

Rehabilitation after traumatic injury

C.4 Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

NICE guideline <number>

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These evidence reviews were developed by the National Guideline Alliance which is part of the Royal College of Obstetricians and Gynaecologists

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Contents

Summary of review questions covered in this report.....	8
Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury.....	9
Review question	9
Introduction	9
Summary of the protocol	9
Methods and process	11
Clinical evidence: Adults.....	12
Summary of clinical studies included in the evidence review	12
Results and quality assessment of clinical outcomes included in the evidence review	14
Clinical evidence: Children and young people	15
Summary of clinical studies included in the evidence review	15
Results and quality assessment of clinical outcomes included in the evidence review	15
Economic evidence: Adults and children and young people	16
Summary of studies included in the economic evidence review.....	16
Economic model.....	16
The committee’s discussion of the evidence.....	16
References.....	21
Appendices.....	22
Appendix A – Review protocols	22
Review protocol for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?.....	22
Review protocol for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	27
Appendix B – Literature search strategies	34
Literature search strategies for review questions:.....	34
C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	34
C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?.....	34
Review question search strategies	34
Databases: Medline; Medline EPub Ahead of Print; and Medline In-Process & Other Non-Indexed Citations.....	34

Databases: Embase; and Embase Classic	36
Databases: Cochrane Central Register of Controlled Trials; and Cochrane Database of Systematic Reviews	37
Health economics search strategies	39
Databases: Medline; Medline Epub Ahead of Print; and Medline In-Process & Other Non-Indexed Citations	39
Databases: Embase; and Embase Classic	41
Database: Cochrane Central Register of Controlled Trials	43
Appendix C – Clinical evidence study selection	45
Clinical study selection for review questions:	45
C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	45
C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	45
Appendix D – Clinical evidence tables	47
Clinical evidence tables for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	47
Clinical evidence tables for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	64
Appendix E – Forest plots	65
Forest plots for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable? ..	65
Forest plots for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	65
Appendix F – GRADE tables	66
GRADE tables for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable? ..	66
GRADE tables for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	70
Appendix G – Economic evidence study selection	71
Economic study selection for:	71
C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	71
C.4b For children and young people with complex rehabilitation needs after	

traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?.....	71
Appendix H – Economic evidence tables.....	73
Economic evidence tables for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?.....	73
Economic evidence tables for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	73
Appendix I – Economic evidence profiles	74
Economic evidence profiles for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?.....	74
Economic evidence profiles for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	74
Appendix J – Economic analysis	75
Economic evidence tables for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?.....	75
Economic evidence tables for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	75
Appendix K – Excluded studies	76
Excluded clinical and economic studies for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?	76
Clinical studies	76
Economic studies	82
Excluded clinical and economic studies for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?.....	83
Clinical studies	83
Economic studies	90
Appendix L – Research recommendations	91
Research recommendations for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?.....	91
Research recommendations for review question: C.4b For children and young	

people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable? 91

1 **Summary of review questions covered**
2 **in this report**

3 This evidence report contains information on 2 reviews

4 C.4a For adults with complex rehabilitation needs after traumatic injury that
5 involves chest injury, what specific rehabilitation programmes and packages are
6 effective and acceptable?

7 C.4b For children and young people with complex rehabilitation needs after
8 traumatic injury that involves chest injury, what specific rehabilitation programmes
9 and packages are effective and acceptable?

1 Specific programmes and packages in 2 chest injury for people with complex 3 rehabilitation needs after traumatic 4 injury

5 Review question

6 This evidence report contains information on 2 reviews relating to specific
7 rehabilitation programmes and packages for chest injury:

8 C.4a For adults with complex rehabilitation needs after traumatic injury that
9 involves chest injury, what specific rehabilitation programmes and packages are
10 effective and acceptable?

11 C.4b For children and young people with complex rehabilitation needs after
12 traumatic injury that involves chest injury, what specific rehabilitation programmes
13 and packages are effective and acceptable?

