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

Sheehan KJ,^{1*} Smith TO,² Martin FC,³ Johansen A,⁴ Drummond A,⁵ Beaupre L,⁶
Magaziner J,⁷ Whitney J,¹ Hommel A,⁸ Cameron ID,⁹ Price I,¹⁰ Sackley C¹

¹ Department of Population Health Sciences, School of Population Health and Environmental Sciences, King's College London, London, United Kingdom

² School of Health Sciences, University of East Anglia, Norwich, United Kingdom

³ Medical Gerontology, King's College London, London, United Kingdom

⁴ Trauma Unit, University Hospital of Wales, Cardiff, United Kingdom

⁵ School of Health Sciences, University of Nottingham, Nottingham, United Kingdom

⁶ Departments of Physical Therapy and Division of Orthopaedic Surgery, University of Alberta, Edmonton, Canada

⁷ Department of Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore, United States of America

⁸ Faculty of Health and Society, Malmö University, Sweden

⁹ John Walsh Centre for Rehabilitation Research, Kolling Institute of Medical Research, University of Sydney, Australia

¹⁰ Patient and carer representative, Royal College of Physicians Patient and Carer Network, London, United Kingdom

*Corresponding author:

Katie Jane Sheehan
Department of Population Health Sciences,
School of Population Health and Environmental Sciences,
King's College London
5th Floor Addison House,
Guy's Campus,
London, SE1 1UL
Email addresses: katie.sheehan@kcl.ac.uk

30 **ABSTRACT**

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

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1. BACKGROUND

49 1.1 Hip fracture and rehabilitation

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

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

65 **Table 1:** National Institute for Health and Care Excellence and Cochrane systematic review
 66 authors recommended research questions and priority areas for future research on
 67 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>

68 **1.2 Episode of care**

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

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

81 **Table 2:** Definition, purpose, and example of **hip fracture surgery** for terms used in the
82 construction of episodes of care.

Term	Definition	Purpose	Example: hip fracture surgery
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 inpatient health care services following admission for hip fracture surgery.

Index event	The event that triggers the start of an episode of care.	To define the point from which services are considered by an evaluation. To identify the population for the evaluation.	Admission to acute inpatient care.
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. To define the point for measuring outcomes of the services.	Discharge from acute inpatient care.
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 acute inpatient stay.
Episode of illness	Healthcare, environmental, and cultural dimensions of a clinical condition. May include multiple episodes of care. ²⁵	To describe the trajectory of health, environmental and cultural dimensions of a clinical condition.	Malnutrition.
Acute care episode	Tracks patients from acute inpatient admission to discharge.	To evaluate services received during acute inpatient stay.	Follows patients with hip fracture from acute inpatient admission to acute inpatient 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 inpatient admission to post-acute services (e.g. until 6-week outpatient orthopaedic follow-up).

83 *intervention or independent variable of interest

84 In the current context, the episode of care reflects services related to rehabilitation after hip

85 fracture surgery. Yet, there is no framework outlining an appropriate index event, scope of

86 services, and endpoint of the episode of care. Previous studies of rehabilitation after hip

87 fracture surgery have predominantly adopted an acute-care episode using discharge from
88 hospital as the episode endpoint.²¹ This approach restricts outcomes to those that occur in-
89 hospital, implying that rehabilitation ends at the point of discharge despite the fact that most
90 patients go on to receive post-acute rehabilitation. Further, discharge from acute care is often
91 driven by reducing acute length of hospital stay rather than rehabilitation outcome.²⁷ For
92 these reasons, a continuum-care episode that follows patients through an array of health
93 services spanning different levels and intensity of care ending with a rule or time window
94 may be a more appropriate means to capture the true outcome of rehabilitation after hip
95 fracture surgery. Continuum-care episodes have been successfully defined for other fields of
96 specialist rehabilitation, for example, cardiac and stroke rehabilitation.^{28,29}

97 Therefore, the purpose of this paper is to describe a conceptual framework for a continuum-
98 care episode of rehabilitation after hip fracture. We propose definitions for the index event,
99 service scope, and endpoint of the episode. This framework will provide a guide for
100 researchers when designing and interpreting evaluations of the effectiveness of rehabilitation
101 after hip fracture.

