

# Rehabilitation Interventions after Traumatic Brain Injury: A Scoping Review

Disabil Rehabil. 2022 Feb;44(4):653-660. doi: 10.1080/09638288.2020.1773940. Epub 2020 Jun 13. PMID: 32536222

Unni Sveen<sup>1,2</sup>, Rikke Guldager<sup>3,4</sup>, Helene Lundgaard Soberg<sup>1,2</sup>, Tone Alm Andreassen<sup>5</sup>, Ingrid Egerod<sup>6</sup>, Ingrid Poulsen<sup>4,7</sup>

## Affiliations:

<sup>1</sup>Faculty of Health Sciences, OsloMet - Oslo Metropolitan University, Oslo, Norway

<sup>2</sup>Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway

<sup>3</sup>Department of Neurosurgery, Copenhagen University Hospital, Rigshospitalet, Denmark

<sup>4</sup>Department of Neurorehabilitation, Traumatic Brain Injury Unit, Copenhagen University Hospital, Rigshospitalet, Denmark

<sup>5</sup>Centre for the Study of Professions, OsloMet - Oslo Metropolitan University, Oslo, Norway

<sup>6</sup>Intensive Care Unit, University of Copenhagen, Rigshospitalet, Denmark

<sup>7</sup>Research Unit for Nursing and Health Care, Health, Aarhus University, Denmark

## Corresponding author:

Unni Sveen, Professor in Occupational Therapy

Faculty of Health Sciences

OsloMet - Oslo Metropolitan University

Po. Box. 4 St. Olavs Plass

N-0130 Oslo, Norway

Telephone: +47 91884768

E-mail: [unni.sveen@oslomet.no](mailto:unni.sveen@oslomet.no)

## Declaration of interest

The project was supported by funding from the Norwegian Research Council (project number 229082). The project is also part of the Danish-Norwegian collaboration linked to and partly financed by the “Phlegethon network”. The authors report no conflicts of interest.

## ORCID ID's

Unni Sveen: 0000-0001-8720-760X

Rikke Guldager: 0000-0003-1491-2556

Helene Lundgaard Soberg: 0000-0001-6908-7480

Tone Alm Andreassen: 0000-0001-9976-3777

Ingrid Egerod: 0000-0002-9576-4390

Ingrid Poulsen: 0002-0342-017X

## **ABSTRACT**

*Purpose:* To 1) identify interventional research topics in traumatic brain injury (TBI) rehabilitation, 2) describe potential knowledge gaps, and 3) uncover further needs for interventional TBI rehabilitation research for patients and families.

*Method:* We searched three databases (2006-2019) and screened 1552 non-duplicate articles. Titles and abstracts were screened for relevance, yielding 754 articles for full-text review. Of these, 425 were included, as relevant to the purpose of the scoping review.

*Findings:* Among articles on TBI rehabilitation, the majority (71.8%) applied quantitative methodology; of these only 19.7% were randomized controlled trials. Severe TBI was described more often than mild/moderate TBI populations. Hospital vs community/home rehabilitation was 55.1% vs 37.2%; rehabilitation at workplace/school was described in only 4.5% articles, while in 7.2% the setting was undisclosed. Of 83 articles describing work/education, only 14 were in a work/school context. An additional focus in the work/education articles was activities of daily living (n=28), cognition (n=33) and emotions (n=23), few targeted family or network.

*Conclusion:* The main attention of interventional TBI rehabilitation studies has been on severe TBI and long-term rehabilitation. Gaps identified were rehabilitation of mild/moderate TBI populations, older populations, acute/sub-phase rehabilitation, return to work issues and studies including the family.

Keywords:

traumatic brain injury, rehabilitation, interventions, scope, rehabilitation setting

## **Introduction**

The consequences of traumatic brain injury (TBI) are multifaceted, they depend on severity, and affect the individual's cognitive, psychological, physical, and social functioning and health-related quality of life [1, 2, 3]. TBI is classified as mild, moderate or severe based on the Glasgow Coma Scale (GCS) score at the time of injury [4] and the duration of posttraumatic amnesia (PTA) [5]. Most cases of TBI are mild and commonly occur in adult males 18-65 years of age [6]. Even mild concussions, not necessarily requiring hospitalization, are often associated with long-term (or permanent) disability, lost work, or neuropsychiatric complications [6]. Many individuals who have sustained TBI must find a new place within, or outside, the labour market [1, 7, 8] depending on their age and remaining years of productive work [1]. Rehabilitation efforts are essential for the recovery process and should involve interdisciplinary services across health care sectors leading to better outcomes [9].

