

CONCEPTUAL FRAMEWORK FOR AN EPISODE OF REHABILITATIVE CARE AFTER HIP FRACTURE SURGERY

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ABSTRACT

Researchers face a challenge when evaluating the effectiveness of rehabilitation after hip fracture surgery. Reported outcomes of rehabilitation will vary depending on the endpoint of the episode of care. Evaluation at an inappropriate endpoint may suggest a lack of effectiveness leading to the underuse of rehabilitation which could improve outcomes. The purpose of this paper is to describe a conceptual framework for a continuum-care-episode of rehabilitation after hip fracture surgery. We propose definitions for the index event, endpoint, and service scope of the episode. We discuss challenges in defining the episode of care, operationalizing the episode, and next steps for researchers. The episode described includes all patients eligible for entry to rehabilitation after hip fracture and most functional recovery endpoints. This framework will provide a guide for researchers when designing and interpreting evaluations of the effectiveness of rehabilitation after hip fracture. Evaluation of all potential care episodes facilitates transparency in reporting of outcomes enabling researchers to determine the true effectiveness of rehabilitation after hip fracture surgery.

1. BACKGROUND

1.1 Hip fracture and rehabilitation

A projected 4.5 million people will fracture their hip in 2050.¹ The injury has been dubbed the “hip attack” due to its clinical severity and adverse outcomes.² In spite of treatment, 30% of patients die within a year.³ Among survivors, 25-50% need assistance in walking or never walk again, and 22% transition from independent living to long-term care.⁴⁻⁶ These adverse outcomes reflect the interplay among characteristics of patients, their injury, and their access to medical care, surgery, and rehabilitation.^{7,8}

Rehabilitation assists ‘*individuals who experience disability to achieve and maintain optimal functioning in interaction with their environment*’.⁹ Patients describe access to and delivery of rehabilitation as key to recovery after hip fracture.¹⁰⁻¹⁴ However, the most effective rehabilitation remains unclear.¹⁵⁻²² This is evidenced by limited National Institute for Health and Care Excellence (NICE) guidance,²³ the absence of recent Cochrane systematic reviews, the conclusion *insufficient evidence to recommend practice change* from earlier Cochrane reviews,¹⁹⁻²² and the need for national audit of rehabilitation after hip fracture.²⁴ NICE and the authors of the Cochrane systematic reviews recommended research questions and priority areas for future research on rehabilitation after hip fracture (Table 1).

Table 1: National Institute for Health and Care Excellence and Cochrane systematic review authors recommended research questions and priority areas for future research on rehabilitation after hip fracture.

Source	Research Question/Priority Area
NICE 2017	<i>What is the clinical and cost effectiveness of additional intensive physiotherapy and/or occupational therapy (for example progressive resistance training) after hip fracture?</i>
NICE 2017	<i>Do patients admitted to hospital with a fractured hip who live permanently in a care/nursing home have equal access to multidisciplinary rehabilitation as patients admitted from their own homes?</i>
Smith et al 2015; Handoll et al 2011	<i>Identify the optimal model of rehabilitation after hip fracture to improve outcomes for patients with dementia.</i>

Handoll et al 2011	<i>Identify the optimal method to enhance long-term mobility after hip fracture.</i>
Handoll et al 2009; Handoll et al 2011	<i>Determine whether differing responses to rehabilitation occur among different subgroups of patients with hip fracture.</i>
Crotty et al 2010	<i>Identify the optimal timing, duration, setting, and administering discipline(s) of rehabilitation after hip fracture across care settings.</i>
Handoll et al 2009	<i>Determine the effectiveness and cost effectiveness of multidisciplinary rehabilitation overall, rather than evaluate its component parts.</i>

64 **1.2 Episode of care**

65 There is currently no framework which specifies the appropriate start, duration, and endpoint
66 of rehabilitation after hip fracture. Therefore, researchers face a challenge when designing
67 and interpreting evaluations of the effectiveness of rehabilitation after hip fracture surgery. In
68 particular, evaluation at an inappropriate time may suggest lack of effectiveness leading to
69 the underuse of rehabilitation which could improve outcomes.²⁵

70 Since the early 1960's, researchers have used *episodes of care* to identify and evaluate a set
71 of services provided to treat a clinical condition.²⁶ This episode of care is often embedded in
72 a broader *episode of illness* which may include multiple episodes of care as well as
73 environmental and cultural dimensions of the illness.²⁵ Researchers must define three key
74 elements when constructing an episode of care – the index event (start), scope of services and
75 endpoint (acute- or continuum- care) (Table 2). These three elements are customized based
76 on the objectives of a research study and the nature of a health condition under examination.²⁵

77 **Table 2:** Definition, purpose, and surgical care example for terms used in the construction of
78 episodes of care.

