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Confused about Rehabilitation? Multi-Faceted Approaches for Brain Injured Patients in a Confusional State

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Abstract: Post-injury confusional state is a common phenomenon following acquired brain injury. A multi-faceted approach for decreasing confusion is recommended, but there is a paucity of research related to non-pharmacological management. The main objective was to present a conceptual model of multi-faceted approaches for confusion, and secondly to investigate the rehabilitation outcome following these approaches. The setting is a specialized ward for rehabilitation of patients with severe cognitive difficulties following acquired brain injury. The conceptual model encompasses neurobehavioral strategies, pharmacological treatment, engagement in meaningful occupations, next of kin involvement, organizational demands, the physical environment, along with differential diagnostics. Patient cases are provided to illustrate the impact of each approach. A total of 141 of 281 patients were in a confusional state at admission. At discharge, 62% had emerged from the confusional state. Patients in a confusional state due to traumatic brain injury and subarachnoid hemorrhage had clinically important differences of >22 points in the functional independence measure from admission to discharge, following rehabilitation efforts based on the conceptual model. No clinically important difference was seen in patients with non-SAH stroke and patients with other types of brain injuries. The proposed conceptual model should be further evaluated in complex intervention studies.

Keywords: rehabilitation; confusion; post-traumatic amnesia; conceptual model; acquired brain injury

Citation: Fabricius, J.; Andersen, A.B.; Lindegård Munk, G.; Kaae Kristensen, H. Confused about Rehabilitation? Multi-Faceted Approaches for Brain Injured Patients in a Confusional State. *Hospitals* **2024**, *1*, 50–64. https://doi.org/10.3390/hospitals1010005

Academic Editor: Adam Rose

Received: 5 April 2024
Revised: 29 April 2024
Accepted: 30 April 2024
Published: 9 May 2024

1. Introduction

Acquired brain injury (ABI) is a collective term for brain injuries which are non-progressive and non-congenital, such as stroke and traumatic brain injury (TBI) [1]. Post injury confusion is a phenomenon which is often observed in the acute and post-acute phases following ABI.

The terms Post Traumatic Amnesia (PTA) and post-traumatic confusional state are applied in describing post injury confusion following TBI, in the phase following emersion from a minimally conscious state [2]. Confusion is seen in most patients with TBI, with the duration lasting anywhere between a few minutes to several months [3]. In patients with stroke, the prevalence of confusion has been reported in 10–48% of patients with ischemic or hemorrhagic stroke [4], and in 16–37% of patients with subarachnoid hemorrhage (SAH) [5–7]. However, interpretation of prevalence should take into account that a wide range of measures may be applied in defining confusion [8,9].

Presently, the confusional state is defined according to the criteria applied for diagnosing the post-traumatic confusional state—(A) Disturbances of attention: reduced ability to focus or sustain attention, (B) Disorientation: impaired orientation to place, time and situation, (C) Disturbances of memory: impaired ability to encode and recall new information, and (D) Fluctuation: the character and severity of the disturbance waxes and wanes

during the course of the day. This definition closely resembles that of delirium, except that delirium is defined as a direct physiologic consequence of an acute medical condition or intoxication [10]. Based on this resemblance, the present study will draw on knowledge on delirium management, due to the paucity of research literature related to management of the confusional state following ABI.

Confusion, regardless of the underlying neurophysiological cause, is a great burden for patients, next of kin, and hospital staff [11]. Patients have reported disorientation related to not knowing where they are, and not being able to recognize next of kin, episodes of hallucination, short-temperedness, frustration about the way they are treated, and a general loss of control related to decision making [11,12]. Family members have reported burden from the unpredictability on whether the patient recognizes them, helplessness from not being able to apply assistance and comfort, but also frustration from not wanting to be around the patient when the symptoms are cause for embarrassment [11]. Staff have reported burden from loss of control related to patients not being able to receive care or engage in rehabilitation, lack of staff during night shifts, and emotional distress from thinking about the patient after work [11]. Confusion is also associated with agitated behavior [13,14], sleep disorders [15,16], and an increased dependency in activities of daily living (ADL) [17,18], and confusion is thus a major complication in the rehabilitation of patients with ABI.

Most research related to lowering confusion has investigated the effects of pharmacological agents. In acute care, the administration of benzodiazepines and antipsychotics is highlighted due to their sedative effect, which may be warranted to facilitate the acute care of patients; and to a higher degree the use of beta-blockers, antiepileptic agents, and psychostimulants during inpatient rehabilitation, due to long lasting and less sedative effect, along with their facilitating effect on neuroplasticity [19]. However, for patients to actively engage in their own rehabilitation, a multi-faceted approach for decreasing confusion is recommended [20].

Evidence on the effectiveness of multi-faceted non-pharmacological interventions for lowering delirium in elderly patients has been reported in a review and meta-analysis [21]. These interventions included initiatives related to cognition and orientation, fall prevention, sleep-wake cycle preservation, visual and hearing aids, and hydration. The overall conclusion was that multi-component non-pharmacological interventions showed a markedly decrease in odds of developing delirium. However, the review only included studies in acute care which addressed delirium in a broader population of elderly medical, surgical and geriatric patients. Post-acute rehabilitation of patients in a confusional state due to ABI differs from management of delirium in acute care in several aspects: confused patients are generally younger [22,23], the confusional state is arguably more stable in patients with ABI in the post-acute phase compared to acute onset of delirium, and patients with severe ABI are generally admitted for a much longer time [24]. Therefore, the underlying brain injury and its neurological sequelae should be taken into account in the management of confusion, along with thorough considerations about the patients' social and physical environment. However, to the best of our knowledge, there is a lack of description of multi-faceted approaches for a post-injury confusional state, and there is thus a great deal of important tacit knowledge on this topic.

Conceptual models, which are being increasingly valued in healthcare, can be applied for understanding, describing and visualizing links between different concepts [25,26]. Accordingly, they may be appropriate for describing the complexity of rehabilitation initiatives for lowering post injury confusion. Based on this, the main objective was to present a conceptual model of multi-faceted rehabilitation approaches for patients in a confusional state, and secondly, to investigate the rehabilitation outcome following these multi-faceted approaches.

2. Materials and Methods

2.1. Design

Development of a conceptual model [26], along with evaluation of the rehabilitation outcome following the multi-faceted approaches described in the model. Reporting of the study was inspired by the Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) [27].

2.2. Setting

The study took place at a post-acute rehabilitation hospital, where specialized neurorehabilitation is provided for patients with ABI who have complex rehabilitation needs. The hospital has ten wards and a nationwide catchment area, and patients may be admitted once they are medically stable.

The ward for cognitive rehabilitation mainly admits patients with severe cognitive disturbances following ABI, once they are free from mechanical ventilation (and decannulated). Patients may also suffer from, e.g., hemiparesis, dysphagia, and spasticity, but these disturbances are less dominant. The ward has 10 beds and around 76 patients are admitted each year, with a median length of stay of 45 days. The ward has around 70 employees, mostly nurses, auxiliary nurses, occupational therapists, physiotherapists, but also physicians, a speech language pathologist, a neuropsychologist, a dietician, social care workers, and service assistants. Among the 36 nursing staff members, the average employment at the hospital is 11 years, among the eight occupational therapists the average employment is 17 years, and among the seven physiotherapists, the average employment is 9 years. Nursing staff cover all shifts and occupational and physiotherapists cover dayshifts and evening shifts on weekdays and weekends. A great emphasis is on interdisciplinary teamwork [28], in which each clinician apart from working within their own discipline, also incorporate knowledge and skills acquired from the other disciplines. The multi-faceted approaches which are described represent how the interdisciplinary teams have worked with lowering post-injury confusion for years.