Most of the recovery work is performed by the patients and their families, and for this reason, professional interventions should be based on systems and routines established by those directly involved [10]. Learning to adjust to life changes related to a new social and cultural position might be as important as receiving physical care and therapy [11]. These viewpoints are reflected in the emergence of biopsychosocial perspectives on rehabilitation manifested in the development of the International Classification of Functioning, Disability and Health (ICF) [12] and in the recognition of the patients' experiential knowledge [13, 14].

Professional expertise plays an important role in the rehabilitation process, but there is a paucity of knowledge regarding the breadth of issues, rehabilitation intervention services and processes addressed in TBI research. Among 20 published scoping studies on rehabilitation after TBI, only three have reviewed an intervention [15, 16, 17]. The topics included programmes for community integration, transitional living, concussion education, and group-

delivered interventions. While contributing valuable knowledge, they failed to provide a comprehensive review of the broad spectrum of rehabilitation studies. Our intention was to fill this gap with the present review. The aim of our study was to examine the literature to 1) identify research topics in TBI rehabilitation interventions, 2) describe potential knowledge gaps in TBI rehabilitation, and 3) uncover further needs for TBI rehabilitation intervention research for patients and families.

## **Materials and Methods**

We conducted a scoping review to address the broad aim of our study [18, 19]. According to the Canadian National Collaborating Centre for Methods and Tools (NCCMT), a research gap is a research question that has not been addressed or fully answered in a given field of study, thus limiting decision makers' ability to make informed decisions ([www.nccmt.ca](http://www.nccmt.ca)). Studies reporting the need for generating further knowledge on a particular question or topic might also be a source of information [20, 21].

According to Arksey and O'Malley [18], a scoping review is a technique to map key concepts underpinning a research area and the main sources of evidence available [18]. The specifics of scoping studies have not been precisely defined, but they usually consist of one or more discrete components. The most common component is that they are not driven by a predetermined protocol [22], but they may involve consultations with stakeholders addressing a broad topic including research with different study designs, and they do not assess the quality of included studies [23]. Four arguments have been put forth for undertaking a scoping review: 1) to examine the extent, range and nature of research activity in a particular area; 2) to determine the value of undertaking a full systematic review; 3) to summarize and disseminate research findings; and 4) to identify research gaps in the existing literature. We will focus on arguments 1, 3 and 4.

Arksey and O'Malley's [18] six-stage framework for scoping reviews guided our study. The stages are 1) identifying the research question; 2) identifying relevant studies; 3) selecting studies and establishing inclusion and exclusion criteria; 4) charting data according to key issues and themes; 5) collating, summarizing, and reporting the results; and 6) consulting with consumers to provide insights beyond those in the literature. The last stage is optional. Due to contemporary requirements for service-user involvement in research, we invited users to present knowledge gaps in TBI rehabilitation [24, 25]. We combined stages 5 and 6.

The present scoping review was initiated, planned and conducted by an interprofessional team of three nurses, one physiotherapist, one occupational therapist, and one sociologist. Three researchers were from Norway, and three were from Denmark, and all were experienced in health research and TBI rehabilitation. Thus, the team had a broad theoretical and clinical knowledge base for undertaking the current study.

### ***The Five Stages of the Study***

#### ***Step 1: Identifying the Research Question***

A broad and creative discussion was conducted to identify relevant research questions, and it incorporated the scientific and empirical knowledge of the researchers. We assumed that existing research focused on early rehabilitation, return to work (typical TBI patients are of working age), and support needs for the whole family (TBI affects the whole family). A narrowing of research questions was performed in a final round until consensus was reached among the members of the team. Our initial research questions regarding the *TBI rehabilitation intervention research* literature were as follows: What type of problems are addressed? What types of interventions are offered? What are the target groups described in the literature?

### *Step 2: Identifying Relevant Studies*

A search strategy for relevant papers was conducted by a librarian. PubMed, Cochrane Database of Systematic Reviews, and National Institute for Health and Care Excellence (NICE) were searched for papers published between February 2006 and the middle of June 2019. In PubMed, we conducted a search using Medical Subject Headings (MeSH) and text words, including traumatic brain injury and rehabilitation. The search was limited to English and the Scandinavian languages. See the full search strategy in the Supplementary Material. The search results were entered into EndNote X9.

### *Step 3: Study Selection*

The research team established criteria for inclusion of articles to be reviewed. Our inclusion criteria were:

- Articles explicitly including one or more adolescent/adult patients with TBI (age  $\geq 16$  years).
- Articles written in English language.
- Articles describing TBI rehabilitation interventions for patients, family/carers, or professionals, including effect studies, qualitative studies (e.g., patient experience), implementation descriptions, studies describing organization of rehabilitation (e.g., hospital vs community), and studies of factors influencing the rehabilitation process and outcome (e.g., compliance).
- Articles describing the prediction of factors potentially affecting rehabilitation trajectories.