102 **2. CONCEPTUAL FRAMEWORK**

103 **2.1 Index event**

104 Surgery to repair hip fracture is the index event that triggers the start of the care episode
105 (Figure 1). The selection of surgery as the index event, rather than the fracture itself, excludes
106 between 2% and 6% of patients who do not undergo surgery after hip fracture.^{30,31} In higher
107 income countries, non-surgical patients are often non-ambulatory or deemed unfit for
108 surgery.^{32,33} These patients are often treated palliatively with a focus on quality of life and
109 symptom control with different expected outcomes than patients treated surgically.^{33,34}

110 **2.2 Endpoint**

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

113 **2.2.1 Decision rule**

114 A logical episode endpoint is recovery from hip fracture. Recovery may be categorized as
115 *from fracture*, or *functional*.³⁵ Recovery *from fracture* is achieved with fixation and bone
116 healing, or arthroplasty.³⁶ *Functional recovery* is less clearly defined. Early studies described
117 functional recovery in the context of survival whereby recovery is considered an alternative
118 to death.³⁷ In this case *recovery from fracture* and *functional recovery* may be used
119 interchangeably for an episode endpoint. However, ensuring survival to fracture repair is not
120 the **only** important endpoint, especially for older adults who value the quality as well as
121 quantity of survival time.³⁸ A similar construct was operationalized for quantifying the
122 burden of disease in the form of the Disability-Adjusted Life Year (DALY) – the sum of
123 years of life lost due to premature death and years of life lost due to disability.³⁹ In the current
124 context, to ensure value from rehabilitation a functional recovery endpoint should reflect
125 survival as well as additional dimensions of recovery.

126 Patients, caregivers, and therapists describe additional dimensions of functional recovery as
127 *getting back to normal* or *back to baseline* (Figure 1).⁴⁰ Therapists often adopt a traditional
128 biomedical model to define return to baseline as the attainment of prefracture physical
129 dimensions of function (gait, balance, activities of daily living) (Figure 2).^{35,41,42} Patients
130 and caregivers adopt a more personal definition, which incorporates the importance to
131 individuals of functioning well physically, instrumentally, cognitively, affectively and
132 socially (Figure 2).^{35,43,44} This is consistent with the World Health Organization (WHO)
133 approach to healthy ageing as having the functional ability to be or to do what the individual

134 has reason to value.⁴⁵ Further, Griffiths et al. recently reported that patients with hip fracture
135 considered functional recovery as “*stable mobility (without falls or fear of falls) for valued*
136 *activities*”.⁴⁴

137 In current practice, patients often achieve a level of functional recovery better than simply
138 avoiding death but not back to baseline.⁴⁻⁶ It is not clear whether failure to attain baseline
139 function is due to access and delivery of medical care, surgical care, and rehabilitation, or to
140 characteristics of the patient and their injury.^{8,46} *Back to baseline* may not be a feasible
141 endpoint where characteristics of the patient and their injury limit recovery. Indeed, some
142 patients report they do not expect to return to their baseline function.^{43,47} In this case
143 rehabilitation may be considered a re-adaptive process, where the patient adapts his/her set of
144 values to a different, more restricted life situation – their new baseline.⁴⁸

145 **2.2.2 Time window**

146 Completion of a predefined time window could trigger the end of a rehabilitation continuum-
147 care-episode.

148 The time window may be defined as completion of a fixed period from the episode index
149 event. This endpoint is commonly used for clinical and cost effectiveness evaluation that
150 seeks to compare outcomes across locations that have different discharge practices.²⁵