14 Introduction

15 Blunt chest-wall trauma accounts for 10-15% of all trauma admissions to Emergency
16 Departments globally. Rib fractures may complicate up to two thirds of these injuries
17 and are associated with significant morbidity and mortality. Other associated injuries
18 include pneumothorax, haemothorax, pulmonary contusion, sternal fracture and
19 cardiac contusion.

20 Injuries caused by chest trauma are frequently associated with pulmonary
21 complications such as pneumonia and respiratory failure which result in prolonged
22 hospital admission, intensive care unit stay and higher healthcare costs. Acute pain
23 is frequently problematic and early specialist pain intervention can aid a timely
24 recovery and discharge. Chronic pain and disability are common after rib fractures,
25 especially in adults, and many patients are unable to return to work after their
26 injuries. Older patients have consistently been shown to have worse outcomes,
27 higher complication rates and greater mortality after rib fractures than younger
28 people. Risk stratification models (e.g. battle score; Battle 2014) exist to aid the
29 identification of patients at high risk of respiratory deterioration who may benefit from
30 invasive strategies.

31 The objective of this review was to examine what specific rehabilitation programmes
32 and packages are effective and acceptable for people with complex rehabilitation
33 needs after traumatic injury that involves chest injury.

34 Summary of the protocol

35 Please see Table 1 and Table 2 for a summary of the Population, Intervention,
36 Comparison and Outcome (PICO) characteristics of this review in the adult and
37 children and young people populations, respectively.

38 Table 1: Summary of the adult protocol (PICO table)

Population

- Adults (aged 18 years or above) with complex rehabilitation needs resulting from traumatic injury that involves chest injury and requires admission to hospital

Intervention	<ul style="list-style-type: none"> • Standard care consisting of at least 2 of the following: physiotherapy [range of movement exercises, exercises to maintain muscle function, respiratory management, mobilisation and training with mobilisation aids such as crutches or frame], occupational therapy assessment, identification and support of activities of daily living through training or equipment (e.g., raised toilet seats, back rest, bed lever) in addition to at least one of the following: <ul style="list-style-type: none"> ○ Cardio-pulmonary rehab (including cycling, aerobic exercise, swimming) ○ Early pain management (i.e., rib fixation, intercostal or paravertebral nerve blocks, thoracic epidural) ○ Specific respiratory interventions i.e, incentive spirometry, relaxation, ACBT (Active cycle breathing technique), intermittent positive pressure breathing
Comparison	<ul style="list-style-type: none"> • Standard care (as defined above) • Studies that employ the same intervention program as listed under ‘interventions’ but vary it in terms of any of the following: <ul style="list-style-type: none"> ○ Frequency ○ Intensity ○ Timing
	<p>Critical</p> <ul style="list-style-type: none"> • Overall quality of life (EURO-QoL 5D 3L, SF-36, SF-12, SF-6D) • Changes in activity of daily living (Barthel ADL index, COPM, EADL-Test, Katz, OARS, PAT, PSMS) • Pain (VAS) <p>Important</p> <ul style="list-style-type: none"> • Patient acceptability (any direct measure) • Return to work or education • Changes in mood (Depression measures: BDI, DAS, HADS, PH-Q9) • Changes in mobility (any measure)

1 *ADL: Activities of daily living; BDI: Beck depression inventory; COPM: Canadian Occupational*
2 *Performance Measure; DAS: Disability assessment schedule; EADL-test: Erlangen Activities of Daily*
3 *Living test; EURO-QoL 5D 3L: EuroQol 5 dimensions and 3 levels; HADS: Hospital anxiety and*
4 *depression scale; OARS: Oxford athroplasty early recovery score; PAT: Performance ADL test; PH-Q9:*
5 *Patient health questionnaire with 9 questions; PSMS: Physical self-maintenance scale; SF-12: 12 item*
6 *short-form survey; SF-36: 36 item short-form survey; SF-6D: 6-dimension short-form*