2.3. Development of Conceptual Model

A conceptual model of the multi-faceted approaches was developed by J.F. based on clinical reflections by A.B.A. and G.L.M, concerning pivotal multi-faceted approaches used in everyday practice [26], in rehabilitation of patients in a confusional state. The model encompasses neurobehavioral strategies, the pharmacological treatment plan, participation in meaningful occupation, next of kin involvement, organizational demands, the physical environment at the ward, along with differential diagnostics. The conceptual model was presented to the interdisciplinary staff at the ward, in order to verify that the model represents how post-injury confusion is managed by the staff [26]. The theoretical and conceptual framework for the conceptual model [26] is the international classification of functioning (ICF) by the World Health Organization [29]. The ICF model is a biopsychosocial model which provides a standard language and a conceptual basis for the definition and measurement of health and disability [29]. The ICF is highly applicable in rehabilitation medicine [30,31].

In the result section, each approach is described along with short anonymized patient cases, which represent narrative data from clinical practice at the ward from 2019 to 2022 [32]. These cases should not be regarded as scientific evidence, but merely as examples that illustrate the observed impact of each approach.

2.4. Patient Data

Data from electronic medical records were extracted to present patient characteristics and the rehabilitation outcome following the multi-faceted approach described in the conceptual model. The extracted data included age, sex, referral diagnosis, Rancho Los Amigos Scale (RLAS) [33], Functional Independence Measure (FIM®) [34] and the Rehabilitation Complexity Scale: extended (RCS-E) [35]. Changes in FIM are displayed in spider webs and

analyzed in a logarithmically transformed one-sample t-test, according to main diagnostic groups, in order to show the rehabilitation outcome following the multi-faceted approaches. FIM is a multi-dimensional scale measuring level of functional independence in a wide range of tasks and ADL, encompassing both a motoric and cognitive subdomain [34]. The scale has 18 items (13 motoric and 5 cognitive items) which are scored on a seven-point Likert scale, with one denoting complete dependence on assistance in the activity, and seven denoting complete independence in the activity. FIM was developed for patients with stroke and has been thoroughly validated in individuals with ABI [36–38].

2.5. Categorization of Confusion

The RLAS is often used in conjunction with the Glasgow Coma Scale to provide an early assessment of cognitive function in brain injury patients [33]. However, RLAS is helpful in evaluating a patient's recovery beyond the initial emergence from a coma. The RLAS encompasses eight levels describing the continuum of cognitive recovery, from being in a coma to being consistently oriented in time, place, and own data [33]. Level 4–5 in the RLAS was presently applied in categorizing patients as being in a confusional state at admission and discharge, with level 4 describing confused/agitated behavior and level 5 describing confused, inappropriate non-agitated behavior.

3. Results

3.1. Multi-Faceted Conceptual Model for Rehabilitation of Patients in a Confusional State

The conceptual model for multi-faceted approaches for lowering confusion is displayed in Figure 1. The overarching approach for the confused patient is the neurobehavioral strategy in combination with the pharmacological treatment. The pharmacological treatment is displayed with a dotted line to illustrate that pharmacological treatment is not a desired approach, because the aim as far as possible is to manage confusion without pharmacological treatment. However, in reality, pharmacological treatment is necessary for almost all confused patients admitted to the ward, and thus plays an integral part in management of confusion. Rehabilitation goals related to meaningful occupations are chosen in collaboration with family as displayed by the overlapping figures, since family and other next of kin are often those who provide information on premorbid everyday living. Likewise, the organization at the ward and the physical environment are mutually dependent. Each element in the figure may vary in size: For some patients the allocation and organization of staff may be essential, whereas, for other patients, having the patients' spouse present may be essential for lowering confusion.

Differential diagnostics is essential in diagnosing a post-injury confusional state, since it will guide the treatment and rehabilitation approaches [39]. Accordingly, neurological examinations along with clinical observations are crucial. Differential causes of confusion such as infections, delirium, sleep deprivation, undernutrition, and anxiety need to be ruled out as the cause of the confusional state [40]. In the figure, the line connecting differential diagnostics with the rest of the model has arrows in both directions, to display that differential diagnostics is an ongoing focus throughout the course of rehabilitation.

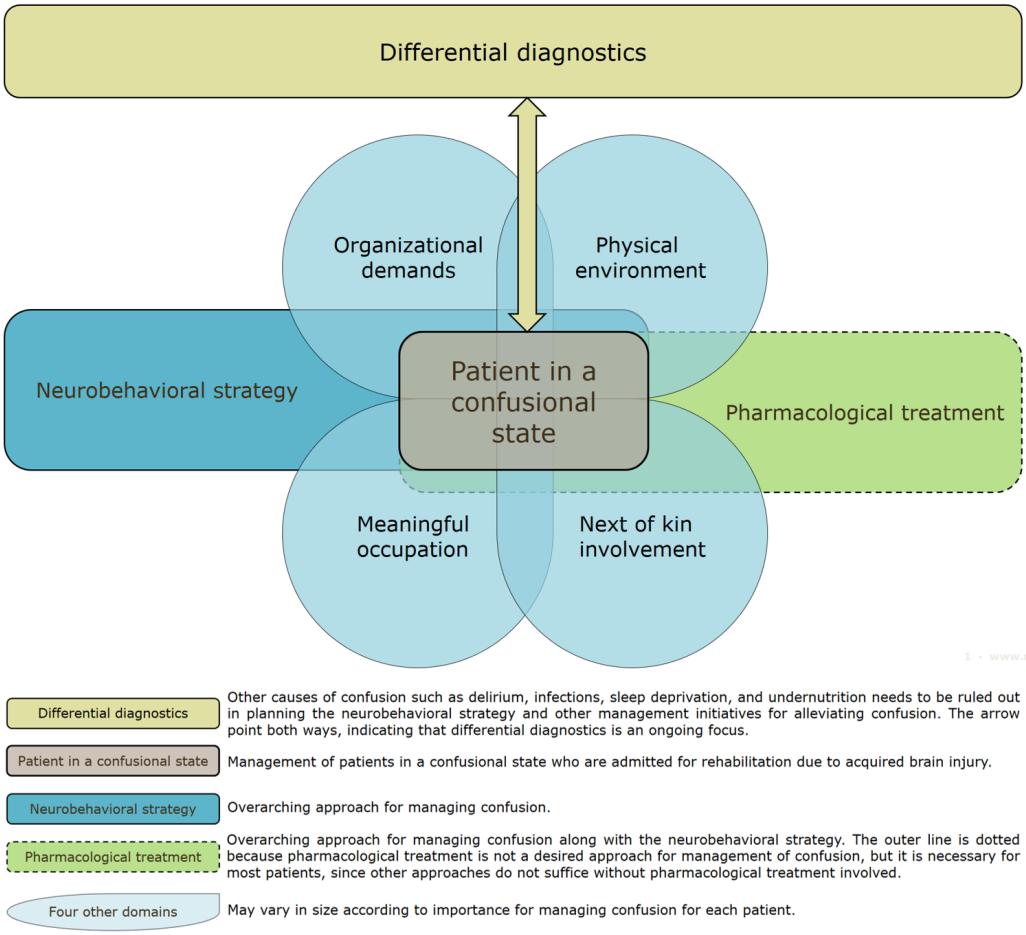

Figure 1. Conceptual model for multi-faceted approaches for inpatient rehabilitation of patients in a confusional state due to acquired brain injury.