151 However, the optimal duration of this period is unclear. In the US, a new episode of care,
152 Surgical Hip and Femur Fracture Treatment Model, took effect in January 2018. Under this
153 episode providers pay for acute inpatient hospital services and post-acute services within 90
154 days.⁴⁹ The 90-day window was selected after cost evaluation indicated “*significant services*
155 *related to the clinical condition that is the focus of the model [hip fracture] occurred during*
156 *days 31-90*”.⁴⁹ However, patterns of recovery vary by dimensions of functional recovery
157 (physical, instrumental, cognitive, affective and social).³⁵ Recovery of most dimensions show

158 a lessening of dependence in the first 6-12 months.³⁵ Therefore, the UK's National Institute
159 for Health and Care Excellence (NICE) guideline and the Canadian National Hip Fracture
160 Toolkit support a longer window of 12-months suggesting that changes in health state after
161 12 months are no longer influenced by their hip fracture.^{23,50}

162 The time window may also be defined as completion of a fixed period where no improvement
163 in patient function is observed. This endpoint is sometimes described as *reached recovery*
164 *potential* or a *plateau* in recovery. A US survey noted more than 50% of physiotherapists fail
165 to use standardized outcome measures to inform their care plan.⁵¹ Therefore, for many
166 patients a plateau endpoint may be motivated by a therapist's previous experience or by finite
167 health care resources rather than an objective measure of recovery.^{43,52-54} However, in non-
168 clinical populations, a performance plateau is not indicative of a lack of capacity for further
169 gain.⁵⁵ Indeed, an observed plateau may be a temporary cessation in recovery rather than an
170 outcome (Figure 3).⁵² This plateau may be overcome by changes in the dose, timing, and
171 composition of rehabilitation which the therapist can offer.⁵² For older adults, a plateau may
172 also reflect functional gains mitigated by declining function associated with other diseases or
173 ageing.⁴⁶ Therefore, termination of rehabilitation may lead to accelerated decline for these
174 patients. To minimize harm from potential underuse of rehabilitation, a follow-up
175 reassessment should be scheduled for patients whose episode is ended after failure to
176 overcome an objectively measured plateau despite changes in rehabilitation parameters.^{28,29}

177 Alternatively, a time window may be defined by a clean period where no services related to
178 the episode are provided. This period may be defined by local protocol and is more consistent
179 with episodes for chronic conditions whereby patients enter symptom-free periods or periods
180 or remission.²⁵

181 **2.2.3 Healthcare events**

182 A patient's death will trigger the end of a rehabilitation continuum-care-episode. Healthcare
183 events which also trigger the end of a rehabilitation continuum-care-episode include a
184 transfer to palliative care, readmission to hospital for complications, readmission for revision
185 surgery, or the start of a new unrelated episode of care (Figure 1).⁵⁶ The assessment,
186 treatment and management of these healthcare events is prioritized over rehabilitation after
187 hip fracture. The patient may enter a new continuum-care-episode of rehabilitation following
188 their healthcare event. The occurrence of a healthcare event may influence the change of
189 functional recovery. Indeed, mortality is higher following second hip fracture.⁵⁶ Therefore,
190 this episode should be defined by the healthcare event or as a subsequent rehabilitation
191 episode.

192 **2.3 Scope of Services**

193 A Cochrane systematic review points to the need to evaluate all components of rehabilitation
194 together rather than its component parts.²¹ The continuum-care-episode of rehabilitation
195 supports the inclusion of all relevant healthcare services following hip fracture surgery,
196 which may be delivered across multiple care settings, and numerous individual providers.
197 The specific scope of services, settings, and providers will depend on the exposure
198 (intervention/independent variable) - outcome relationship under evaluation, available data,
199 as well as the needs of individual patients as they relate to services.²⁵ Here we discuss acute
200 and post-acute rehabilitation services as well as secondary prevention services delivered
201 during rehabilitation.