7 **Table 2: Summary of the children and young people protocol (PICO table)**

Population	<ul style="list-style-type: none"> • Children and young people (aged below 18 years) with complex rehabilitation needs resulting from traumatic injury that involves chest injury and requires admission to hospital
Intervention	<ul style="list-style-type: none"> • Standard care consisting of at least 2 of the following: physiotherapy [range of movement exercises, exercises to maintain muscle function, respiratory management, mobilisation and training with mobilisation aids such as crutches or frame], occupational therapy assessment, identification and support of activities of daily living through training or equipment (e.g., raised toilet seats, back rest, bed lever) in addition to at least one of the following: <ul style="list-style-type: none"> ○ Cardio-pulmonary rehab (including cycling, aerobic exercise, swimming) ○ Early pain management (i.e., rib fixation, intercostal or

	<ul style="list-style-type: none"> paravertebral nerve blocks, thoracic epidural) <ul style="list-style-type: none"> ○ Specific respiratory interventions i.e., incentive spirometry, relaxation, ACBT (Active cycle breathing technique), intermittent positive pressure breathing ○ School-based educational interventions (ergonomics) ○ Specialist play therapy
Comparison	<ul style="list-style-type: none"> ● Standard care (as defined above) ● Studies that employ the same intervention program as listed under 'interventions' but vary it in terms of any of the following: <ul style="list-style-type: none"> ○ Frequency ○ Intensity ○ Timing
	<p>Critical</p> <ul style="list-style-type: none"> ● Overall quality of life (CHQ-CF80, CHQ-PF-50, PEDS-QL, EURO-QoL 5D 3L, SF-36, SF-12, SF-6D) ● Changes in mobility (WeeFIM, any measure) ● Pain (VAS, any measure) <p>Important</p> <ul style="list-style-type: none"> ● Patient and families and carers' acceptability (any direct measure; if not reported, but patient satisfaction is, this will be reported instead) ● Return to nursery, education, training or work ● Changes in mood (Any measure, Depression measures – HADS, PH-Q9, BDI, DAS) ● Changes in activity of daily living (e.g., Barthel ADL index, COPM, E-ADL-Test. Katz, OARS, PAT, PSMS)

1 *Barthel ADL index: Barthel Index for Activities of Daily Living; BDI: Beck's Depression Inventory; CHQ-*
 2 *CF80: a self-report measure of child health questionnaires; CHQ-PF-50: a measure of child health*
 3 *questionnaires for parents; COPM: Canadian Occupational Performance Measure; DAS: Depression*
 4 *Anxiety Stress Scales; EADL-Test: Erlangen Activities of Daily Living-Test; EQ-5D-Y: an child-friendly*
 5 *EQ-5D version for measuring quality of life; HADS: Hospital Anxiety and Depression Scale; Katz: a tool*
 6 *to assess independence in activities of daily living; OARS: Older Americans Resources and Services;*
 7 *OTs: occupational therapists; PAT: Performance ADL Test; Peds-QL: Pediatric Quality of Life Inventory;*
 8 *PHQ-9: Patient health questionnaire; PSMS: Physical Self-Maintenance Scale; PT: physical therapists;*
 9 *SF-6D: short-form six-dimension to assess the cost-effectiveness of health care interventions; SF-12: a*
 10 *short-form survey with 12 questionnaires selected from SF-36 to create 2 scales to assess mental and*
 11 *physical functioning and overall health-related quality of life; SF-36: Short form health survey-36; VAS:*
 12 *visual analog scale; WeeFIM: standardized measure of functional independence for use in children*

13 For further details see the review protocols in appendix A.

14 Methods and process

15 This evidence review was developed using the methods and process described in
 16 [Developing NICE guidelines: the manual](#). Methods specific to this review question
 17 are described in the review protocol in appendix A and in the methods chapter
 18 (Supplement 1).

19 Declarations of interest were recorded according to NICE's 2018 [conflicts of interest](#)
 20 [policy](#).

1 Clinical evidence: Adults

2 Included studies

3 Five studies were identified for this review, all randomised controlled trials (RCTs)
4 (Grammatopoulou 2010, Iacco 2016, Moon 1999, Sum 2019 and Yeying 2017).

5 Two studies were carried out in the USA (Iacco 2016; Moon 1999); two were from
6 China (Sum 2019, Yeying 2017); and one was from Greece (Grammatopoulou 2010).