Our exclusion criteria were:

- Non-scientific articles, e.g., tutorials, editorials, opinion articles, recommendations, data base presentations, guideline development, expert consultations, consensus reports, etc.
- Articles on outcomes or group comparisons not describing interventions.

- Articles focusing on instrument validation (psychometric studies).
- Review articles were excluded but were referred to in the present article.

We initially determined the inclusion of articles in pairs of researchers blinded to each other's decision. Thereafter, each researcher reviewed and included articles in full text by consulting a second member of the team when necessary to ensure a uniform approach. We held face-to-face and video conferences with all members of the research team to ensure consistency. An overview of the selection of included and excluded articles is shown in figure 1.

#### *Step 4: Charting the Data*

At this stage, the articles were sifted, charted and sorted according to key issues and themes. We categorized according to the type of intervention while taking care not to exclude articles contributing to the knowledge of TBI rehabilitation. A two-step process of reference categorization was undertaken. This process involved extensive discussions within the research team about the interpretation of intervention and rehabilitation. In line with the ICF model, we included the levels of impairment, types of activities and participation. We included interventions ranging from single symptom therapy to large comprehensive rehabilitation programmes and included interventions aimed at the family and professionals. We adopted the WHO definition of rehabilitation as "a set of measures that assist individuals, who experience or are likely to experience disability, to achieve and maintain optimum functioning in interaction with their environments" (WHO, 2011). After coding, we further developed the variables to be included in an overview. We used the IBM SPSS Statistics software package version 24 (SPSS Inc., Chicago, IL, USA) for categorizing the included studies. The categories were based on the experiences of the research team and basic

demographics: age groups, TBI severity, trajectory phases, and common aims for TBI interventions (table 1).

**[Table 1: about here]**

*Step 5 Collating, Summarizing and Reporting the Results as Informed by Discussions with Service Users*

We performed qualitative and quantitative analyses. The 425 included articles were statistically summarized. Unless otherwise stated, all percentages are provided in relation to the total number of articles (n=425; 100%). Maintaining a keen eye for unmet needs and research gaps, we compared the findings from the scoping review with experiences reported by people who live with TBI.

A service-user panel linked to the research project ‘Transitions in rehabilitation’ (see Acknowledgements) provided user perspectives on rehabilitation. The panel consisted of six people recruited from two non-governmental organizations representing traumatically injured persons with TBI or spinal cord injuries or their parents. From 2014 to 2019, the panel met three to four times a year. Recurring topics in the users’ discussions were thematically systematized. Furthermore, the panel discussed results and preliminary analyses of the scoping review in September 2017 and June 2018. The panel members were also invited to propose research topics of importance where new or additional knowledge is needed. The recurrent topics in the panel discussions and proposals were compared with the main findings from the scoping review.

## **Findings and Discussion**

Following the database search, 1552 potentially eligible articles were screened after duplicates were removed. Titles and abstracts were screened for relevance, yielding 754 articles for full-text review. A resulting 425 articles were selected as relevant to our aim; see flow chart, figure 1. Descriptions of the included articles are presented in tables 2 and 3. In the following, we present the included articles in more detail.

**[Figure 1: about here]**

**[Tables 2 and 3: about here]**

### ***Countries Dominating TBI Rehabilitation Intervention Research***

The main contributor of TBI rehabilitation articles was the US (39.8%). Other Anglo-Saxon countries (e.g., Australia, UK and Canada) were highly represented along with other countries publishing in English-language journals, (table 2). The relative lack of English-language articles from countries such as France (1.2%) and Germany (1.0%) indicates that parallel research discussions could be occurring in other languages; Germany has pioneered rehabilitation strategies. It is assumed there are under-utilized opportunities for cross-fertilization. The relatively high number of relevant research articles from the Scandinavian countries of Sweden, Norway and Denmark (12.9%) suggests two things: frequent publication in English-language journals and a high level of focus on TBI research. The proportional per capita contribution of Scandinavia vs the US is 3 to 1.

### ***TBI Rehabilitation Phases***

The long-term rehabilitation phase was the most commonly described phase of the patient trajectory, n=188 (44.2%), followed by the stable phase, n=100 (23.5%); the acute and sub-

acute phases were less represented in the studies, (table 3). This distribution might be due to practical and ethical challenges of conducting research with e.g. experimental designs during the acute or sub-acute phases. An experimental design requires participants to be able to understand the implications for randomization, participation and consent. In the early stage after injury, research opportunities are hampered by the patient's low level of consciousness, lack of self-awareness and decreased information processing [26]. Less demanding designs such as before-and-after or quasi-experimental designs might be more appropriate during the early stages of TBI [27].