Term	Definition	Purpose	Surgical Care Example
Episode of care	A set of health services provided to treat a clinical condition. ²⁶	To evaluate health services provided to treat a clinical condition.	Acute care following hip fracture.
Index event	The event that triggers the start of an episode of care.	To define the point from which services	Admission to hospital.

		are considered by an evaluation.	
		To identify the population for the evaluation.	
Endpoint	The event that triggers the end of an episode of care.	To define the point after which services are no longer considered by an evaluation.	Discharge from hospital.
		To define the point for measuring outcomes of the services.	
Scope of services	Services considered part of treatment for a clinical condition.	The service scope will depend on the needs of individual patients, the exposure*-outcome relationship under evaluation, and available data.	Surgical repair of hip fracture completed during hospital stay.
Episode of illness	Healthcare, environmental, and cultural dimensions of a clinical condition. May include multiple episodes of care. ²⁵	To evaluate the aetiology of illness.	Malnutrition.
Acute care episode	Tracks patients from acute hospital admission to discharge.	To evaluate services received during acute hospital stay.	Follows patients with hip fracture from acute hospital admission to acute hospital discharge.
Continuum care episode	Follows patients through an array of health services spanning different levels and intensity of care.	To evaluate all services related to the index event.	Follows patients with hip fracture from acute hospital admission to post-acute services (e.g. until 6-week outpatient orthopaedic follow-up).

*intervention or independent variable of interest

In the current context, the episode of care reflects services related to rehabilitation after hip fracture surgery. Yet, there is no framework outlining an appropriate index event, scope of services, and endpoint of the episode of care. Previous studies of rehabilitation after hip fracture surgery have predominantly adopted an acute-care episode using discharge from

hospital as the episode endpoint.²¹ This approach restricts outcomes to those which occur in-hospital, implying that rehabilitation ends at the point of discharge despite the fact that most patients go on to receive post-acute rehabilitation. Further, discharge from acute care is often driven by reducing acute length of hospital stay rather than rehabilitation outcome.²⁷ For these reasons, a continuum-care episode which follows patients through an array of health services spanning different levels and intensity of care ending with a rule or after a prespecified duration of time may be a more appropriate means to capture the true outcome of rehabilitation after hip fracture surgery.

The service scope and patient populations available for study differ depending on the episode endpoint. An acute-care episode offers a degree of homogeneity in rehabilitation services as all patients in higher income countries receive early mobilisation and daily physiotherapy during their inpatient stay irrespective of their length of stay or treatment location.^{23,28} This approach also enables an evaluation of the full benefit of acute rehabilitation after hip fracture by including all patients who undergo hip fracture surgery. A continuum-care episode presents more challenges when assessing the benefits of rehabilitation since there will be heterogeneity among subgroups of patients selected for services along different care pathways, with service and patient selection varying between locations.²⁹⁻³¹

Despite these challenges, continuum-care episodes are defined for other fields of specialist rehabilitation, for example, cardiac and stroke rehabilitation.^{32,33} Therefore, the **purpose** of this paper is to describe a conceptual framework for a continuum-care episode of rehabilitation after hip fracture. We propose definitions for the index event, service scope, and endpoint of the episode. This framework will provide a guide for researchers when designing and interpreting evaluations of the effectiveness of rehabilitation after hip fracture.