3.1.1. Neurobehavioral Strategy

Neurobehavioral strategies are an interdisciplinary approach in which the goal is to facilitate autonomy and patient-centered practice, in patients where cognitive or emotional disabilities may challenge rehabilitation initiatives [41]. The interdisciplinary team develops strategies for clinical practice, based on knowledge about the (damaged) brain, pedagogy, neuropsychology, the effect of the physical environment, and background information from family members and other next of kin on personal resources and premorbid life (e.g., about substance abuse, mental state, diurnal rhythm), along with inward observations of the patient during ADL, social interaction, and registration of diurnal rhythm. The locally adapted principles behind the neurobehavioral strategies encompass the following:

- Balance between activity and rest to prevent overstimulation and agitation and facilitate consolidation of acquired knowledge following rehabilitation initiatives. This requires constant observations of increased muscle tone, restlessness, anxiety, and confabulation, along with documentation of agitated behavior [42], and registration of diurnal rhythm.
- Staff should have an appreciative approach and trustful communication with the patient [43].
- Staff should be informative without too much confrontation of the patients' understanding of reality, and options should be kept at a minimum according to the patients' capabilities.
- Staff provide an overall structure for rehabilitation interventions without being controlling [43]. Thus, patients are never stopped in their doings but are rather diverted

into more purposeful and meaningful occupation, since confrontation may exacerbate frustration and agitation [44].

- Staff prepare activities in a natural context to facilitate understanding and adherence and they assist in sorting stimuli in order to direct attention and lower stress [44].
- Relaxing activities such as massage, soothing stimulation of senses, and positioning are chosen to facilitate body awareness and lower stress.
- Activities related to problem solving are only chosen when staff are able to present solutions in order to avoid cognitive overstimulation [43].
- Shifts in personal in critical situations are promoted, e.g., in situations where the patient becomes agitated and wants to leave the ward.
- Staff structure the amount and duration of visits to inhibit potential conflicts between patients and visitors and to prevent overstimulation.

Case: A young woman who was severely confused following encephalitis. She was severely sleep deprived, she was not oriented in her own situation, and she was constantly looking for food. At one point she left the hospital without the staff being able to stop her, since she reacted aggressively when she met restrictions. Occasionally she had fallen asleep in the couch in the ward living room. As a consequence, the staff arranged the physical environment in the following way: (1) They filled a refrigerator in her room and in the living room with vegetable snacks and removed all other accessible food. (2) They moved the living room couch to her room. (3) They prepared a strategy in case she wanted to leave the ward. If she passed the first door trying to leave the ward, staff would try to distract her and escort her back. If this did not work, and she would walk to the outer door of the ward, then staff had placed a small chocolate bar (which she loved) on a visible shelf. This would distract her from leaving. The consequence was that conflicts with the patient were avoided, since she did not feel restrictions in her doings. She also began to eat healthier because of the prepared snacks, and she slept longer because she had the couch in her own room.

3.1.2. Pharmacological Treatment

The neurobehavioral strategy will go hand-in-hand with the pharmacological treatment plan. The medical doctor is responsible for the pharmacological treatment, but it is administered in close collaboration with the interdisciplinary team who make observations on the drug effect, on a 24 hour basis. For agitation, such observations are documented in the Agitated Behavior Scale (ABS), and for diurnal rhythm it is documented in a locally developed schedule. Pharmacological treatment for the confused patient is administered when the non-pharmacological treatment is insufficient by itself [43] in managing the following circumstances:

- The diurnal rhythm is greatly affected causing the patient to have a sleep deficit.
- The patient cannot find rest, e.g., tries to leave the ward.
- Lack of insight of the need for assistance in basic activities, which causes the patient to be agitated.
- Signs of cognitive overstimulation such as incoherent and confabulating speech.

Sleep hormone treatment and hypnotics are administered to facilitate a healthy diurnal rhythm, benzodiazepines and antipsychotics are administered due to their sedative effect for patients who are agitated and restless, and antiepileptic drugs are administered due to long lasting and less sedative effects for patients feeling anxious. Only one drug is administered at a time, in order to evaluate the direct effect without having effects of other drugs interacting. As a starting point, pharmacological treatment which may facilitate stabilization of the diurnal rhythm is administered, since sleep deprivation may lead to increased confusion and agitation. Following this, the focus will be on the most prominent behavior, e.g., restlessness, agitation, or confabulation. In choosing the appropriate pharmacological treatment, it is essential to consider the effect, the dose, half-life, and side effects of the drug.

Case: A middle-aged man who was in a post-traumatic confusional state following severe TBI. At admission he was medicated with morphine and Quetiapine. He was bedridden but had difficulties sleeping, and he shouted loudly and agitatedly every time the staff approached him. He explained that he had a feeling that his head was not attached to his body and that his legs were falling off when he was assisted out of bed. He would also speak incoherently and confabulating. The staff decided to seponate his present pharmacological treatment and prescribe Pregabalin, which is an antiepileptic drug with a relaxing effect on the central nervous system through inhibition of glutamate and noradrenaline. Following the change in the pharmacological treatment plan, staff observed that his sleep quality had significantly improved, his agitation was markedly reduced, and his body awareness seemed to have improved. Staff could now assist him in ADL without him shouting agitatedly.

3.1.3. Meaningful Occupations

Engagement in meaningful occupation is used both as a mean and as an end goal of rehabilitation efforts [45]. Meaningful occupation may not necessarily be occupations that the patient was motivated for premorbidly, but rather what motivates the patient in the present situation. Research in stroke survivors show that engagement in meaningful occupations influences the physical activity level of patients [46].

Patients in the present ward are encouraged to engage in meaningful occupations, with awareness to the limitations that a hospital ward causes, since personally meaningful occupations have means of maintaining the patients' attention and motivation, hence entailing improvements on psychological wellbeing [47].

Case: A middle-aged man who was in PTA and restricted to a wheelchair due to a hemiparesis. Premorbidly, he often rode his bicycle and took pictures of nature scenarios. In the ward he was highly agitated and could not find any rest. The staff decided to accompany him on trips to a nearby forest to provide surroundings that would help him calm down. Two staff members would go, but only one of them would have verbal contact with the patient. He would get his mobile phone (without a SIM card) since it brought him comfort. The staff would lend his phone and take pictures of the motives he talked about. As a consequence, he was not agitated during these trips. After returning to the ward, he would often be very relaxed or fall sleep.

3.1.4. Next of Kin Involvement

Family and friends often play an essential role in the rehabilitation of patients in a confusional state. The patients are not in a state where they are able to be interviewed about premorbid life, and family members are therefore interviewed about the patients' daily routines and activity preferences from before the injury, in order to base the rehabilitation initiatives on motivation and recognizability in daily routines, and thus inhibit confusion. Furthermore, the presence of family or close friends at the ward may often lower confusion and help the patient to find rest [48,49]. However, this is often a fine balance since long visits may sometimes exacerbate conflicts and agitation.