7 One RCT compared the effectiveness of active cycle breathing techniques (ACBT) in
8 combination with routine chest physiotherapy to routine chest physiotherapy alone
9 (Grammatopoulou 2010). Another RCT compared incentive spirometer treatment
10 with standard analgesic treatment to standard analgesic treatment alone (Sum 2019).

11 One RCT was a three-arm trial that compared the effectiveness of intercostal nerve
12 block using either a low or high dose of bupivacaine to patient-controlled analgesia
13 (PCA; Iacco 2016), while the fourth study compared the effectiveness of thoracic
14 epidural compared to PCA (Moon 1999). The final included study compared the
15 effectiveness of paravertebral block to PCA (Yeying 2017).

16 See the literature search strategy in appendix B and study selection flow chart in
17 appendix C.

18 Excluded studies

19 Studies not included in this review with reasons for their exclusions are provided in
20 appendix K.

21 Summary of clinical studies included in the evidence review

22 A summary of the studies that were included in this review are presented in Table 3.

23 **Table 3: Summary of included studies**

Study	Population	Intervention ^a	Comparison ^a	Outcomes
Grammatopoulou 2010 RCT Greece	N=90 (90 analysed) • Age in years [Mean (SD)]: ○ ACBT=59.13 (10.17) ○ Routine chest physiotherapy=56.91 (8.86) • Number of ribs fractured (3/4/5): ○ ACBT (N): 24/14/7 ○ Routine chest physiotherapy (N): 21/16/9	Active cycle breathing technique + routine chest physiotherapy	Routine chest physiotherapy	<ul style="list-style-type: none"> • Critical <ul style="list-style-type: none"> ○ Pain (at days 1-7) • Important <ul style="list-style-type: none"> ○ None
Iacco 2016 RCT USA	N=10 (9 analysed) • Age in years [Mean (SD)]: ○ Block-low dose=60.4 (24.93)	Intercostal nerve block with low (0.25%) or high (0.5%) dose bupivacaine	PCA (intravenous hydromorphone hydrochloride)	<ul style="list-style-type: none"> • Critical <ul style="list-style-type: none"> ○ Pain (at day 3) • Important <ul style="list-style-type: none"> ○ None

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Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Population	Intervention ^a	Comparison ^a	Outcomes
	<ul style="list-style-type: none"> ○ Block-high dose=63.5 (6.36) ○ PCA=61.67 (16.56) ● Number of ribs fractured [Mean (SD)]: <ul style="list-style-type: none"> ○ Block-low dose=6.6 (3.7) ○ Block-high dose=5 (1.4) ○ PCA=4.7 (2.5) 			
Moon 1999 RCT USA	N=34 (24 analysed) <ul style="list-style-type: none"> ● Age in years [measure and dispersion not reported]: <ul style="list-style-type: none"> ○ Epidural=37 ○ PCA=40 ● Number of ribs fractured: Not reported 	Thoracic epidural (bupivacaine and morphine)	PCA (intravenous morphine)	<ul style="list-style-type: none"> ● Critical <ul style="list-style-type: none"> ○ Pain (at days 1-3) ● Important <ul style="list-style-type: none"> ○ None
Sum 2019 RCT China	N=50 (50 analysed) <ul style="list-style-type: none"> ● Age in years [Mean (SD)]: <ul style="list-style-type: none"> ○ Incentive spirometer=56 (13.9) ○ Standard analgesia=54.5 (15.2) ● Number of ribs fractured [Mean (SD)]: <ul style="list-style-type: none"> ○ Incentive spirometer=3.79 (2.21) ○ Standard analgesia=4.08 (1.94) 	Incentive spirometer and standard analgesia.	Standard analgesia.	<ul style="list-style-type: none"> ● Critical <ul style="list-style-type: none"> ○ Pain (at days 2 and 5) ● Important <ul style="list-style-type: none"> ○ None
Yeying 2017 RCT China	N=90 (90 analysed) <ul style="list-style-type: none"> ● Age in years [Mean (SD)]: <ul style="list-style-type: none"> ○ Block=39.1 (8.9) ○ PCA=41.2 (9.7) ● Number of ribs fractured [Mean (SD)]: <ul style="list-style-type: none"> ○ Block=3.9 (1.2) ○ PCA=4.1 (1.4) 	Paravertebral nerve block (ropivacaine).	PCA (intravenous sufentanil)	<ul style="list-style-type: none"> ● Critical <ul style="list-style-type: none"> ○ Pain (at 60 mins and days 1-3) ● Important <ul style="list-style-type: none"> ○ None