2. CONCEPTUAL FRAMEWORK

2.1 Index event

Surgery to repair hip fracture is the index event that triggers the start of the care episode (Figure 1). The selection of surgery as the index event, rather than the fracture itself, excludes between 2% and 6% of patients who do not undergo surgery after hip fracture.^{34,35} In higher income countries, non-surgical patients are often non-ambulatory or deemed unfit for surgery.^{36,37} These patients are often treated palliatively with a focus on quality of life and symptom control with different expected outcomes than patients treated surgically.^{37,38}

2.2 Endpoint

The endpoint of a rehabilitation continuum-care-episode may be triggered by a decision rule, a predetermined time window, or a healthcare event.²⁵

2.2.1 Decision rule

A logical episode endpoint is recovery from hip fracture. Recovery may be categorized as *from fracture*, or *functional*.³⁹ Recovery from fracture is achieved with fixation and bone healing, or arthroplasty.⁴⁰ Functional recovery is less clearly defined. Early studies described functional recovery in the context of survival whereby recovery is considered an alternative to death.⁴¹ In this case *recovery from fracture* and *functional recovery* may be used interchangeably for an episode endpoint. However, ensuring survival to fracture repair is not the only important endpoint, especially for older adults who value the quality as well as quantity of survival time.⁴² A similar construct was operationalized for quantifying the burden of disease in the form of the Disability-Adjusted Life Year (DALY) – the sum of years of life lost due to premature death and years of life lost due to disability.⁴³ In the current context, to ensure value from rehabilitation a functional recovery endpoint should reflect survival as well as additional dimensions of recovery.

Patients, caregivers, and therapists describe additional dimensions of functional recovery as *getting back to normal* or *back to baseline* (Figure 1).⁴⁴ Therapists often adopt a traditional biomedical model to define baseline as the attainment of prefracture physical dimensions of function (gait, balance, activities of daily living) (Figure 2).^{39,45,46} Patients and caregivers adopt a more personal definition, which incorporates the importance to individuals of functioning well physically for both affective (cognitive function, depressive symptoms, post-traumatic stress) and social participation (loneliness, instrumental activities of daily living, relationships) dimensions of their functional recovery (Figure 2).^{39,47,48} This is consistent with the World Health Organization (WHO) approach to healthy ageing as having the functional ability to be or to do what the individual has reason to value.⁴⁹ Further, Griffiths et al. recently reported that patients with hip fracture considered functional recovery as “*stable mobility (without falls or fear of falls) for valued activities*”.⁴⁸

In current practice, patients often achieve a level of functional recovery better than simply avoiding death but not back to baseline.⁴⁻⁶ It is not clear whether failure to attain baseline function is due to access and delivery of medical care, surgery, and rehabilitation, or to characteristics of the patient and their injury.^{8,50} For the latter *back to baseline* may not be a feasible endpoint. In this case rehabilitation may be considered a re-adaptive process, where the patient adapts his/her set of values to a different, more restricted life situation – their new baseline.⁵¹

2.2.2 Time window

Completion of a predefined time window can trigger the end of a rehabilitation continuum-care-episode.

The time window may be defined as completion of a fixed period from the episode index event. This endpoint is commonly used for clinical and cost effectiveness evaluation that

seeks to compare outcomes across locations that have different discharge practices.²⁵

However, the optimal duration of this period is unclear. In the US, a new episode of care, Surgical Hip and Femur Fracture Treatment Model, will take effect in January 2018. Under this episode providers pay for acute inpatient hospital services and post-acute services within 90 days.⁵² The 90-day window was selected after cost evaluation indicated “*significant services related to the clinical condition that is the focus of the model [hip fracture] occurred during days 31-90*”.⁵² However, patterns of recovery vary by dimension.³⁹ Recovery of most dimensions show a lessening of dependence in the first 12 months.³⁹ Therefore, the UK’s National Institute for Health and Care Excellence (NICE) guideline and the Canadian National Hip Fracture Toolkit support a longer window of 12-months suggesting that changes in health state after 12 months are no longer influenced by their hip fracture.^{23,53}

The time window may also be defined as completion of a fixed period where no improvement in patient function is observed. This endpoint is sometimes described as *reached recovery potential* or a *plateau* in recovery. A recent US survey noted more than 50% of physiotherapists fail to use standardized outcome measures to inform their care plan.⁵⁴

Therefore, for many patients a plateau endpoint may be motivated by a therapist’s previous experience or by finite health care resources rather than an objective measure of recovery.^{47,55-57} However, in non-clinical populations, a performance plateau is not indicative of a lack of capacity for further gain.⁵⁸ Indeed, an observed plateau may be a temporary cessation in recovery rather than an outcome (Figure 3).⁵⁵ This plateau may be overcome by changes in the dose, timing, and composition of rehabilitation which the therapist can offer.⁵⁵ For older adults, a plateau may also reflect functional gains mitigated by declining function associated with other diseases or ageing.⁵⁰ Therefore, termination of rehabilitation may lead to accelerated decline for these patients. To minimize harm from potential underuse of rehabilitation, a follow-up reassessment should be scheduled for patients whose episode is

ended after failure to overcome an objectively measured plateau despite changes in rehabilitation parameters.^{32,33} in recovery.