### ***TBI Severity***

Severe TBI populations were described more often than mild/moderate TBI populations. Recovery is generally good after mild TBI, but up to 20% of patients may experience a protracted course of recovery with symptoms of headache, fatigue, dizziness, emotional distress, depression and mild cognitive impairment [28, 29]. In the long term, this group has trouble sustaining employment due to somatic, cognitive and emotional symptoms [3, 28, 30]. There were few studies focusing exclusively on people with moderate TBI. Studies targeting mild/moderate TBI and moderate/severe TBI may, however, provide useful knowledge regarding the needs of people with moderate TBI.

### ***TBI Age Groups***

Not surprisingly, adults were the most frequently studied group, n=342 (80.5%). We found only three studies exclusively targeting elderly individuals over the age of 66 years. Admittedly, there were some studies including both adults and elderly individuals (n=28; 6.6%). However, such studies may mask the specific needs and challenges in the elderly

individuals post TBI. This shortcoming has been addressed in recent years, e.g., studying functional outcomes and mortality in old and very old people with severe TBI [31].

### ***TBI Rehabilitation Setting and Scopes***

In-hospital vs community rehabilitation was examined in 55.1% vs 37.2% of the included articles. As the responsibility is shifting from the hospital to the primary care sector, more studies are needed that describe community and home-based rehabilitation interventions. There is an ongoing policy shift in the organization of rehabilitation in many countries. We found only 19 (4.5%) articles describing rehabilitation performed in the *context* of workplace or school, which is somewhat alarming, as typical TBI individuals are people of working age [1, 6, 7, 8] and in need of effective return-to-work (RTW) interventions [3, 32, 33, 34]. We identified 83 articles with interventions within the *scope* of work or education. Few of these studies, n=14, were performed in the work/school setting, whereas 31 were performed in hospital settings and 38 in the community/home. The discrepancy between the context and scope of interventions might suggest that rehabilitation was not performed in the most ideal setting.

TBI severity in the studies focusing on work/education (n=83) was equally distributed between mild/moderate (n=44) and moderate/severe TBI (n=39). Of these 83 articles describing interventions with the *scope* of return to work or education, 33 had an additional focus on cognition. The aim of these studies was mainly oriented towards cognitive and psychological aspects of work/vocational performance, testing cognitive rehabilitation interventions, or using positive psychology and comprehensive cognitive training programmes. Another 23 of the 83 articles focused on emotional aspects in addition to

work/education. Five studies focused on the family and 10 studies on the social network; daily life was an additional scope in 28 of the 83 articles focusing on work/education.

### ***Research Methodology Applied***

Most of the studies in the 425 papers reviewed used quantitative methodology (n=305; 71.8%). This was not surprising, as we were looking for interventional studies. We used the term “interventional studies” in a broad sense to include articles describing experiences with intervention development and intervention participation. These 305 quantitative articles applied a longitudinal design in 87.6% and a cross sectional design in 12.4% of the studies. The distribution of methods were cohort, case-control or case-report studies in 44.4%, randomized controlled trials (RCTs) in 19.7%, quasi experimental in 13.6%, pilot RCTs in 4.4% and 17.9% had other designs. Thus, only few studies were designed as RCTs, usually regarded as the gold standard when evaluating interventions. This might reflect negatively on the quality of the evidence in the field.

Of the 425 papers reviewed, we identified 83 (19.5%) qualitative studies. The distribution of designs in the 83 qualitative studies was cross sectional in 71.7% and longitudinal in 28.3%, which is the opposite of the distribution found in quantitative studies. As such, more longitudinal qualitative studies are needed that describe the patient perspective over time. The distribution of methods in the 83 qualitative studies was individual interviews 70.7%, focus groups 11.5%, triangulated studies (e.g. interview/observation) 9.8%, text analysis 6.6% and auto-ethnography 1.4%. This distribution is, perhaps, as could be expected in qualitative interventional studies.

### ***Aims and Scopes of Studies***

The aims and scopes of the rehabilitation interventions described in the articles mainly focused on areas of functioning, from body functions to social activities and participation, (table 3). In the following the percentages add up to more than 100%, because some studies had more than one scope. Quantitative and qualitative studies analysed separately showed that the scope of quantitative papers (n=305) was daily life (36.4%), work/education (20.8%), physical deficits (30.0%), cognitive deficits (46.6%), and emotional factors (29.7%). The quantitative studies were distributed as 58.6% in the hospital and 37.9% in the community/home, targeting mainly moderate/severe TBI (48.0%) or all severities (32.8%). The focus was the stable phase of rehabilitation 3-12 months post injury (24.7%) and the long-term chronic phase (48.8%). The remaining 26.5%, focused on the acute, sub-acute or all phases.