1 ACBT: Active cycle breathing techniques; mins: minutes; N: Number; PCA: Patient-controlled analgesia;
 2 RCT: Randomised controlled trial; SD: Standard deviation;
 3 (a) For full details about the intervention/comparison, please see the evidence tables in Appendix D

1 See the full evidence tables in appendix D. No meta-analysis was conducted (and so
2 there are no forest plots in appendix E).

3

4 **Results and quality assessment of clinical outcomes included in the** 5 **evidence review**

6 **Summary of the evidence**

7 No meta-analyses were performed as the interventions or outcomes were either not
8 sufficiently similar to allow them to be combined or they were not reported by more
9 than one study

10 Of the pre-defined outcomes, evidence was found for pain only. There was no
11 evidence for the following outcomes: overall quality of life, changes in activity of daily
12 living, patient acceptability, return to work or education, changes in mood and
13 changes in mobility.

14 **Active cycle breathing technique + chest physiotherapy**

15 One RCT compared the effectiveness of active cycle breathing technique + routine
16 chest physiotherapy with routine chest physiotherapy (Grammatopoulou 2010). Pain
17 during cough was significantly lower in the 'Active cycle breathing techniques +
18 routine chest physiotherapy' group on days 3-7 compared to the 'routine chest
19 physiotherapy' group, with no significant differences between the groups on days 1-2.
20 Whether the statistically significant differences on days 3-7 were clinically important
21 could not be assessed due to the factorial design of the study. The evidence was of
22 very low quality.

23 **Intercostal nerve block**

24 One RCT compared intercostal nerve block with low (0.25%) or high (0.5%) dose
25 bupivacaine with patient controlled analgesia (PCA; intravenous hydromorphone
26 hydrochloride) (Iacco 2016). No inferential analyses performed due to the low
27 number of participants and 0 standard deviations. Mean time to improvement in pain
28 intensity in days (SD):

- 29 ○ Block-high dose (n=1) = 1 (0)
- 30 ○ Block-low dose (n=3) = 3 (0)
- 31 ○ PCA (n=5) = 2 (0)

32 For both comparisons, the evidence was of very low quality

33 **Thoracic epidural**

34 One RCT compared thoracic epidural (bupivacaine and morphine) with PCA
35 (intravenous morphine) (Moon 1999). Pain during cough: The authors have not
36 reported or depicted any measure of variability of the data and have analysed the
37 results using 3 Students t-tests without reporting the exact p-values. This analysis
38 strategy is incorrect (results should have been analysed with a mixed 2 (group) by 3
39 (day) factorial ANOVA) and results in alpha-level inflation. The absence of the exact
40 p-values precludes our adjusting the significance level and the results should
41 therefore be interpreted with extreme caution: The authors report that the Students t-
42 test was significant on days 1 and 3, but not on day 2, at $p < 0.05$, in each case
43 favouring thoracic epidural over PCA. For the reasons already outlined the clinical
44 importance of these differences could not be assessed. The evidence was of very
45 low quality.

1 **Incentive spirometer + standard analgesia**

2 One RCT compared treatment with incentive spirometer in combination with standard
3 analgesia to standard analgesic treatment alone (Sum 2019) and found no
4 statistically significant difference in chest pain at days 2 and 5 between the
5 intervention groups. The evidence was of very low quality.