202 Access to acute rehabilitation is more homogenous than other components of the
203 rehabilitation care episode whereby all patients who undergo hip fracture surgery in higher
204 income countries enter the rehabilitation service by default irrespective of treating country.

205 While most patients in high-income countries will receive early mobilisation and daily
206 physiotherapy during their inpatient stay,^{23,57} additional processes and duration of the service
207 may vary. Indeed, the average postoperative acute length of stay was five days in the United
208 States compared to 34 days in Japan.⁵⁸ The episode ends during acute rehabilitation only if a
209 patient is transferred to palliative care, dies in hospital, or recovers their baseline function.
210 Most patients' episode will progress to some form of post-acute rehabilitation services
211 (Figure 4).

212 Access to post-acute rehabilitation is more heterogeneous whereby services and patients
213 selected for entry vary by treating location. Evidence from the United States, England, and
214 Canada suggests there is variation, even within a single health region, in the proportion of
215 patients that are immediately discharged to each post-acute service such as inpatient
216 rehabilitation, outpatient rehabilitation, home-based rehabilitation or long-term care
217 rehabilitation (Figure 4).⁵⁹⁻⁶³ Depending on their recovery status, patients may transition
218 between several post-acute services as they progress towards the end of their continuum-care-
219 episode of rehabilitation. In one Canadian province, Pitzul et al. noted 49 distinct post-acute
220 patient pathways in the first year postfracture.⁶³ Moreover, these pathways are frequently
221 changing in response to healthcare reform (e.g. restructuring of primary health care
222 services⁶⁴). The variation coupled with changing post-acute pathways present substantial
223 challenges for researchers when attempting to evaluate the effectiveness of post-acute
224 rehabilitation after hip fracture surgery.

225 Secondary prevention services are incorporated into the continuum-care-episode after hip
226 fracture surgery. Processes of secondary prevention may begin within the acute care setting.
227 Post-acute services may include fracture liaison services (services who case-find patients
228 with fragility fractures at risk of osteoporosis and second hip fracture),⁶⁵⁻⁶⁷ falls clinics,^{68,69} or

229 the prescription of osteoporosis medication.⁷⁰ A truly comprehensive episode might even
230 include services beyond those delivered by health-care providers. For example, it may be
231 ideal to also include social care services which enable increased physical activity in the
232 community.

233 3. DISCUSSION

234 3.1 Main findings

235 The extent to which outcomes of hip fracture surgery may be attributed to rehabilitation
236 depends on the scope and endpoint of the episode. Here we describe a conceptual framework
237 for constructing a rehabilitation continuum-care-episode. We identified surgery as the index
238 event. We identified several independent potential endpoints. We suggest an episode
239 endpoint of baseline, no improvement in recovery, 1-year postoperatively, or a healthcare
240 event, whichever comes first (Figure 1). We suggest service scope should incorporate acute
241 rehabilitation, post-acute rehabilitation, and secondary prevention.

242 3.2 Operationalizing the framework

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

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

Element	Conceptual framework	Operational framework
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

250

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, instrumental, cognitive, affective and
253 social dimensions of this endpoint. There is no consensus on a core outcome set for
254 evaluation of current and/or new interventions after hip fracture. In 2014, Haywood et al.
255 recommended 5 core outcome measures for hip fracture trials - mortality, pain, activities of
256 daily living, mobility, and quality of life as a minimum for all hip fracture trials.⁷¹ They
257 recommended single-item measures of mortality and mobility (indoor/outdoor walking
258 status), and the EQ-5D.⁷¹ This is less comprehensive than the 12 core outcomes for
259 evaluation of orthogeriatric co-management for hip fractures (mortality, pain, activities of
260 daily living (Barthel Index), mobility (Parker Mobility Score and the Timed Up and Go),
261 quality of life, length of stay, time to surgery, complications, re-admission rate, medication
262 use, place of residence, costs).⁷² Consensus may lie somewhere between the two
263 recommendations -to avoid burden of assessment while collecting sufficient data for
264 evaluation. However, there is a need for consensus among rehabilitation researchers with
265 respect to appropriate standardized outcome measures for activities of daily living and