Case: A middle-aged man with left side hemiparesis and spasticity due to TBI. He could move right side extremities but in monotonous unpurposeful movements. This behavior was seen as a sign of overstimulation, and staff tried to facilitate that he would rest during the day, but without luck. In days where his wife was visiting, his room was arranged such that his wife could rest next to him, while listening to music. As a consequence, his spasticity decreased, his monotonous movements stopped, and he would often fall asleep.

3.1.5. Organizational Demands

There is a need for a comprehensive organizational setup of the staff in relation to continuity, intercollegial sparring and support, competence development, relief in critical situations, and a well-functioning work environment. The confused patient often requires

constant supervision from one (sometimes two) staff members during waking hours. The unpredictability is often very high, and it is rarely possible to plan activities beforehand. The patient's ability to maintain attention is often severely affected, which is why the staff must be constantly attentive and ready to change plans. For this to be possible, the entire staff group must be qualified to meet the high need for creativity regarding approaches and activities that are often far from what is in general demand in a hospital setting.

When a patient in a confusional state is mobile (either walking or in a wheelchair), it often requires that all staff members are informed about the patient and what procedures are needed when the patient tries to leave the ward. A password needs to be entered on the outer door leading to the rest of the hospital. However, it is possible to push the door open if the patient is strong enough. Thus, it is not similar to a psychiatric ward in which patients cannot leave. Furthermore, physical restrain will only be applied if the patient is putting him/herself or staff in immediate danger. It is therefore not sufficient that the team around the patient know him/her, but all staff members in the ward must be able to offer support when the patient tries to leave the ward. This calls for an extremely high level of information and intercollegial teamwork, where one member of the staff often knows what the other staff will do.

Case: An elderly man who was in a state of severe confusion following an intracerebral hemorrhage. He was able to perform most ADL with support. However, he was not capable of structuring the day, and in his own mind he was performing activities in his premorbid context. During a specific episode, he was about to go to bed and the occupational therapist had prepared his toothbrush for him. All of the sudden he wanted to go home, and he walked determined towards the outer door of the ward. The occupational therapist followed him without intervening. The occupational therapist got eye contact with a nurse, and without words the nurse knew what was going on, based on her knowledge about the patient. The nurse convinced the patient to come back to his room, where he brushed his teeth. The nurse withdrew and the occupational therapist offered the patient a massage before he got to bed.

3.1.6. Physical Environment

The physical environment is arranged to facilitate the following factors:

- Easy orientation and recognizability. This is often facilitated by having a personalized interior design in the patient room, with, e.g., personal items and family pictures, but without overstimulating the patient. Furthermore, easily recognizable objects in the corridors, e.g., a large plant helps differentiating the otherwise similar corridors from one-another.
- Environment stimulating rest is facilitated by having armchairs and couches around the ward, warm colors and pictures on the walls, along with an electric fireplace in the living room.
- Home-like surroundings: A small apartment has been established in the ward, which is separated from the rest of the ward to facilitate home-like surroundings (Figure 2). A sliding door in the same color as the walls separates the apartment from the rest of the ward, to allow the patient to move around freely. There is a small kitchen and a bedroom with blue walls, blackout curtains, lighting for diurnal rhythm, and a surround sound system for playing relaxing music or music chosen by the patient.
- Participation in meaningful occupations is facilitated by having e.g. a mobile kitchen which can be moved to the patient room to facilitate not being overstimulated from going to a training kitchen.

Case: A young girl who suffered from cardiac arrest and anoxic brain injury. She was disoriented, with very short attention span and tendency for hallucinations. Premorbidly, she had difficulties in independently take care of daily living, and she seemed to be at a lower development stage than her age would imply. Most of the time she was in her bed and refused all rehabilitation efforts. Her foster parents informed the staff that she liked to cook food, particularly making pizza. One day an occupational therapist took

a small mobile kitchen table to her room with all ingredients for a pizza. She started making the pizza without involving the patient. The patient got more and more interested. However, she was distracted through hallucinations about her dog who had to go pee. The occupational therapist accepted the premise, called for the dog, and opened the door for the imaginary dog. This calmed the patient and the occupational therapist got the patient to participate. The following day, the girl told all staff members that she had made pizza.

Figure 2. A 3D view of the training apartment used for patients who are in a confusional state. 1. Apartment for patients in a confusional state. Encompass bedroom, small living room with kitchen, bathroom, and a large hallway. 2. Sliding door separating the apartment from the wards' living room. 3. Living room which may be used by all patients in the ward. 4. Door leading to the rest of the ward. The door may be closed for other patients if the confused patient needs more space.

3.2. Patient Characteristics and Rehabilitation Outcome following Multi-Faceted Approaches in the Conceptual Model

3.2.1. Characteristics of Patients Admitted to the Ward

From 2018 to 2022, a total of 281 patients were admitted to the ward. A total of 141 of these patients were in a confusional state at admission, according to the RLAS. Characteristics of patients are shown in Table 1. As seen in Figure 3, 66 of the 141 confused patients (48%) required constant 1:1 supervision to maintain their own safety and to minimize confusion.

Table 1. Characteristics of patients admitted at the specialized ward, according to their level on the Rancho Los Amigos Scale (RLAS).

RLAS Level *	**Minimally Conscious**	**Confusional State**	**Appropriate Response**
Number of patients	36	141	104
Age, mean (SD)	59 (±13)	58 (±12)	52 (±14)
Sex, female	9 (25%)	47 (33%)	35 (34%)
Diagnosis			
- Stroke	21 (58%)	61 (43%)	51 (49%)
- SAH	4 (11%)	25 (18%)	12 (12%)
- TBI	5 (14%)	35 (25%)	27 (26%)
- Other brain injury¤	6 (17%)	20 (14%)	14 (13%)
Injury until admission, days	34 (21–47)	33 (23–48)	28 (16–40)
FIM, admission	18 (18–19)	34 (21–62)	61 (42–100)

Abbreviations: SAH: subarachnoid hemorrhage; TBI: traumatic brain injury; FIM = functional independence measure. * Minimally conscious = RLAS 2–3, confused = RLAS 4–5, appropriate response = RLAS 6–8. ¤Other brain injury constitutes anoxic brain injury, encephalitis, meningitis, and brain tumors.