Alternatively, a time window may be defined by a clean period where no services related to the episode are provided. A clean period is more consistent with episodes for chronic conditions whereby patients enter symptom-free periods or periods of remission.²⁵

2.2.3 Healthcare events

A patient's death will trigger the end of a rehabilitation continuum-care-episode. Healthcare events which also trigger the end of a rehabilitation continuum-care-episode include a transfer to palliative care, readmission for complications, readmission for revision surgery, or the start of a new unrelated episode of care (Figure 1).⁵⁹ The assessment, treatment and management of these healthcare events is prioritized over rehabilitation after hip fracture. The patient may enter a new continuum-care-episode of rehabilitation following their healthcare event. The occurrence of a healthcare event may influence the change of functional recovery. Indeed, mortality is higher following second hip fracture.⁵⁹ Therefore, this episode should be defined by the healthcare event or as a subsequent rehabilitation episode.

2.3 Scope of Services

A Cochrane systematic review points to the need to evaluate rehabilitation as a whole rather than its component parts.²¹ The continuum-care-episode of rehabilitation supports the inclusion of all relevant healthcare services following hip fracture surgery, which may be delivered across multiple care settings, numerous individual providers, and up to 1-year postoperatively. The specific scope of services, settings, and providers will depend on the exposure (intervention/independent variable) - outcome relationship under evaluation, available data, as well as the needs of individual patients as they relate to services.²⁵ Here we

204 discuss acute and post-acute rehabilitation services as well as secondary prevention services
205 delivered during rehabilitation.

206 Acute rehabilitation is more homogenous than other components of the rehabilitation care
207 episode whereby all patients who undergo hip fracture surgery in higher income countries
208 enter the rehabilitation service by default irrespective of treating location. The processes and
209 duration of the service may vary. Indeed, the average postoperative acute length of stay was
210 five days in the United States compared to 34 days in Japan.⁶⁰ The episode ends during acute
211 rehabilitation only if a patient is transferred to palliative care, dies in hospital, or recovers
212 their baseline function. Most patients' episode will progress to some form of post-acute
213 rehabilitation services (Figure 4).

214 Post-acute rehabilitation is more heterogeneous whereby services and patients selected for
215 entry vary by treating location. Evidence from the United States, England, and Canada
216 suggests there is variation, even within a single health region, in the proportion of patients
217 that are immediately discharged to each post-acute service such as inpatient rehabilitation,
218 outpatient rehabilitation, home-based rehabilitation or long-term care rehabilitation (Figure
219 4).^{29,30,61,62} Depending on their recovery status, patients may transition between several post-
220 acute services as they progress towards the end of their continuum-care-episode of
221 rehabilitation. In one Canadian province, Pitzul et al. noted 49 distinct post-acute patient
222 pathways in the first year postfracture.²⁹ Moreover, these pathways are frequently changing in
223 response to healthcare reform (e.g. restructuring of primary health care services⁶³). The
224 variation coupled with changing post-acute pathways present substantial challenges for
225 researchers when attempting to evaluate the effectiveness of post-acute rehabilitation after
226 hip fracture surgery.

Secondary prevention services are incorporated into the continuum-care-episode after hip fracture surgery. Processes of secondary prevention may begin within the acute care setting. Post-acute services may include fracture liaison services (services who case-find patients with fragility fractures at risk of osteoporosis),⁶⁴⁻⁶⁶ falls clinics,^{67,68} or the prescription of osteoporosis medication.⁶⁹ A truly comprehensive episode might even include services beyond those delivered by health-care providers. For example, it may be ideal to also include social care services which enable increased physical activity in the community.