266 mobility. Indeed, a recent randomized feasibility study of rehabilitation after hip fracture
267 reported a ceiling effect for the Barthel Index.⁷³

268 Further, it is difficult to objectively determine whether patients achieve ‘back to baseline’ as
269 objective baseline measures are rarely available. Moreover, we highlighted *back to baseline*
270 may not be a feasible endpoint for all patients after hip fracture. For those who do not achieve
271 baseline status it is often not clear whether this relates to characteristics of the patient or the
272 clinical effectiveness of rehabilitation. We suggest patient/caregiver reported outcome
273 measures as well as patient/caregiver reported experience measures should be incorporated
274 into the evaluation of rehabilitation after hip fracture surgery.⁷⁴ These measures will help to
275 assess patients along two dimensions 1) satisfaction with outcome and rehabilitation
276 experience and 2) more objective view on degree of returning to baseline status. We may
277 cautiously interpret those who did not reach baseline status and were dissatisfied with their
278 outcome due to receiving ineffective rehabilitation.

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

284 **3.3 Next steps**

285 Since the early 1960’s, researchers have used episodes of care to frame analyses of
286 administrative and registry data.²⁶ External bodies standardize collection of these data which
287 occurs at regular intervals. Researchers have no (or limited) control over which data is
288 collected. Historically, most of these databases have not included data related to rehabilitation
289 exposures and outcomes limiting their utility for rehabilitation research. Exposures focused

290 predominantly on structures such as composition of the multidisciplinary team and staffing
291 levels, and outcomes included length of stay and discharge destination.^{59,75} In 2010 Porter
292 argued that “*achieving high value for patients must become the overarching goal of health*
293 *care delivery*”.³⁸ Since this time national registries have begun to incorporate rehabilitation
294 process exposures such as timing of first mobilisation, and outcomes including the
295 Cumulated Ambulation Score and the EQ-5D.^{31,76} In 2018, a national audit of physiotherapy
296 after hip fracture demonstrated variation in the frequency, type and duration of rehabilitation,
297 as well as community waiting times and handover across services in the UK.²⁴ We anticipate
298 an increase in the availability of rehabilitation process and outcome measures in
299 administrative and registry data in the coming years.

300 This paper represents a step to prepare researchers for future evaluations of these data. It also
301 provides clinicians with an understanding of the implications of framework selection for
302 interpreting evaluation of these data. If operationalized, the care episode will enable
303 evaluation of the effectiveness of rehabilitation after hip fracture surgery across the
304 continuum care episode. Finally, the framework will help rehabilitation researchers to better
305 design and implement evaluations to address evidence gaps highlighted by NICE and
306 Cochrane systematic reviews.¹⁹⁻²³

307 The framework focuses on the endpoint of a rehabilitation continuum-care episode. It does
308 not include interim endpoints during this episode i.e. endpoints for acute care, inpatient
309 rehabilitation, long-term care, outpatient or home-based rehabilitation. Further, the focus of
310 the episode is functional recovery. However, other outcomes beyond this episode endpoint
311 such as immobility related complications are also important. Optimizing these outcomes
312 often require interplay between rehabilitation and environmental interventions.