The scope of qualitative papers (n=83) was daily life (33.8%), work/education (28.4%), cognitive deficits (20.3%), and emotional factors (10.8%). The qualitative studies mainly focused on the patient (47.7%) or a combination of patient and carer (22.1%), and others (6.7%). The main attention was on the stable phase of rehabilitation at 3-12 months post injury (23.3%) and the long-term chronic phase (44.2%). Some studies targeted the family (12.8%) or professionals (22.1%). The qualitative studies were distributed as 44.7% in the hospital and 46.1% in the community/home; in 9.2% the context was workplace or school. These studies mainly targeted people with moderate/severe TBI (46.3%) or all severities (39.4%). This focus on the moderate/severe group may, as expected, be explained by the need for knowledge on the experiences of people living with long-term consequences of a severe and disabling condition.

### ***Service-user Perspectives***

The recurring topics of the user panel's discussions were the importance of rehabilitation services, qualified professional expertise, long-term care, interdisciplinary care, coordinated care, and holistic service provisions addressing the individual needs of the injured persons; well-functioning transitions between levels and sectors; opportunities for support from peers; and awareness of mental, physical, and cognitive problems. The users emphasized the importance of returning to work after injury, the role of spouses and families, the need for individual support when coming to terms with a transformed life, and the importance of being met as a human being. Additionally, they stressed the quality of the relationships with the professionals, and the difficult and delicate balance professionals must handle between opportunity vs expectations and reality vs hope. The panel emphasized the importance of peer-support, as well (table 4).

The main concern of the panel was vocational rehabilitation and collaboration between health professionals and their employers. This finding was supported by the scoping review where only few interventions were in the context of the workplace. Additionally, the relatively low proportion of articles focusing on work/education (19.5%) indicates a gap in this field [7, 30, 34]. The user panel called for research evaluation of peer-group interventions as well as the benefit of social media meeting places for designated user groups. The scoping review found only one study [35] on peer mentoring for individuals with TBI and their families.

**[Table 4: about here]**

### **Strengths and limitations**

Our study was strengthened by our research team consisting of highly experienced researchers from four different professions in two countries, and with a broad competency in various research designs. We were able to meet face-to-face and online when necessary and exploited

our collective resources to perform the search and analysis. We worked both in smaller teams and in the larger group. The validity and rigour of the study were increased by using a well-documented method of conducting scoping reviews [18], applying all 6 steps recommended by Arksey and O'Malley. Validity was additionally increased in that the findings were discussed with stakeholders, such as the user panel, as well as colleagues in the Danish-Norwegian rehabilitation research network "Phlegethon" (<http://www.phlegethon.net/>). Generalizability was increased by the broad scope of the study, and transferability was increased by a detailed description of the qualitative studies.

Limitations may pertain to a potential omission of relevant articles due to the choice of including only articles that explicitly studied TBI. We did, however, evaluate acquired brain injury (ABI) articles for potential inclusion and did so in cases where it was documented that participants with TBI were included in the study. Moreover, despite our efforts to comprehensively and broadly search the electronic published and grey literatures, we might have missed some relevant studies. To safeguard against this, we used an iterative process to refine our search strategy, including text words in addition to key words for concepts that were poorly indexed in the literature (e.g., rehabilitation), and scanned the reference lists of our included studies.

The process of analysing and summarizing the data were iterative and might have been organized differently by another research team. For the analysis, we constructed a coding system for categorizing the studies. Because we wanted to tailor our method to the broader focus of our scoping review, we chose not to use the PICO model. Instead, we constructed a system that accommodated all methodologies (qualitative, quantitative, mixed or multiple methods). Finally, our assessment of the relevance of studies for the review was limited by the descriptions provided by the original authors.

## **Conclusions**

The main attention of interventional TBI rehabilitation studies has been on severe TBI and long-term rehabilitation. Most studies applied quantitative methodology, whereas few were randomized controlled trials. There were gaps regarding studies including older patients, and interventions in the acute and sub-acute phase. A large proportion of the articles on TBI rehabilitation interventions described the long-term phase of the patient trajectory. The focus was on daily life and physical, emotional and cognitive functioning. Important issues such as return to work, life and leisure after injury, and the role of the family and social network had lower representation in the literature. The user panel emphasized the need for more research on peer-support, continuity of care and equality in service delivery. Looking forward, future research should address these issues, and especially, the long-term perspective of young people with their full lives ahead of them.

## **Acknowledgements**

This study is part of the research project “Transitions in rehabilitation. Biographical reconstruction, experiential knowledge and professional expertise” and the Danish-Norwegian collaboration the “Phlegethon network”. The Transitions Project is headed by Professor Tone Alm Andreassen, Oslo and Akershus University College of Applied Science. We thank the Transitions Project’s User panel for valuable contributions to the uncovered needs for rehabilitation research and interventions. We also thank [name of the librarian at .....] for helpful assistance with the literature search and search strategy. Last but not least, thanks to the Phlegethon network for fruitful discussions and comments on the manuscript.