3. DISCUSSION

3.1 Main findings

The extent to which outcomes of hip fracture surgery may be attributed to rehabilitation depends on the scope and endpoint of the episode. Here we describe a conceptual framework for constructing a rehabilitation continuum-care-episode. We identified surgery as the index event. We identified baseline, 1-year postoperatively, no improvement in recovery, or a healthcare event, whichever comes first as the episode endpoint. We suggest service scope should incorporate acute rehabilitation, post-acute rehabilitation, and secondary prevention.

3.2 Operationalizing the framework

The index event, service scope, and endpoints *time frame* and *healthcare event* may be operationalized using existing data sources (Table 3). For the additional endpoints *baseline* and *no improvement in recovery* proxy measures in existing data sources include return to preadmission residence and presence of a long-term follow-up reassessment respectively (Table 3).

Table 3: Element, conceptual and operational frameworks for episode of rehabilitation after hip fracture.

Element	Conceptual framework	Operational framework
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Index event	Surgery for hip fracture	Procedure code for surgery after hip fracture
Endpoint	(i) Baseline	Return to preadmission residence (proxy) <i>Need to identify core outcome set inclusive of patient reported outcome and experience measures</i>
	(ii) Time frame	1 year after the procedure date
	(iii) No improvement in recovery	Presence of long-term follow-up reassessment (proxy) <i>Need to determine duration of fixed period with no improvement in recovery after which to end the episode</i>
	(iv) Healthcare event	Code for death, transfer to palliative care, or admission to acute care
Service scope	Acute and postacute rehabilitation, and secondary prevention	Unique patient identifier to link data from the index event acute hospital stay to postacute rehabilitation and secondary prevention services

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251 We described the multifaceted nature of *back to baseline* as an episode endpoint. There is a
252 need to determine how best to measure the physical, affective and social dimensions of this
253 endpoint. There is no consensus on a core outcome set for evaluation of current and/or new
254 interventions after hip fracture. In 2014, Haywood et al. recommended 5 core outcome
255 measures for hip fracture trials - mortality, pain, activities of daily living, mobility, and
256 quality of life.⁷⁰ They suggested single-item measures of mortality and mobility
257 (indoor/outdoor walking status) and the EQ-5D as a minimum for all hip fracture trials.⁷⁰
258 This is less comprehensive than the 12 core outcomes for evaluation of orthogeriatric co-
259 management for hip fractures (mortality, pain, activities of daily living (Barthel Index),
260 mobility (Parker Mobility Score and the Timed Up and Go), quality of life, length of stay,
261 time to surgery, complications, re-admission rate, medication use, place of residence, costs).⁷¹
262 Consensus may lie somewhere between the two recommendations -to avoid burden of
263 assessment while collecting sufficient data for evaluation.

We highlighted *back to baseline* may not be a feasible endpoint for all patients after hip fracture. It is difficult to capture a ‘new baseline’ which represents a more restricted life situation using objective outcome measurement (as it is not possible to differentiate a ‘new baseline’ from a lack of effectiveness). Therefore, we suggest patient reported outcome measures and patient reported experience measures should be incorporated into the evaluation of rehabilitation after hip fracture surgery.⁷² These measures will help to identify two patient groups - those who present with ‘new baseline’ and who were 1) satisfied with their outcome and rehabilitation experience or 2) were dissatisfied with their outcome and rehabilitation experience. We may cautiously interpret these two groups as those with a ‘new baseline’ and those who received ineffective rehabilitation.

The endpoint *no improvement in recovery* presents even greater challenges. It is not clear whether it is feasible to define a fixed period after which to end an episode of care for rehabilitation after hip fracture for all patients. There is large heterogeneity in characteristics of the patient and their injury at baseline. This may lead to differing responses to rehabilitation among different subgroups of patients with hip fracture.^{20,21}

3.3 Next steps

Since the early 1960’s, researchers have used episodes of care to frame analyses of administrative and registry data.²⁶ External bodies standardize collection of this data which occurs at regular intervals. Researchers have no (or limited) control over which data is collected. Historically, most of these databases have not included data related to rehabilitation exposures and outcomes limiting their utility for rehabilitation research. Exposures focused predominantly on structures such as composition of the multidisciplinary team and staffing levels, and outcomes included length of stay and discharge destination.^{30,73} In 2010 Porter argued that “*achieving high value for patients must become the overarching goal of health*

care delivery".⁴² Since this time national registries have begun to incorporate rehabilitation process exposures such as timing of first mobilisation, and outcomes including the Cumulated Ambulation Score and the EQ-5D.^{35,74} In 2018, a national audit of physiotherapy after hip fracture demonstrated variation in the frequency, type and duration of rehabilitation, as well as community waiting times and handover across services in the UK.²⁴ We anticipate an increase in the availability of rehabilitation process and outcome measures in administrative and registry data in the coming years.