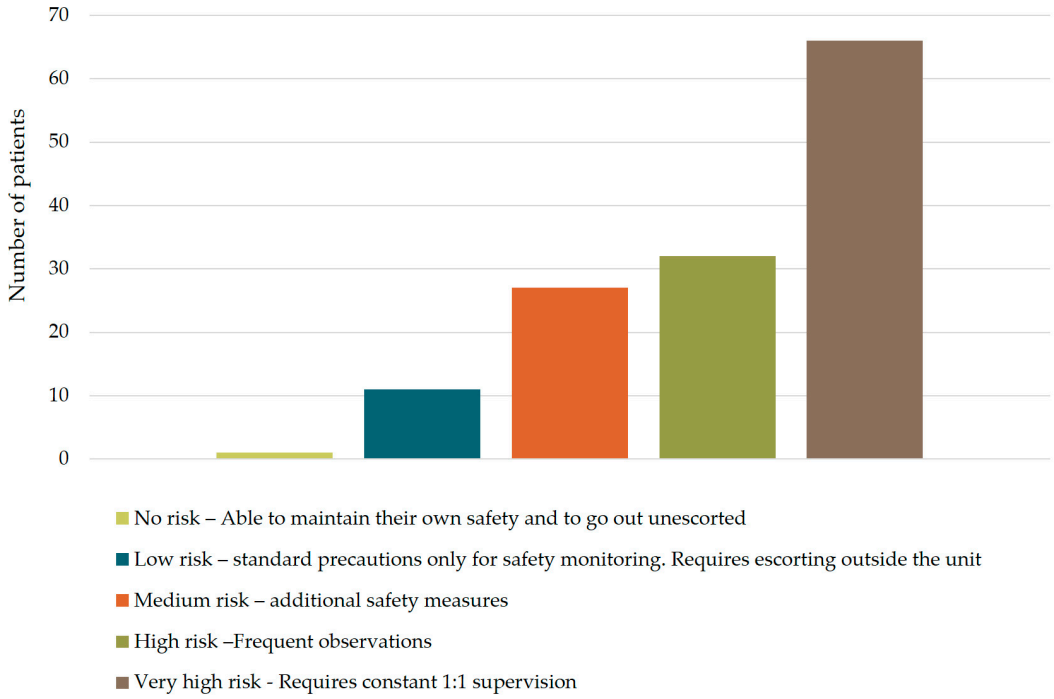

Figure 3. Cognitive/behavioral needs for patients in a confusional state according to the Rehabilitation Complexity Scale: Extended (n = 141).

3.2.2. Functional Independence following Multi-Faceted Rehabilitation Approaches in the Conceptual Model

Among the 141 patients who were in a confusional state at admission, 29% were still in a confusional state at discharge, 62% had emerged from the confusional state, and the remaining 9% did not have a follow-up score on RLAS due to short stay for inpatient rehabilitation. In Figure 4, the median scores for each of the 18 items in FIM at admission and discharge are displayed. Results showed that patients with SAH and TBI had clinically important differences of at least 22 on the FIM sum score [50] using one-sample t-tests, with $p = 0.046$ and $p = 0.043$, respectively; whereas patients with non-SAH stroke and other brain injuries did not have clinically important differences, with $p = 0.101$ and $p = 0.606$, respectively. The mean length of stay for patients with stroke was 66 (±33) days, for patients with TBI it was 64 (±29) days, for patients with SAH it was 55 (±29) days, and for patients with other brain injuries it was 53 (±25) days, $p = 0.297$.

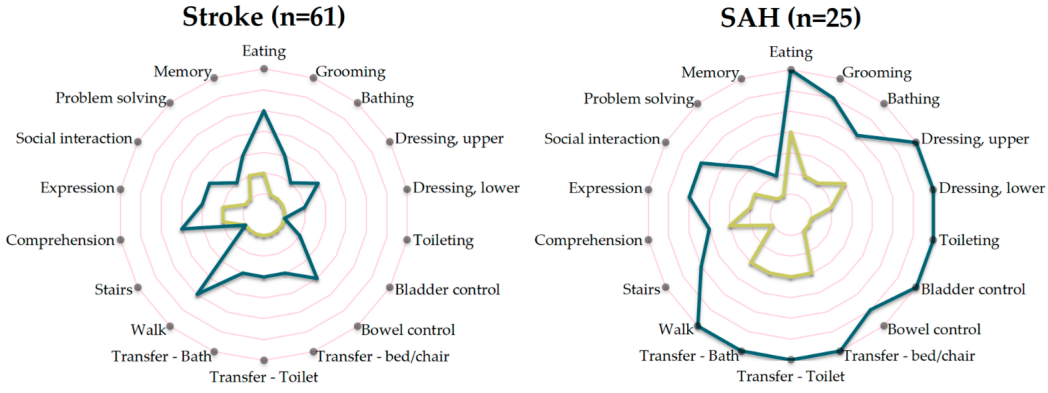

Figure 4. *Cont.*

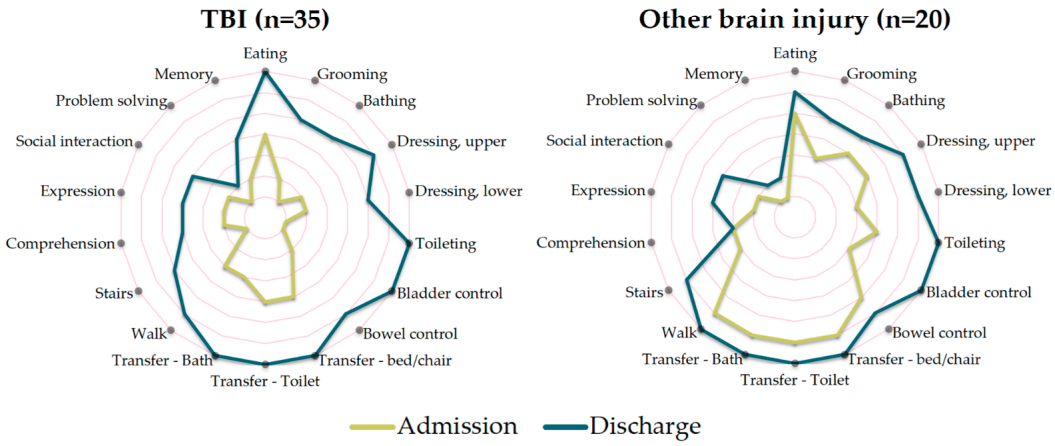

Figure 4. Median change in the functional independence measure (FIM) among patients in a confusional state (n = 141). Abbreviations: TBI = traumatic brain injury; SAH = subarachnoid hemorrhage. Other brain injury constitutes anoxic brain injury, encephalitis, meningitis, and brain tumors.

4. Discussion

A conceptual model describing multi-faceted approaches for patients in a post-injury confusional state was developed. The model encompasses approaches which were considered core elements in managing patients in a confusional state by the interdisciplinary staff at the specialized ward [26]. The most pivotal component in the conceptual model is the neurobehavioral strategy [41], which concerns facilitation of autonomy and patient-centered practice through the therapeutic approach and clinical observations of distress. This approach is similar to a non-aversive approach, which has been proposed by Rothwell et al. for managing patients with ABI displaying aggressive behavior [43]. This approach encompasses reactive strategies for reducing problematic behavior, such as allowing patients to move away from demanding situations, diversion of attention to more meaningful activity, and also active listening [43]. In the study by Rothwell et al., it is also suggested that punitive initiatives such as sedative treatment, locked rooms, physical restrain, and electroconvulsive treatment may have negative effects on client self-esteem, deterioration of staff–client relationship and ultimately the risk of litigation [43]. This is in line with the basic principles behind the neurobehavioral strategy presently proposed. Sedative treatment may be used as a last resort, but physical restrain and locked rooms is never applied in the case setting due to ethical reasons. Electroconvulsive therapy was highlighted in a recent review that investigated the effect of non-pharmacological interventions for agitation following PTA [51]. However, this approach would not be applied in the case setting due to ethical reasons, but also since electroconvulsive therapy may entail temporary cognitive difficulties [52], which may delay the cognitive recovery following rehabilitation.

