):593-599. doi:10.7861/clinmedicine.7-6-593

37. Von Steinbuechel N, Petersen C, Bullinger M, the QOLIBRI Group. Assessment of health-related quality of life in persons after traumatic brain injury - Development of the Qolibri, a specific measure. *Acta Neurochir Suppl*. 2005;(93):43-49. doi:10.1007/3-211-27577-0_6

38. Von Steinbüchel N, Wilson L, Gibbons H, et al. Quality of life after brain injury (QOLIBRI): Scale development and metric properties. *J Neurotrauma*. 2010;27(7):1167-1185. doi:10.1089/neu.2009.1076

39. Turner-Stokes L, Shaw A, Law J, Rose H. Development and initial validation of the Northwick Park Therapy Dependency Assessment. *Clin Rehabil*. 2009;23(10):922-937. doi:10.1177/0269215509337447

40. Turner-Stokes L, Tonge P, Nyein K, Hunter M, Nielsona S, Robinson I. The Northwick Park Dependency Score (NPDS): a measure of nursing dependency in rehabilitation. *Clin Rehabil*. 1998;12(4):304-318. doi:10.1191/026921598669173600

41. StataCorp. Stata statistical software: Release 16. Published online 2019.

42. Simons LA, McCallum J, Friedlander Y, Simons J. Risk factors for ischemic stroke: Dubbo study of the elderly. *Stroke*. 1998;29(7):1341-1346. doi:10.1161/01.STR.29.7.1341

43. Kelly-Hayes M. Influence of age and health behaviors on stroke risk: Lessons from longitudinal studies. *J Am Geriatr Soc*. 2010;58(SUPPL. 2):325-328. doi:10.1111/j.1532-5415.2010.02915.x

44. Langhorne P, Ramachandra S. Organised inpatient (stroke unit) care for stroke: network meta-analysis. *Cochrane Database Syst Rev*. Published online April 23, 2020. doi:10.1002/14651858.CD000197.pub4

45. Gavett BE, Stern RA, McKee AC. Chronic Traumatic Encephalopathy: A Potential Late Effect of Sport-Related Concussive and Subconcussive Head Trauma. *Clin Sports Med*. 2011;30(1):179-188. doi:10.1016/j.csm.2010.09.007

46. Burn J, Dennis M, Bamford J, Sandercock P, Wade D, Warlow C. Long-term risk of recurrent stroke after a first-ever stroke. The Oxfordshire Community Stroke Project. *Stroke*. 1994;25(2):333-337. doi:10.1161/01.STR.25.2.333

47. Tardif PA, Moore L, Boutin A, et al. Hospital length of stay following admission for traumatic brain injury in a Canadian integrated trauma system: A retrospective multicenter cohort study. *Injury*. 2017;48(1):94-100. doi:10.1016/j.injury.2016.10.042

48. Williams E, Martini A, Jackson H, Wagland J, Turner-Stokes L. Time between acquired brain injury and admission to community-based rehabilitation: differences in cognitive and functional gains. *Brain Inj*. 2020;34(6):713-722. doi:10.1080/02699052.2020.1740943

49. Royal Australian College of General Practitioners (RACGP). Part A: Multimorbidity. In: *RACGP Aged Care Clinical Guide (Silver Book)*. 5th ed. Royal Australian College of General Practitioners; 2019.

50. Giaquinto S. Comorbidity in post-stroke rehabilitation. *Eur J Neurol*. 2003;10(3):235-238. doi:10.1046/j.1468-1331.2003.00563.x

51. Stineman MG, Ross RN, Williams S V., Goin JE, Granger C V. A functional diagnostic complexity index for rehabilitation medicine: Measuring the influence of many diagnoses on functional independence and resource use. *Arch Phys Med Rehabil*. 2000;81(5):549-557. doi:10.1053/mr.2000.5977

52. Hart T, Brenner L, Clark AN, et al. Major and minor depression after traumatic brain injury. *Arch Phys Med Rehabil*. 2011;92(8):1211-1219. doi:10.1016/j.apmr.2011.03.005

53. Colantonio A, Gerber G, Bayley M, Deber R, Yin J, Kim H. Differential profiles for patients with traumatic and nontraumatic brain injury. *J Rehabil Med*. 2011;43(4):311-315. doi:10.2340/16501977-0783

54. Williams LS, Ghose SS, Swindle RW. Depression and other mental health diagnoses increase mortality risk after ischemic stroke. *Am J Psychiatry*. 2004;161(6):1090-1095. doi:10.1176/appi.ajp.161.6.1090

55. Jackson HM, Troeung L, Martini A. Prevalence, Patterns, and Predictors of Multimorbidity in Adults With Acquired Brain Injury at Admission to Staged Community-Based Rehabilitation. *Arch Rehabil Res Clin Transl*. 2020;2(4):100089. doi:10.1016/j.arrct.2020.100089