This paper represents a first step to prepare researchers for future evaluations of these data. If operationalized the care episode will enable evaluation of the effectiveness of rehabilitation after hip fracture surgery across the continuum care episode. It will help to inform clinicians and policymakers as to when rehabilitation is more/less effective along the care-continuum. Finally, the framework will help researchers to better design and implement evaluations to address evidence gaps highlighted by NICE and Cochrane systematic reviews.¹⁹⁻²³

4. CONCLUSION

To conclude, we constructed a continuum-care episode to guide researchers when designing and interpreting evaluations of rehabilitation after hip fracture. The episode described includes all patients eligible for entry to rehabilitation after hip fracture and most potential functional recovery endpoints. Evaluation of all potential care episodes facilitates transparency in reporting of outcomes enabling researchers to determine the true effectiveness of rehabilitation after hip fracture surgery.

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FIGURE LEGENDS

508 **Figure 1:** Conceptual framework for rehabilitation *continuum-care-episode* after hip
509 fracture surgery.

510 * readmission for complications, readmission for revision surgery, or the start of a new
511 unrelated episode of care.

512 **Figure 2:** Defining back to baseline from patient and caregiver, and therapist
513 perspective.

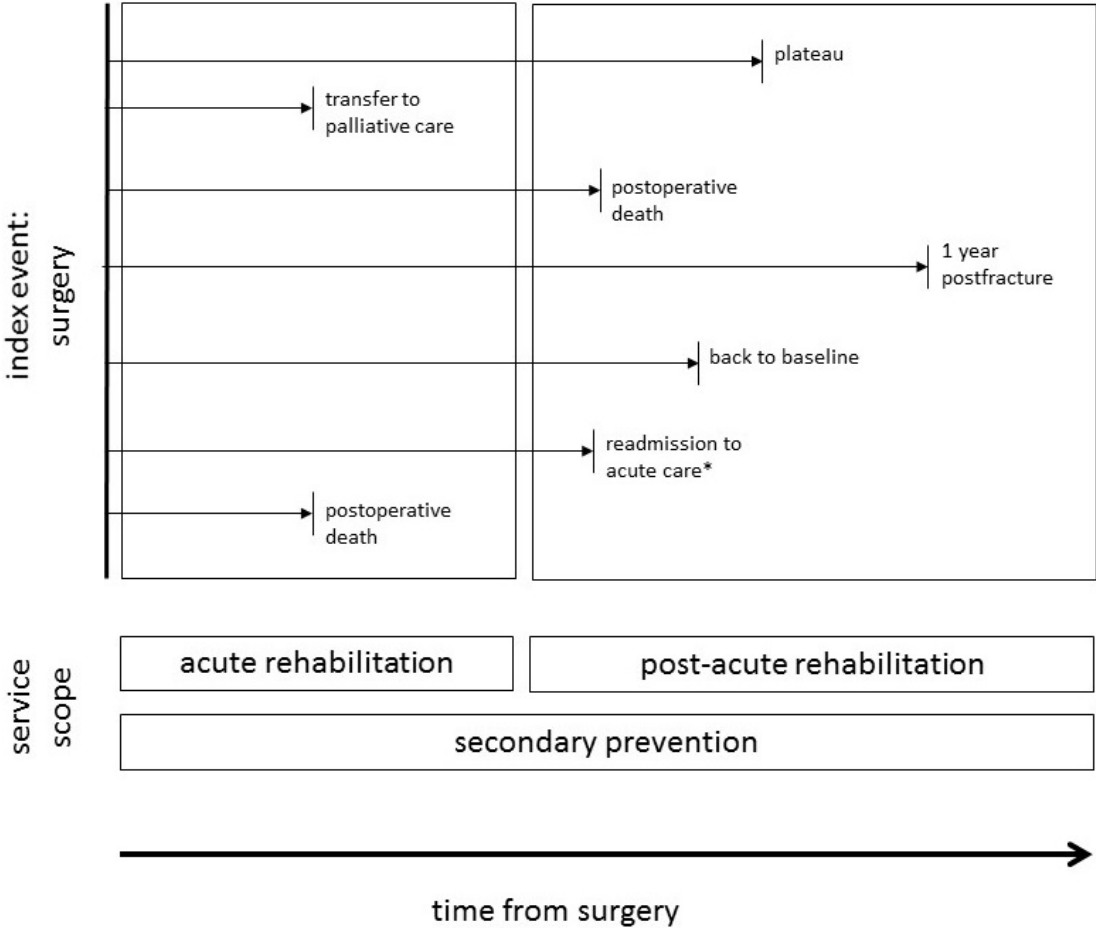
514 **Figure 3:** Plateau as an episode endpoint.