## **Implications for Rehabilitation**

- A substantial number of interventional studies exist to guide long-term rehabilitation after traumatic brain injury
- Research supporting patients and families in relation to return to work after traumatic brain injury is lacking.
- Research on rehabilitation after traumatic brain injury needs more focus on family involvement supporting both patient and family
- Randomized controlled trials in the various phases of TBI rehabilitation are needed to improve the level of evidence in clinical practice

## References

1. Andelic N, Hammergren N, Bautz-holter E, et al. Functional outcome and health-related quality of life 10 years after moderate-to-severe traumatic brain injury. *Acta Neurologica Scandinavica*. 2009;120(1):16-23.
2. Bach LJ, David AS. Self-awareness after acquired and traumatic brain injury. *Neuropsychological Rehabilitation*. 2006;16(4):397-414.
3. Benedictus MR, Spikman JM, van Der Naalt J. Cognitive and Behavioral Impairment in Traumatic Brain Injury Related to Outcome and Return to Work. *Archives of physical medicine and rehabilitation*. 2010;91(9):1436-1441.
4. Teasdale G, Maas A, Lecky F, et al. The Glasgow Coma Scale at 40 years: standing the test of time. *Lancet Neurology*. 2014;13(8):844-854.
5. Nakase-Richardson AR, Yablon GS, Sherer CM, et al. Emergence from minimally conscious state: Insights from evaluation of posttraumatic confusion. *Neurology*. 2009;73(14):1120-1126.
6. Nguyen R, Fiest KM, McChesney J, et al. The international incidence of traumatic brain injury: A systematic review and meta-analysis. *Canadian Journal of Neurological Sciences*. 2016;43(6):774-785.
7. Soberg HL, Roise O, Bautz-Holter E, et al. Returning to Work After Severe Multiple Injuries: Multidimensional Functioning and the Trajectory From Injury to Work at 5 Years. *J Trauma-Injury Infect Crit Care*. 2011;71(2):425-434.
8. Van Velzen JM, Van Bennekom CAM, Edelaar MJA, et al. How many people return to work after acquired brain injury?: A systematic review. Taylor & Francis; 2009. p. 473-488.
9. Turner-Stokes L, Vanderstay R, Stevermuer T, et al. Comparison of Rehabilitation Outcomes for Long Term Neurological Conditions: A Cohort Analysis of the Australian Rehabilitation Outcomes Centre Dataset for Adults of Working Age. *PLoS One*. 2015;10(7):e0132275.
10. Pound P, Gompertz P, Ebrahim S. Social and practical strategies described by people living at home with stroke. *Health & Social Care in the Community*. 1999;7(2):120-128.
11. Hammell KW. Perspectives on disability & rehabilitation : contesting assumptions ; challenging practice. Edinburgh: Churchill Livingstone/Elsevier; 2006.
12. World Health O. International classification of functioning, disability and health : ICF. Geneva: World Health Organization; 2001.
13. King PR, Beehler GP, Vest BM, et al. Qualitative Exploration of Traumatic Brain Injury-Related Beliefs Among U.S. Military Veterans. *Rehabilitation Psychology*. 2018;63(1):121-130.
14. Slomic M, Christiansen B, Soberg H, et al. User involvement and experiential knowledge in interprofessional rehabilitation: a grounded theory study. *BMC Health Services Research*. 2016;16(1).
15. McColl MA. Postacute Programming for Community Integration: A Scoping Review. *Brain Impairment*. 2007;8(03):238-250.
16. Patterson F, Fleming J, Doig E. Group-based delivery of interventions in traumatic brain injury rehabilitation: a scoping review. Taylor & Francis; 2016. p. 1961-1986.
17. Potter A, Sansonetti D, D'Cruz K, et al. What is known about transitional living services for adults with an acquired brain injury? A scoping review. *Brain Impairment*. 2017;18(2):240-257.

18. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*. 2005;8(1):19-32.
19. O'Brien Kelly K, Colquhoun H, Levac D. Scoping studies: advancing the methodology. *Implementation Science*. 2010;5(1):69.
20. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology.(Debate). *Implementation Science*. 2010;5:69.
21. Sveen U, Sjøberg HL, Østensjø S. Biographical disruption, adjustment and reconstruction of everyday occupations and work participation after mild traumatic brain injury. A focus group study. *Disability and rehabilitation*. 2016;38(23):2296-2304.
22. Armstrong R, Hall B, Doyle J, et al. 'Scoping the scope' of a cochrane review. *J Public Health*. 2011;33(1):147-150.
23. Anderson S, Allen P, Peckham S, et al. Asking the right questions: Scoping studies in the commissioning of research on the organisation and delivery of health services.(Review). *Health Research Policy and Systems*. 2008;6(7):7.
24. Brett J, Staniszewska S, Mockford C, et al. Mapping the impact of patient and public involvement on health and social care research: a systematic review. *Health Expect*.2014. p. 637-650.
25. Boote J, Wong R, Booth A. 'Talking the talk or walking the walk?' A bibliometric review of the literature on public involvement in health research published between 1995 and 2009. *Health Expectations*. 2015;18(1):44-57.
26. Spikman JM, van der Naalt J, Faculty of Medical S, et al. Indices of Impaired Self-Awareness in Traumatic Brain Injury Patients with Focal Frontal Lesions and Executive Deficits: Implications for Outcome Measurement. *Journal of Neurotrauma*. 2010;27(7):1195-1202.
27. Andelic N, Bautz-Holter E, Ronning P, et al. Does an Early Onset and Continuous Chain of Rehabilitation Improve the Long-Term Functional Outcome of Patients with Severe Traumatic Brain Injury? *Journal of Neurotrauma*. 2012;29(1):66-74.
28. Iverson GL, Gardner AJ, Terry DP, et al. Predictors of clinical recovery from concussion: a systematic review. *British journal of sports medicine*. 2017 Jun;51(12):941-948.
29. Ponsford J, Nguyen S, Downing M, et al. Factors associated with persistent post-concussion symptoms following mild traumatic brain injury in adults. *Journal of rehabilitation medicine*. 2018 Nov 14.
30. Graff HJ, Siersma V, Moller A, Kragstrup J, Andersen LL, Egerod I, Malá Rytter H. 2019b. Labour market attachment after mild traumatic brain injury: nationwide cohort study with 5-year register follow-up in Denmark. *BMJ Open*. 2019 Apr 11;9(4):e027297.
31. Røe C, Skandsen T, Manskow U, et al. Mortality and One-Year Functional Outcome in Elderly and Very Old Patients with Severe Traumatic Brain Injuries: Observed and Predicted. *Behavioural Neurology*. 2015;2015.
32. Saunders SL, Nedelec B. What work means to people with work disability: a scoping review. *Journal of occupational rehabilitation*. 2014 Mar;24(1):100-10.
33. Theadom A, Barker-Collo S, Jones K, et al. Work Limitations 4 Years After Mild Traumatic Brain Injury: A Cohort Study. *Archives of physical medicine and rehabilitation*. 2017 Aug;98(8):1560-1566.

34. Radford K, Sutton C, Sach T, et al. Early, specialist vocational rehabilitation to facilitate return to work after traumatic brain injury: the FRESH feasibility RCT. *Health technology assessment (Winchester, England)*. 2018 May;22(33):1-124.
35. Hanks RA, Rapport LJ, Wertheimer J, et al. Randomized Controlled Trial of Peer Mentoring for Individuals With Traumatic Brain Injury and Their Significant Others. *Archives of physical medicine and rehabilitation*. 2012;93(8):1297-1304.

**Table 1.** Codes used for categorizing the studies

Study ID	ID number, first author, year, and country
Design	1) Cross-sectional (one data point), 2) Longitudinal (two or more data points), 3) Other types of follow-up
Method	1) Qualitative, 2) Quantitative, 3) Mixed or Multiple methods
Design quantitative studies	1) Randomized controlled trial (RCT), 2) Pilot RCT, 3) Quasi experimental, 4) Cohort study, 5) Case control, 6) Cross sectional, 7) Case report/study, 8) Other
Qualitative data collection	1) Individual interview, 2) Focus group interview, 3) Interview and observation, 4) Text analysis, 5) Auto ethnography
Mixed methods studies	1) Mixed method including RCT, 2) mixed other methods (results not reported, few studies, n=22)
Rehabilitation setting	1) Hospital in- and outpatient, 2) Community-based and/or home, 3) School or workplace
Rehabilitation phase	1) Acute (0-6 weeks), 2) Sub-acute (7 weeks-3 months), 3) Stable (3-12 months), 4) Long-term (12+ months, chronic phase)
Age group	1) Adolescents (16-17 years), 2) Adults (18-65 years), 3) Elderly (66+ years), 4) Mixed ages, 5) Adults + Elderly (18+)
TBI severity	1) Mild, 2) Moderate, 3) Severe, 4) Mixed, 5) Mild/moderate, 6) Moderate/severe
Intervention type	1) Single-component intervention, 2) Programme/comprehensive, 3) Other
Intervention scope/aim	1) Daily life (including personal and instrumental activities of daily living (PADL/IADL)), 2) Work/education, 3) Leisure/Sport, 4) Driving, 5) Social network, 6) Carers/family, 7) Physical function, 8) Emotional factors, 9) Medication, 10) Cognitive factors, 11) Other