313

4. CONCLUSION

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

320

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323

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FIGURE LEGENDS

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

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

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

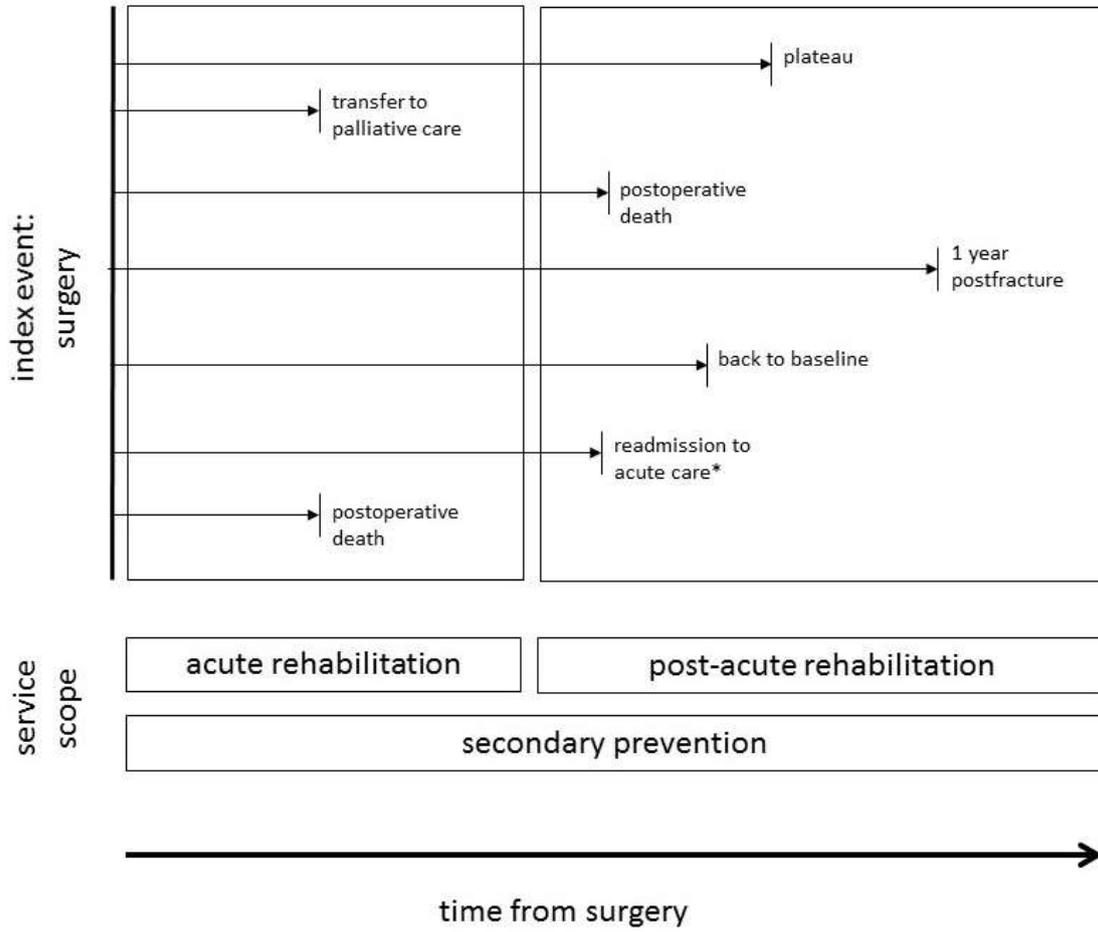
533 **Figure 3:** Plateau as an episode endpoint.