The neurobehavioral strategy is an approach which facilitates scaffolding through positive reinforcement, which closely resembles the principles of errorless learning [53]. In line with this, a recent study propose an errorless learning approach provided by occupational therapists as an add-on for patients in PTA [54], and found that this approach yielded greater improvements in functional independence measured with the FIM, compared to physio- and speech language therapy alone. These findings are very encouraging, because they support the interdisciplinary approach for managing patients in a confusional state, which have been suggested presently.

Establishment of a theoretical framework is recommended as a starting point to broaden one's conceptualization before developing a conceptual model [26]. The theoretical framework for the proposed conceptual model is the biopsychosocial understanding of health and disability proposed in the ICF model [29]. For understanding the conceptual model within the ICF framework, diagnosing the post-injury confusional state and ruling out other diagnoses concerns the health condition; the neurobehavioral strategy and pharmacological treatment concerns reducing physical and psychological disturbances;

organization and the physical environment at the ward constitute the environmental factors in a hospital setting; and meaningful occupation and involvement of next of kin concerns engagement in meaningful activity and participation in everyday living as a whole, taking premorbid living conditions into consideration. Thus, a strength of the conceptual model is that it is rooted in a framework which has undergone decades of validation processes in health care and in rehabilitation medicine [30,31]. This makes the proposed conceptual model generalizable to other hospital settings, in which rehabilitation is structured within the ICF framework.

Among the 141 patients who were in a confusional state at admission for rehabilitation, patients with TBI and SAH had clinically important differences in their need of assistance in ADL following the multi-faceted approach. Gains observed in patients with TBI are likely explained by emerging from PTA, which to a high degree facilitates active participation in person-centered rehabilitation interventions [2]. For patients with SAH, research has shown that among patients who survive a SAH, many patients resume daily living with independence in ADL [55]. This may be explained by cognitive and emotional decline following delayed cerebral ischemia from SAH, compared with physical decline, which is less common [56,57]. Thus, the reason why patients with stroke in a confusional state have less improvements than patients with SAH, may be that they to a higher extent suffer from both physical and cognitive deficits. However, it is also noteworthy that patients in a confusional state regardless of their diagnosis had little to no improvements in problem solving, when assessed with the FIM.

A strength of this study is that it relies on different data sources for describing the multi-faceted approaches, covering clinical guidelines, best practice, data from medical records, and patient cases. This is anticipated to allow the reader to acquire a deeper understanding of the context in which the conceptual model was developed. A limitation, is that the included patient cases were cherry-picked in order to illustrate the observed impact of each approach in the conceptual model, and they should therefore not be considered as evidence of their effect.

5. Conclusions

In the present study, a multi-faceted conceptual model of approaches for lowering post-injury confusion in patients with ABI, was proposed. These approaches encompass the neurobehavioral strategy, the pharmacological treatment, participation in meaningful occupations, next of kin involvement, organizational demands, physical environment at the ward, and an ongoing focus on differential diagnostics. Following rehabilitation efforts based on the conceptual model, patients in a confusional state due to TBI and SAH had clinically important difference in functional independence from admission to discharge, whereas patients with non-SAH stroke and patients with other types of brain injuries did not.

The conceptual model was developed as a frame of reference for the interdisciplinary staff and as a starting point for investigating the effect of multi-faceted approaches in future complex intervention studies, with the goal of lowering post-injury confusion and thus increase adherence to rehabilitation initiatives and increase quality of life.

Author Contributions: Conceptualization, J.F., A.B.A., G.L.M. and H.K.K.; methodology, J.F. and H.K.K.; software, J.F.; validation, A.B.A. and G.L.M.; formal analysis, J.F. and H.K.K.; investigation, A.B.A. and G.L.M.; resources, J.F., A.B.A. and G.L.M.; data curation, J.F.; writing—original draft preparation, J.F.; writing—review and editing, J.F., A.B.A., G.L.M. and H.K.K.; visualization, J.F.; supervision, J.F. and H.K.K.; project administration, J.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Hospital Unit of Central Denmark (protocol code 1-16-02-384-23, Date of approval, 14 March 2023).

Informed Consent Statement: Informed consent from patients was waivered according to Danish legislation due to use of retrospective data.

Data Availability Statement: Data are available within the article.