**Table 2.** Descriptions of articles from the scoping review on TBI rehabilitation interventions (n=425)

Variable		N of articles (%)	
Country	USA	169	(39.8)
	Australia and New Zealand	64	(15.0)
	Scandinavia*	55	(12.9)
	UK, Scotland, Ireland	33	(7.8)
	Central / Southern Europe	30	(7.1)
	Canada	26	(6.1)
	Netherlands	24	(5.6)
	Asia and Israel	20	(4.7)
	South Africa	3	(0.7)
	South America (i.e., Brazil)	1	(0.2)
Design	Cross-sectional	96	(22.6)
	Longitudinal	301	(70.8)
	Other follow-up	6	(1.4)
	Undisclosed	22	(5.2)
Method	Quantitative	305	(71.8)
	Qualitative	83	(19.5)
	Mixed/multiple methods	22	(5.2)
	Undisclosed	15	(3.5)
Rehabilitation setting	Hospital in- and outpatient	217	(55.1)
	Community-based & home	158	(37.2)
	Workplace or school	19	(4.5)
	Undisclosed	31	(7.2)
TBI severity	Mild	38	(8.9)
	Moderate	3	(0.7)
	Severe	106	(24.9)
	Mixed (mild/moderate/severe)	119	(28.0)
	Mild/Moderate	23	(5.4)
	Moderate/Severe	64	(15.1)
	Undisclosed	72	(16.9)
Age group (at inclusion)	Adolescents, 16-17	14	(3.3)
	Adults, 18-65	342	(80.5)
	Adults/elderly	28	(6.6)
	Elderly, 66+	3	(0.7)
	Mixed	18	(4.2)
	Undisclosed	20	(4.7)

\*Sweden, Norway and Denmark

**Table 3.** Description of interventions/aims in the reviewed articles (n=425)

<b>Variables</b>		<b>N of articles (%)</b>	
Rehabilitation phase			
425=100%	Acute (0-6 weeks)	26	(6.1)
	Sub-acute (7 weeks-3 months)	56	(13.2)
	Stable (3-12 months)	100	(23.5)
	Long-term (12+ months)	188	(44.2)
	All phases	13	(3.1)
	Undisclosed	42	(9.9)
Intervention type			
425=100%	Single-component intervention	111	(26.1)
	Programme/comprehensive	240	(56.5)
	Other	26	(6.1)
	Undisclosed	48	(11.3)
Intervention scope/aim <sup>a</sup>			
(% calculated from n=425)	Daily life	139	(32.7)
	Work/education	83	(19.5)
	Leisure/sports	15	(3.5)
	Driving	8	(1.9)
	Social network	30	(7.1)
	Cares/family	43	(10.1)
	Physical function	98	(23.1)
	Emotional	99	(23.3)
	Cognition	160	(37.6)
	Medication	6	(1.4)

<sup>a</sup> More than one scope was coded per article

**Table 4.** Suggested research priorities from the discussion in the user panel

<b>Agendas</b>	<b>Scoping review findings relevant to agendas (n=425 total)</b>
What measures are needed for the purpose of increasing occupational participation? What support programmes/interventions are needed?	Work/education; n=83 (19.5%)
Interventions evaluating the outcome of early cooperation between the 'support' services (health and social services) and the employer?	Employer and health care professional collaboration; n=12 (2.8%)
What are good/effective rehabilitation interventions for cognitive/ mental and emotional challenges? (injured people suffer from these for a much longer time than physical injuries)	Cognition; n=160 (37.6%)
How can the institutions facilitate the users' own contribution (in rehabilitation), for example, in the form of peer-to-peer work or symposia for exchange of experience? Of importance to the individual is a substantial point of reference throughout life, such as a forum of people from a common diagnosis group.	A randomized controlled trial of peer mentoring for individuals with traumatic brain injury and their significant others; n=1 (0.2%) [35]
Is it possible to develop computer program/online/social media-based arenas where the injured can "meet", exchange experiences and support each other, to enhance/empower users through the users? (e.g. in collaboration between healthcare and user organizations?)	None found
Studies on interventions facilitating continuity of care.	Studies concerning continuity of care and case management; n=9 (2.1%)
Is it possible to achieve better rehabilitation pathways (trajectories) in the community health service that are not dependent on the efforts of the relatives as much as it is today?	Rehabilitation in community and home setting; n=158 (37.2%)
How can inequalities in service delivery be reduced to achieve equal and fair quality treatment among service users?	Equality in service delivery: none found

**Figure 1. PRISMA Flow Diagram for the Scoping Review**