56. Katzenellenbogen JM, Atkins E, Thompson SC, et al. Missing voices: Profile, extent, and 12-month outcomes of nonfatal traumatic brain injury in Aboriginal and non-Aboriginal adults in Western Australia using linked administrative records. *J Head Trauma Rehabil*. 2018;33(6):412-423. doi:10.1097/HTR.0000000000000371

57. Kilkenny MF, Harris DM, Ritchie EA, Price C, Cadilhac DA. Hospital management and outcomes of stroke in Indigenous Australians: Evidence from the 2009 Acute Care National Stroke Audit. *Int J Stroke*. 2013;8(3):164-171. doi:10.1111/j.1747-4949.2011.00717.x

58. Katzenellenbogen JM, Vos T, Somerford P, Begg S, Semmens JB, Codde JP. Burden of stroke in Indigenous Western Australians: A study using data linkage. *Stroke*. 2011;42(6):1515-1521. doi:10.1161/STROKEAHA.110.601799

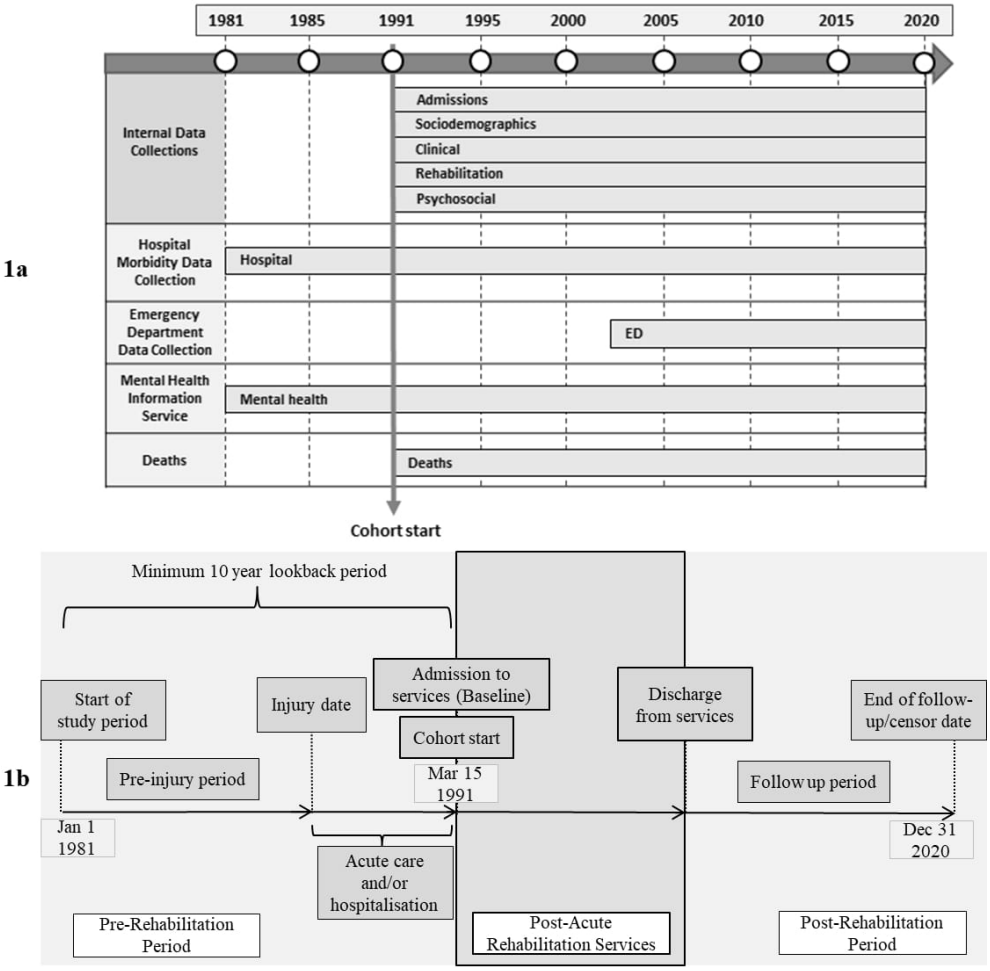

Figure 1. Data Sources and Study Design for the ABI-RESTaRT Study, 1991-2020. (a) Internal and External Data Sources and, (b) Study Design

401x391mm (72 x 72 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8,9
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Table 1
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9,10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10-13
		(b) Indicate number of participants with missing data for each variable of interest	Tables 2,4,5
		(c) Summarise follow-up time (eg, average and total amount)	9
Outcome data	15*	Report numbers of outcome events or summary measures over time	n/a

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	Table 4
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	n/a
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	n/a
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.