515 **Figure 4:** Expanded service scope of conceptual framework for *continuum-care* episode of
516 rehabilitation after hip fracture surgery.

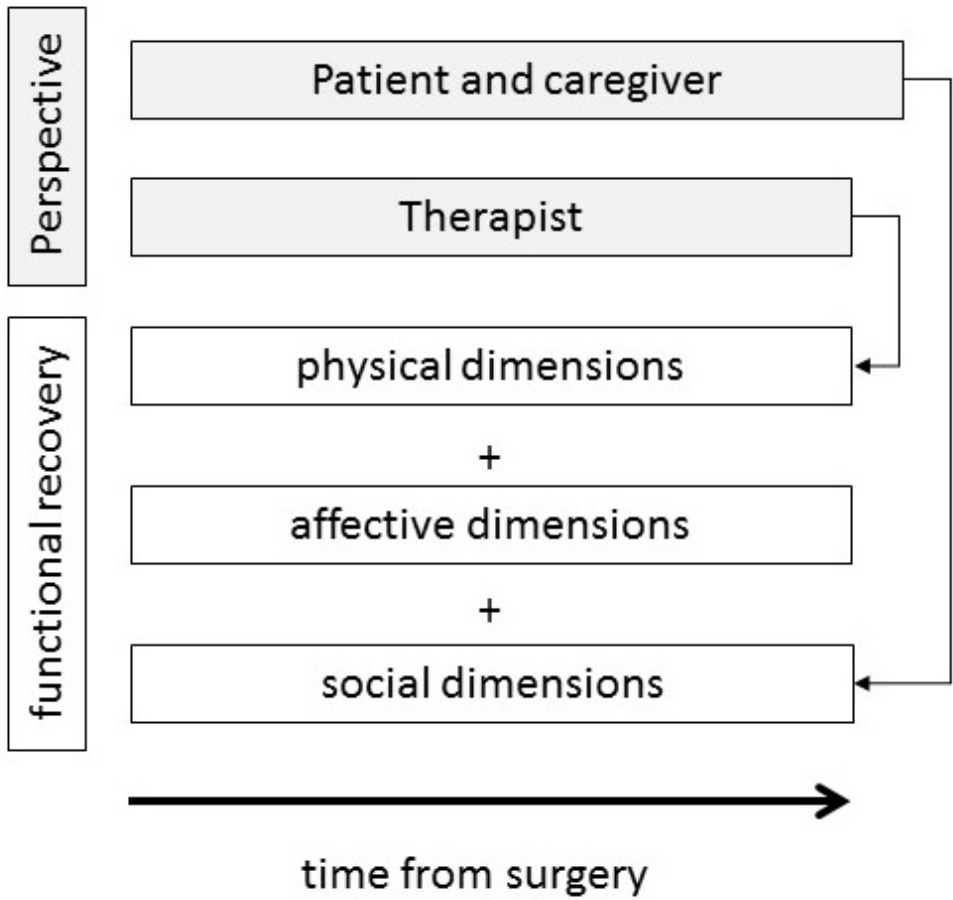
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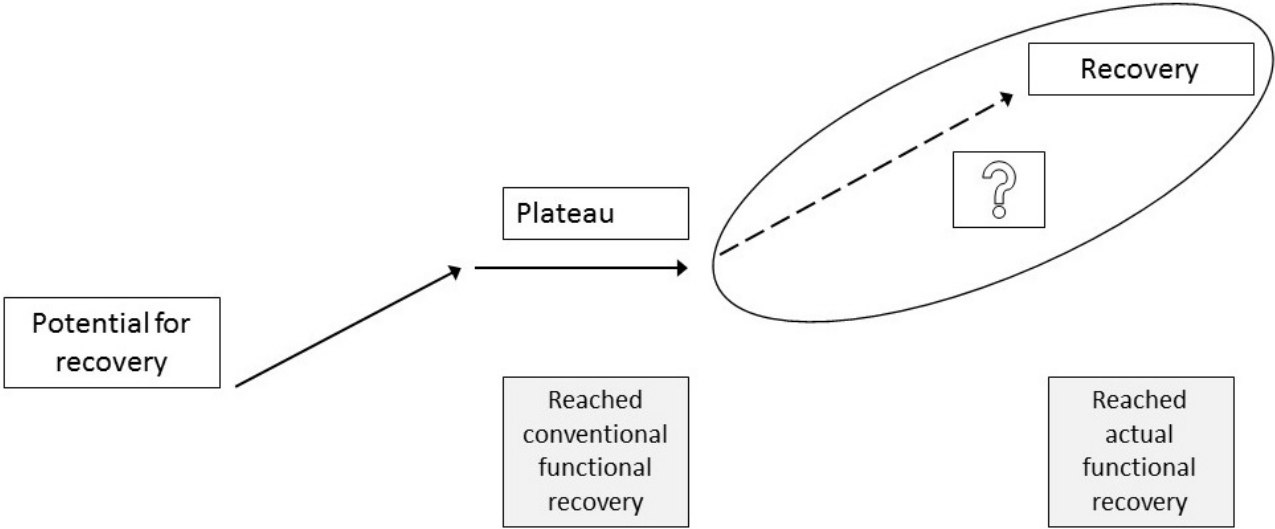
FIGURES