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

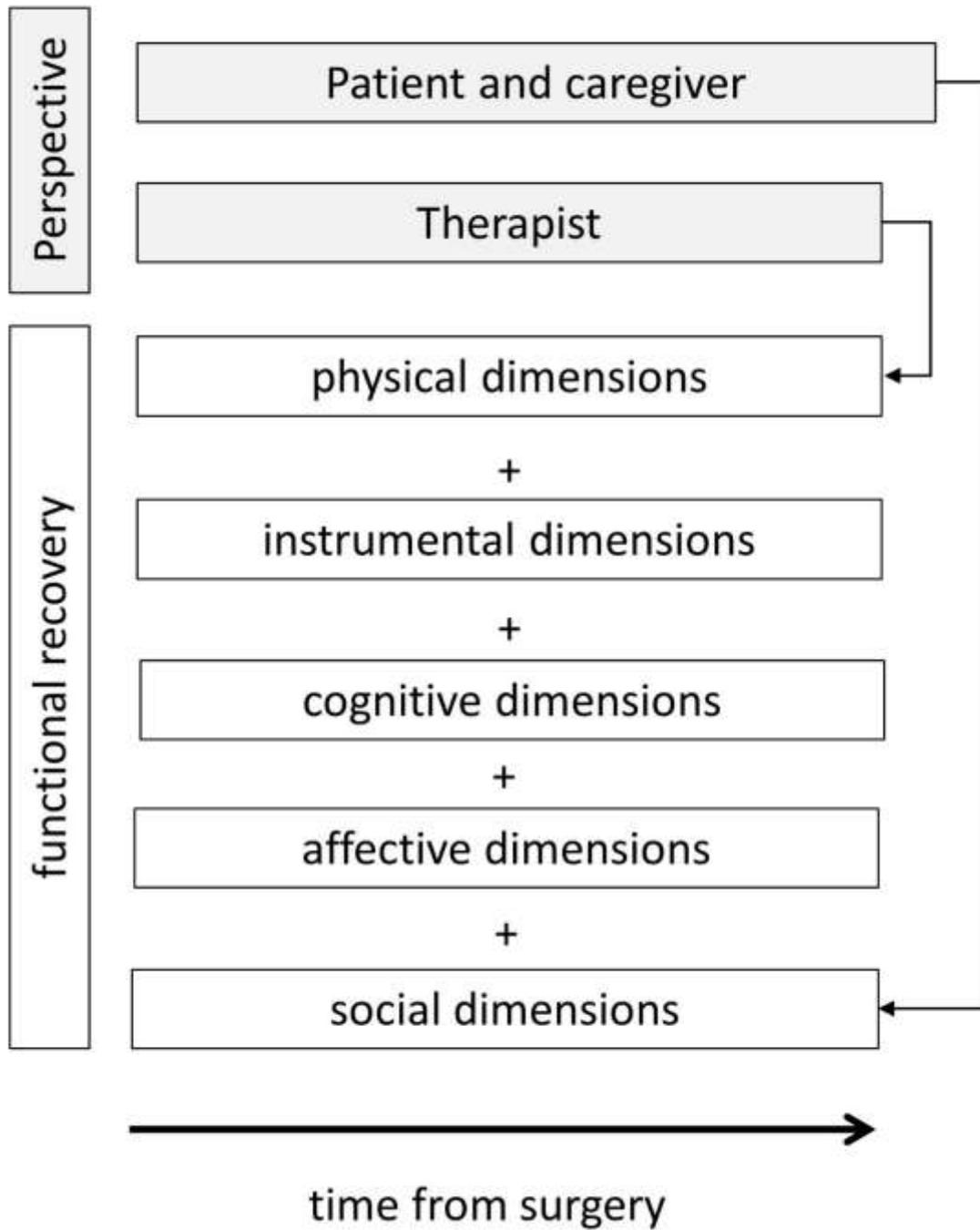
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FIGURES