Acknowledgments: The authors would like to acknowledge the contribution of Rasmus Langelund Jørgensen, Jacob Ahlgreen Gram, the Business Intelligence data management group, and the interdisciplinary staff at ward three.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Goldman, L.; Siddiqui, E.M.; Khan, A.; Jahan, S.; Rehman, M.U.; Mehan, S.; Sharma, R.; Budkin, S.; Kumar, S.N.; Sahu, A.; et al. Understanding Acquired Brain Injury: A Review. *Biomedicines* **2022**, *10*, 2167. [CrossRef] [PubMed]
2. Sherer, M.; Katz, D.I.; Bodien, Y.G.; Arciniegas, D.B.; Block, C.; Blum, S.; Doiron, M.; Frey, K.; Giacino, J.T.; Graf, M.J.P.; et al. Post-traumatic Confusional State: A Case Definition and Diagnostic Criteria. *Arch. Phys. Med. Rehabil.* **2020**, *101*, 2041–2050. [CrossRef] [PubMed]
3. Spiteri, C.; Ponsford, J.; Jones, H.; McKay, A. Comparing the Westmead Posttraumatic Amnesia Scale, Galveston Orientation and Amnesia Test, and Confusion Assessment Protocol as Measures of Acute Recovery Following Traumatic Brain Injury. *J. Head. Trauma. Rehabil.* **2021**, *36*, 156–163. [CrossRef]
4. Mansutti, I.; Saiani, L.; Palese, A. Delirium in patients with ischaemic and haemorrhagic stroke: Findings from a scoping review. *Eur. J. Cardiovasc. Nurs.* **2019**, *18*, 435–448. [CrossRef]
5. Caeiro, L.; Menger, C.; Ferro, J.M.; Albuquerque, R.; Figueira, M.L. Delirium in acute subarachnoid haemorrhage. *Cerebrovasc. Dis.* **2005**, *19*, 31–38. [CrossRef] [PubMed]
6. Reimann, F.; Rinner, T.; Lindner, A.; Kofler, M.; Ianosi, B.A.; Schiefecker, A.J.; Beer, R.; Schmutzhard, E.; Pfausler, B.; Helbok, R.; et al. Hyperactive delirium in patients after non-traumatic subarachnoid hemorrhage. *J. Crit. Care* **2021**, *64*, 45–52. [CrossRef] [PubMed]
7. Sauvigny, T.; Mohme, M.; Grensemann, J.; Duhrsen, L.; Regelsberger, J.; Kluge, S.; Schmidt, N.O.; Westphal, M.; Czorlich, P. Rate and risk factors for a hyperactivity delirium in patients with aneurysmal subarachnoid haemorrhage. *Neurosurg. Rev.* **2019**, *42*, 481–488. [CrossRef]
8. Mansutti, I.; Saiani, L.; Palese, A. Detecting delirium in patients with acute stroke: A systematic review of test accuracy. *BMC Neurol.* **2019**, *19*, 310. [CrossRef] [PubMed]
9. Ponsford, J.; Carrier, S.; Hicks, A.; McKay, A. Assessment and Management of Patients in the Acute Stages of Recovery after Traumatic Brain Injury in Adults: A Worldwide Survey. *J. Neurotrauma* **2021**, *38*, 1060–1067. [CrossRef] [PubMed]
10. Slooter, A.J.C.; Otte, W.M.; Devlin, J.W.; Arora, R.C.; Bleck, T.P.; Claassen, J.; Duprey, M.S.; Ely, E.W.; Kaplan, P.W.; Latronico, N.; et al. Updated nomenclature of delirium and acute encephalopathy: Statement of ten Societies. *Intensive Care Med.* **2020**, *46*, 1020–1022. [CrossRef]
11. Schmitt, E.M.; Gallagher, J.; Albuquerque, A.; Tabloski, P.; Lee, H.J.; Gleason, L.; Weiner, L.S.; Marcantonio, E.R.; Jones, R.N.; Inouye, S.K.; et al. Perspectives on the Delirium Experience and Its Burden: Common Themes Among Older Patients, Their Family Caregivers, and Nurses. *Gerontologist* **2019**, *59*, 327–337. [CrossRef] [PubMed]
12. Martin, J.J. Confusion, agitation and delirium. *Front. Neurol. Neurosci.* **2012**, *30*, 46–49. [CrossRef] [PubMed]
13. KcKay, A.; Love, J.; Trevena-Peters, J.; Gracey, J.; Ponsford, J. The relationship between agitation and impairments of orientation and memory during the PTA period after traumatic brain injury. *Neuropsychol. Rehabil.* **2020**, *30*, 579–590.
14. Bogner, J.; Barrett, R.S.; Hammond, F.M.; Horn, S.D.; Corrigan, J.D.; Rosenthal, J.; Beaulieu, C.L.; Waszkiewicz, M.; Shea, T.; Reddin, C.J.; et al. Predictors of Agitated Behavior During Inpatient Rehabilitation for Traumatic Brain Injury. *Arch. Phys. Med. Rehabil.* **2015**, *96* (Suppl. S8), S274–S281.e274. [CrossRef]
15. Ouellet, M.C.; Beaulieu-Bonneau, S.; Morin, C.M. Sleep-wake disturbances after traumatic brain injury. *Lancet Neurol.* **2015**, *14*, 746–757. [CrossRef] [PubMed]
16. Duclos, C.; Beauregard, M.P.; Bottari, C.; Ouellet, M.C.; Gosselin, N. The impact of poor sleep on cognition and activities of daily living after traumatic brain injury: A review. *Aust. Occup. Ther. J.* **2015**, *62*, 2–12. [CrossRef] [PubMed]
17. Reznik, M.E.; Schmidt, J.M.; Mahta, A.; Agarwal, S.; Roh, D.J.; Park, S.; Frey, H.P.; Claassen, J. Agitation After Subarachnoid Hemorrhage: A Frequent Omen of Hospital Complications Associated with Worse Outcomes. *Neurocrit. Care* **2017**, *26*, 428–435. [CrossRef] [PubMed]
18. Hoover, G.L.; Whitehair, V.C. Agitation after traumatic brain injury: A review of current and future concepts in diagnosis and management. *Neurol. Res.* **2020**, *10*, 884–892. [CrossRef] [PubMed]
19. Ganau, M.; Lavinio, A.; Prisco, L. Delirium and agitation in traumatic brain injury patients: An update on pathological hypotheses and treatment options. *Minerva Anestesiol.* **2018**, *84*, 632–640. [CrossRef] [PubMed]
20. O'Mahony, R.; Murthy, L.; Akunne, A.; Young, J.; Guideline Development Group. Synopsis of the National Institute for Health and Clinical Excellence guideline for prevention of delirium. *Ann. Intern. Med.* **2011**, *154*, 746–751. [CrossRef] [PubMed]