6 **Paravertebral nerve block**

7 One RCT compared paravertebral nerve block (ropivacaine) with PCA (intravenous
8 sufentanil) (Yeying 2017). The authors have analysed the results using Students t-
9 tests without reporting the exact p-values. This analysis strategy is incorrect (results
10 should have been analysed with a mixed 2 (group) by 5 (time) factorial ANOVA) and
11 results in alpha-level inflation. The absence of the exact p-values precludes our
12 adjusting the significance level and the results should therefore be interpreted with
13 extreme caution: The authors report that for pain at rest the Students t-test was
14 significant 60 minutes and 1 day, but not 2 or 3 days, after analgesia, at $p < 0.05$,
15 favouring paravertebral block; and that for pain during cough the Students t-test was
16 significant 60 minutes, 1 day, 2 days and 3 days after analgesia, at $p < 0.05$,
17 favouring paravertebral block. For the reasons already outlined the clinical
18 importance of these differences could not be assessed. The evidence was of very
19 low quality.

20 The quality of the evidence was assessed using GRADE. See the clinical evidence
21 profiles in appendix F.

22 **Clinical evidence: Children and young people**

23 **Included studies**

24 A systematic review of the clinical literature was conducted but no studies were
25 identified which were applicable to this review question.

26 See the literature search strategy in appendix B and study selection flow chart in
27 appendix C.

28 **Excluded studies**

29 Studies not included in this review with reasons for their exclusions are provided in
30 appendix K.

31 **Summary of clinical studies included in the evidence review**

32 No studies were identified which were applicable to this review question (and so
33 there are no evidence tables in Appendix D). No meta-analysis was undertaken for
34 this review (and so there are no forest plots in Appendix E).

35 **Results and quality assessment of clinical outcomes included in the
36 evidence review**

37 **Summary of the evidence**

38 No studies were identified which were applicable to this review question.

1 **Economic evidence: Adults and children and young people**

2 **Included studies**

3 A systematic review of the economic literature was conducted but no economic
4 studies were identified which were applicable to these review questions. A single
5 economic search was undertaken for adult, and children and young people reviews.
6 Please see the study selection flow chart in appendix G.

7 **Excluded studies**

8 Studies not included in this review with reasons for their exclusions are provided in
9 appendix K.

10 **Summary of studies included in the economic evidence review**

11 No economic evidence was identified which was applicable to these review
12 questions.

13 **Economic model**

14 No economic modelling was undertaken for these reviews because the committee
15 agreed that other topics were higher priorities for economic evaluation.

16 **The committee's discussion of the evidence**

17 **Interpreting the evidence**

18 ***The outcomes that matter most***

19 When selecting the critical and important outcomes, the committee agreed that the
20 outcomes needed to be sufficiently generalisable to adequately capture patient-
21 important outcomes for the whole adult and child and young people populations,
22 respectively, which they recognised are quite large and very heterogeneous.

23 For adults, they therefore prioritised overall quality of life and activities of daily living
24 as critical outcomes because the committee considered that one of the main aims of
25 people with chest injury would be to achieve similar quality of life and activity of daily
26 living level as before the injury. Pain was also selected as a critical outcome because
27 pain plays a pivotal role in patients' compliance with rehabilitation programmes and
28 critically affects quality of life and the ability to undertake activities of daily living.

29 Patient acceptability was included as an important outcome as how acceptable a
30 patient finds the rehabilitation intervention is likely to have a large impact in their
31 compliance. The committee also selected return to education or work as well as
32 changes in mobility as important outcomes as these outcomes measure the level of
33 functional independence of the patient after traumatic injury. Changes in mood was
34 also considered to be important because depression and post-traumatic stress
35 disorders are common in people with traumatic injury and this outcome reflects their
36 psychological wellbeing.

37 For children and young people the same outcomes were prioritised, with the following
38 exceptions: Changes in mobility was considered a critical outcome and activities of
39 daily living as an important outcome because the committee agreed that changes in
40 mobility might be a better, more fine-grained (and possibly more directly) measure of
41 function in this group than changes in activities of daily living because the latter might

1 be harder to measure meaningfully, especially in young and very young children. The
2 committee also extended the outcome of “return to education or work” to include
3 nursery and training also and the outcome of patient acceptability to include family
4 and carer ratings.