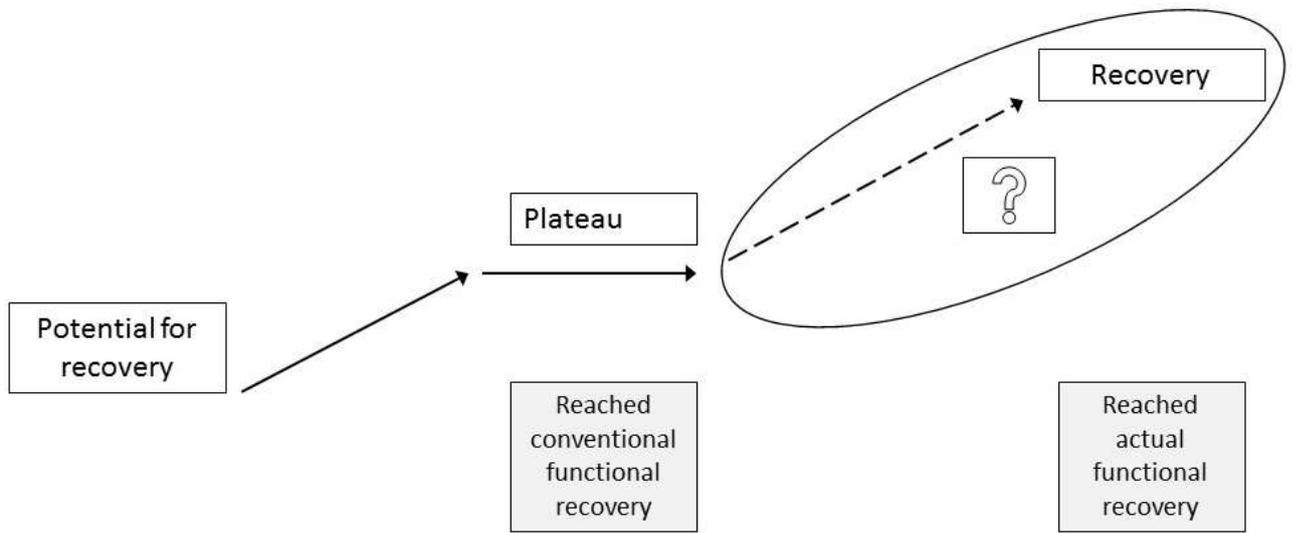
537 Figure 1



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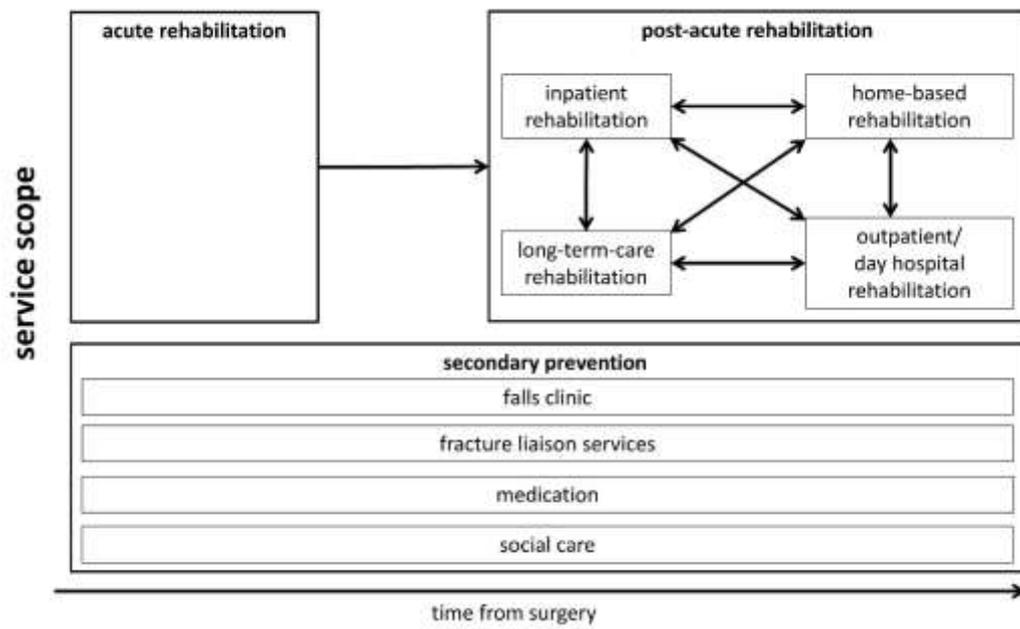


541 Figure 3



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543 Figure 4



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