21. Hshieh, T.T.; Yue, J.; Oh, E.; Puelle, M.; Dowal, S.; Travison, T.; Inouye, S.K. Effectiveness of multicomponent nonpharmacological delirium interventions: A meta-analysis. *JAMA Intern. Med.* **2015**, *175*, 512–520. [CrossRef]
22. Silva, M.A.; Nakase-Richardson, R.; Sherer, M.; Barnett, S.D.; Evans, C.C.; Yablon, S.A. Posttraumatic confusion predicts patient cooperation during traumatic brain injury rehabilitation. *Am. J. Phys. Med. Rehabil.* **2012**, *91*, 890–893. [CrossRef] [PubMed]
23. Persico, I.; Cesari, M.; Morandi, A.; Haas, J.; Mazzola, P.; Zambon, A.; Annoni, G.; Bellelli, G. Frailty and Delirium in Older Adults: A Systematic Review and Meta-Analysis of the Literature. *J. Am. Geriatr. Soc.* **2018**, *66*, 2022–2030. [CrossRef] [PubMed]
24. Bindawas, S.M.; Vennu, V.; Moftah, E. Improved functions and reduced length of stay after inpatient rehabilitation programs in older adults with stroke: A systematic review and meta-analysis of randomized controlled trials. *NeuroRehabilitation* **2017**, *40*, 369–390. [CrossRef]
25. Fawcett, J.; Cariello, F.P.; Davis, D.A.; Farley, J.; Zimmaro, D.M.; Watts, R.J. Conceptual models of nursing: Application to critical care nursing practice (continuing education credit). *Dimens. Crit. Care Nurs.* **1987**, *6*, 202–213. [CrossRef] [PubMed]
26. Brady, S.S.; Brubaker, L.; Fok, C.S.; Gahagan, S.; Lewis, C.E.; Lewis, J.; Lowder, J.L.; Nodora, J.; Stapleton, A.; Palmer, M.H. Prevention of Lower Urinary Tract Symptoms (PLUS) Research Consortium. Development of Conceptual Models to Guide Public Health Research, Practice, and Policy: Synthesizing Traditional and Contemporary Paradigms. *Health Promot. Pract.* **2020**, *21*, 510–524. [CrossRef]
27. Ogrinc, G.; Davies, L.; Goodman, D.; Batalden, P.; Davidoff, F.; Stevens, D. SQUIRE 2.0 (Standards for QUality Improvement Reporting Excellence): Revised publication guidelines from a detailed consensus process. *BMJ Qual. Saf.* **2016**, *25*, 986–992. [CrossRef] [PubMed]
28. Nancarrow, S.A.; Booth, A.; Ariss, S.; Smith, T.; Enderby, P.; Roots, A. Ten principles of good interdisciplinary team work. *Hum. Resour. Health* **2013**, *11*, 19. [CrossRef]
29. WHO. International Classification of Functioning. Available online: https://www.cdc.gov/nchs/data/icd/icfoverview_finalforwho10sept.pdf (accessed on 16 April 2024).
30. Rauch, A.; Cieza, A.; Stucki, G. How to apply the International Classification of Functioning, Disability and Health (ICF) for rehabilitation management in clinical practice. *Eur. J. Phys. Rehab. Med.* **2008**, *44*, 329–342.
31. Tempest, S.; McIntyre, A. Using the ICF to clarify team roles and demonstrate clinical reasoning in stroke rehabilitation. *Disabil. Rehabil.* **2006**, *28*, 663–667. [CrossRef] [PubMed]
32. Flyvbjerg, B. Five misunderstadings about case-study research. In *Qualitative Research Practice*; Seale, C., Gobo, G., Gubrium, J., Silverman, D., Eds.; Sage: Riverside County, CA, USA, 2004; pp. 420–434.
33. Lin, K.; Wroten, M. *Ranchos Los Amigos*; StatPearls: Treasure Island, FL, USA, 2022.
34. Keith, R.A.; Granger, C.V.; Hamilton, B.B.; Sherwin, F.S. The functional independence measure: A new tool for rehabilitation. *Adv. Clin. Rehabil.* **1987**, *1*, 6–18. [PubMed]
35. Turner-Stokes, L.; Scott, H.; Williams, H.; Siegert, R. The Rehabilitation Complexity Scale—Extended version: Detection of patients with highly complex needs. *Disabil. Rehabil.* **2012**, *34*, 715–720. [CrossRef] [PubMed]
36. Brown, A.W.; Therneau, T.M.; Schultz, B.A.; Niewczyk, P.M.; Granger, C.V. Measure of functional independence dominates discharge outcome prediction after inpatient rehabilitation for stroke. *Stroke* **2015**, *46*, 1038–1044. [CrossRef] [PubMed]
37. McClure, J.A.; Salter, K.; Meyer, M.; Foley, N.; Kruger, H.; Teasell, R. Predicting length of stay in patients admitted to stroke rehabilitation with high levels of functional independence. *Disabil. Rehabil.* **2011**, *33*, 2356–2361. [CrossRef] [PubMed]
38. Chumney, D.; Nollinger, K.; Shesko, K.; Skop, K.; Spencer, M.; Newton, R.A. Ability of Functional Independence Measure to accurately predict functional outcome of stroke-specific population: Systematic review. *J. Rehabil. Res. Dev.* **2010**, *47*, 17–29. [CrossRef] [PubMed]
39. Feske, S.K. Coma and confusional states: Emergency diagnosis and management. *Neurol. Clin.* **1998**, *16*, 237–256. [CrossRef] [PubMed]
40. Friedland, D.; Swash, M. Post-traumatic amnesia and confusional state: Hazards of retrospective assessment. *J. Neurol. Neurosurg. Psychiatry* **2016**, *87*, 1068–1074. [CrossRef] [PubMed]
41. Worthington, A.; Alderman, N. Neurobehavioural Rehabilitation: A Developing Paradigm. In *Neurobehavioural Disability and Social Handicap Following Traumatic Brain Injury*; McMillan, T., Wood, R., Eds.; Psychology Press: London, UK, 2017.
42. Bogner, J.A.; Corrigan, J.D.; Bode, R.K.; Heinemann, A.W. Rating scale analysis of the Agitated Behavior Scale. *J. Head Trauma. Rehabil.* **2000**, *15*, 656–669. [CrossRef] [PubMed]
43. Rothwell, N.A.; LaVigna, G.W.; Willis, T.J. A non-aversive rehabilitation approach for people with severe behavioural problems resulting from brain injury. *Brain Inj.* **1999**, *13*, 521–533. [CrossRef] [PubMed]
44. Wiart, L.; Luaute, J.; Stefan, A.; Plantier, D.; Hamonet, J. Non pharmacological treatments for psychological and behavioural disorders following traumatic brain injury (TBI): A systematic literature review and expert opinion leading to recommendations. *Ann. Phys. Rehabil. Med.* **2016**, *59*, 31–41. [CrossRef] [PubMed]
45. Giles, G.M.; Radomski, M.V.; Wolf, T.J. Cognition, Cognitive Rehabilitation, and Occupational Performance. *Am. J. Occup. Ther.* **2019**, *73*, 1. [CrossRef]
46. Espernberger, K.R.; Fini, N.A.; Peiris, C.L. Personal and social factors that influence physical activity levels in community-dwelling stroke survivors: A systematic review of qualitative literature. *Clin. Rehabil.* **2021**, *35*, 1044–1055. [CrossRef] [PubMed]
47. Wilcock, A. *An Occupational Perspective of Health*, 2nd ed.; SLACK Incorporated: West Deptford, NJ, USA, 2006.

48. Adams, A.M.N.; Chamberlain, D.; Gronkjaer, M.; Thorup, C.B.; Conroy, T. Caring for patients displaying agitated behaviours in the intensive care unit—A mixed-methods systematic review. *Aust. Crit. Care* **2021**, *35*, 454–465. [CrossRef] [PubMed]
49. Alvarez, E.A.; Garrido, M.A.; Tobar, E.A.; Prieto, S.A.; Vergara, S.O.; Briceno, C.D.; Gonzalez, F.J. Occupational therapy for delirium management in elderly patients without mechanical ventilation in an intensive care unit: A pilot randomized clinical trial. *J. Crit. Care* **2017**, *37*, 85–90. [CrossRef] [PubMed]
50. Beninato, M.; Gill-Body, K.M.; Salles, S.; Stark, P.C.; Black-Schaffer, R.M.; Stein, J. Determination of the minimal clinically important difference in the FIM instrument in patients with stroke. *Arch. Phys. Med. Rehabil.* **2006**, *87*, 32–39. [CrossRef] [PubMed]
51. Carrier, S.L.; Ponsford, J.; Phyland, R.K.; Hicks, A.J.; McKay, A. Effectiveness of Non-Pharmacological Interventions for Agitation during Post-Traumatic Amnesia following Traumatic Brain Injury: A Systematic Review. *Neuropsychol. Rev.* **2022**, *33*, 374–392. [CrossRef] [PubMed]
52. Landry, M.; Moreno, A.; Patry, S.; Potvin, S.; Lemasson, M. Current Practices of Electroconvulsive Therapy in Mental Disorders: A Systematic Review and Meta-Analysis of Short and Long-Term Cognitive Effects. *J. ECT* **2021**, *37*, 119–127. [CrossRef]
53. Haslam, C.; Kessels, R. *Errorless Learning in Neuropsychological Rehabilitation*, 1st ed.; Routledge: London, UK, 2017.
54. Trevena-Peters, J.; McKay, A.; Spitz, G.; Suda, R.; Renison, B.; Ponsford, J. Efficacy of Activities of Daily Living Retraining During Posttraumatic Amnesia: A Randomized Controlled Trial. *Arch. Phys. Med. Rehabil.* **2018**, *99*, 329–337. [CrossRef] [PubMed]
55. Nieuwkamp, D.J.; Setz, L.E.; Algra, A.; Linn, F.H.; de Rooij, N.K.; Rinkel, G.J. Changes in case fatality of aneurysmal subarachnoid haemorrhage over time, according to age, sex, and region: A meta-analysis. *Lancet Neurol.* **2009**, *8*, 635–642. [CrossRef] [PubMed]
56. Claassen, J.; Park, S. Spontaneous subarachnoid haemorrhage. *Lancet* **2022**, *400*, 846–862. [CrossRef] [PubMed]
57. Thompson, J.C.; Chalet, F.X.; Manalastas, E.J.; Hawkins, N.; Sarri, G.; Talbot, D.A. Economic and Humanistic Burden of Cerebral Vasospasm and Its Related Complications after Aneurysmal Subarachnoid Hemorrhage: A Systematic Literature Review. *Neurol. Ther.* **2022**, *11*, 597–620. [CrossRef] [PubMed]