5 Of these outcomes, evidence was only found for pain and this was only in adults.

6 ***The quality of the evidence***

7 For adults, the evidence in the pairwise comparisons was assessed using the
8 GRADE methodology. The quality of the evidence across all outcomes was very low
9 and was downgraded because of design limitations of the studies and very serious
10 imprecision in the effect estimates, due to small sample sizes. Most often, the design
11 limitations in the studies were due to a lack of any blinding (i.e., the results were
12 subject to both performance and detection bias), little or no detail about the
13 randomisation sequence and adequacy of allocation concealment (selection bias) as
14 well as little or no detail about patient flow through the studies (i.e., potential attrition
15 bias), but the results of a number of the included studies were also compromised by
16 the analyses employed by the authors, which were incorrect in some instances, and
17 the lack of reporting of these results, which limited our ability to re-analyse them.
18 Moreover, the included studies did not cover all the target interventions and none of
19 the studies compared the same interventions, but rather all the studies reported on
20 different comparison or interventions. Taken together, this meant that the available
21 results were uncertain and very limited and the guideline committee were therefore
22 unable to use them to make recommendations. Instead they made recommendations
23 based on their experience and expertise.

24 For children and young people, no evidence was identified which was applicable to
25 this review question. All the recommendations were therefore based on the
26 experience and expertise of the guideline committee.

27 ***Benefits and harms***

28 There was no evidence for rehabilitation in children and young people with traumatic
29 chest injury. Moreover, the evidence for adults with traumatic chest injury was of very
30 low quality and limited by only reporting on 1 of the target outcomes (pain). The
31 committee therefore agreed the recommendations for people with complex
32 rehabilitation needs after traumatic chest injury based on their experience and
33 expertise.

34 The prevention of atelectasis and subsequent pneumonia and respiratory failure is
35 recognised as a key component in chest trauma rehabilitation. The committee agreed
36 that rehabilitation after chest injury should be started as soon as possible because
37 this helps to optimise respiratory function and prevent deconditioning, both of which
38 are explicit goals of effective rehabilitation after traumatic chest injury. The aim of
39 optimising respiratory function and preventing deconditioning is to allow deep
40 breathing because this reduces the risk of developing lung atelectasis and
41 subsequent pneumonia which people with chest injury are at increased risk of. Pain
42 is acknowledged as a contributing factor for much of the morbidity associated with
43 blunt thoracic trauma and therefore optimisation of analgesia at the earliest
44 opportunity is an essential component of management to allow early rehabilitation
45 and prevent morbidity. There are many options for managing pain from rib fractures
46 including multimodal oral therapy, intravenous analgesia, topical treatments and a
47 variety of regional anaesthetic blocks including thoracic epidural and paravertebral
48 block, which are all part of routine practice. The need for and appropriateness of
49 some of these options vary between people with chest injury, for example,

1 depending on both chest injury characteristics, other associated injuries and patient
2 preference, but the committee agreed that early neuraxial (for example, epidural
3 catheter) or regional analgesia (for example paravertebral, erector spinae plane or
4 serratus anterior blocks) are effective and acceptable options for many people with
5 chest injury where oral or intravenous analgesia is inadequate as it will not only
6 provide analgesia, but also allow the person with chest injury to be able to breathe
7 deeply, cough, start moving around early and participate in rehabilitation activities.

8 The committee agreed that it is well-established effective practice to encourage
9 people with chest trauma to start moving around as soon as their injuries allow them
10 to do so safely because this will again help to optimise their respiratory function and
11 prevent deconditioning.

12 The committee agreed to recommend therapies to prevent atelectasis and promote
13 deep breathing and secretion clearance because a failure to prevent atelectasis may
14 lead to subsequent pneumonia and respiratory failure whereas deep breathing and
15 secretion clearance can prevent that. The committee agreed to list a range of
16 different possible therapies, such as supported cough to brace chest wall, active
17 cycle breathing technique, incentive spirometry, and IPPB (portable intermittent
18 positive pressure breathing) devices, as their availability may differ between services
19 and different therapies may be preferred by people with chest injury.