518 Figure 1

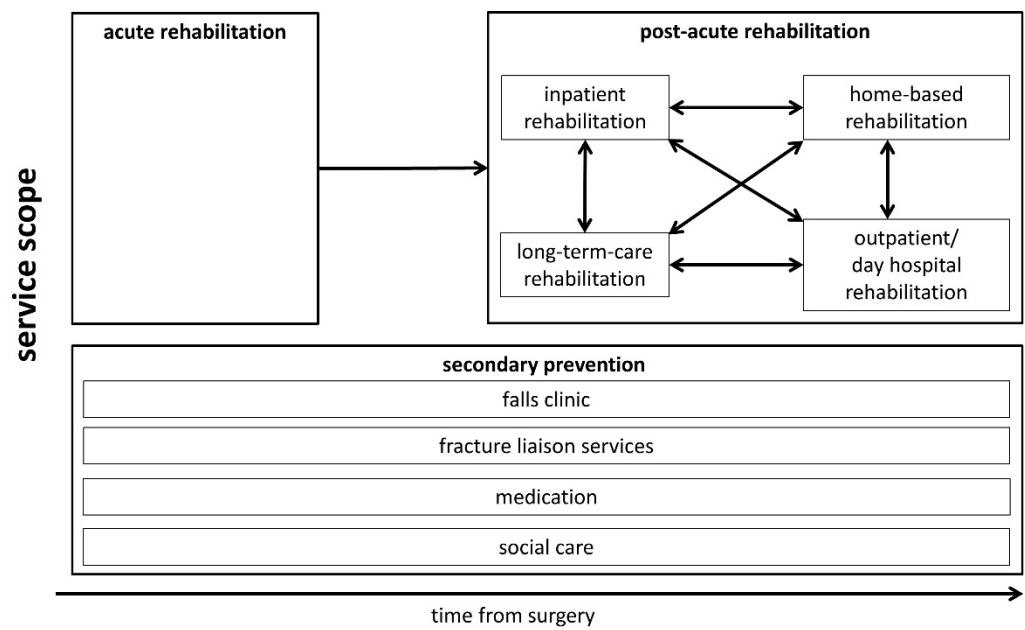


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524 Figure 4



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