20 Moreover, the committee wanted to draw attention to the fact that stiffness of the
21 upper limbs is a common complication of chest and rib injury on the affected side and
22 they agreed that this should be prevented through range of movement exercises and
23 advice about maintaining function as this can otherwise result in compromised
24 function. In children play can usefully be employed as a way to maintain range of
25 movement.

26 People with a co-existent spinal injury (for example a thoracic vertebral fracture)
27 might sometimes be prescribed an orthosis (usually a thoraco-lumbar sacral orthosis)
28 by the spinal surgeon. These orthoses tend to have a tight fit around the chest and
29 therefore may press on the ribcage and can limit deep breathing. This can therefore
30 cause significant problems in patients that have co-existent rib fractures as it will
31 worsen pain and prevent deep breathing (which in turn increases the risk of
32 developing lung atelectasis and subsequent pneumonia). The committee therefore
33 agreed that for people with a combination of spine injury and rib fracture, the use of
34 any spinal orthosis should be discussed with the MDT to decide what is in the best
35 interests of the patient and which treatment should take priority.

36 The committee recognised that recovery and rehabilitation of people with chest injury
37 can take a long time and cause considerable stress and worry, both of which can be
38 ameliorated by the provision of information about what they can do to help
39 themselves return to their normal activities of daily life (for example, how to increase
40 their exercise tolerance), and how to seek help if they are worried about problems
41 such as pain, shortness of breath, fatigue and cough. The committee therefore
42 agreed that such information should be provided.

43 The committee recognised that traumatic chest injuries in children and young people
44 may be from non-accidental causes or as a result of an underlying bone density
45 disorder, which although they may only play a role in a minority of injuries both have
46 important and considerable implications for management of the current injury as well
47 as the prevention of future injuries. They therefore agreed to recommend that these
48 potential causes of traumatic chest injuries should be considered in children and
49 young people with traumatic chest injuries.

1 The committee recognised that rib fractures may be due to underlying osteoporosis
2 in some adults with chest injury and agreed that in order to prevent future
3 osteoporotic fractures, patients should be assessed for osteoporosis and bone
4 protection in line with the NICE guideline on osteoporosis

5 .

6 Given the potential for complex chest injuries to affect communication and
7 swallowing, for example due to severe pain and injuries to the muscles necessary for
8 these functions, which can be particularly detrimental in children, who are still
9 developing these skills, input from speech and language therapy may also be
10 necessary to address the specific issues affecting the person's communication or
11 swallowing ability. The committee therefore agreed to recommend that such input is
12 considered for people with complex chest injuries that affect communication and
13 swallowing skills.

14 Despite the lack of evidence for this review question, the committee decided not to
15 make a research recommendation in this area. The committee discussed the lack of
16 controversy in current clinical management and decided to prioritise other areas
17 where new research evidence might be more valuable.

18 **Cost effectiveness and resource use**

19 There was no existing economic evidence for this review.

20 The committee explained that analgesia recommendations reflect standard practice
21 and are not expected to result in additional resources to the health service. However,
22 there may be some impact on anaesthetic services as invasive regional analgesic
23 strategies could increase. The use of invasive analgesic strategies is likely to result in
24 shorter lengths of hospital stay, reduce complications, and improve patients' quality
25 of life. The committee noted that all recommended regional analgesic strategies have
26 similar intervention costs and are widely used across the health service.

27 Proactively preventing stiffness of the upper limbs with a range of movement
28 exercises and advice on maintaining function will increase physiotherapist time, but
29 this could potentially reduce the number of outpatient appointments and the number
30 of hydrodilatation capsular release procedures carried out. The committee explained
31 that this is done in most rehabilitation services, and the impact of this
32 recommendation is likely to be negligible if any.

33 The committee explained that incentive spirometer devices and portable intermittent
34 positive pressure breathing devices would be available at Major Trauma Centres or
35 Trauma Units, where chest trauma is managed. There will be no additional resources
36 to the health service associated with acquiring such devices. The committee also
37 explained that using such devices may result in fewer admissions to critical care for
38 chest complications and reduced hospital length of stays. The committee noted that
39 the active cycle breathing technique would incur no cost other than physiotherapist
40 teaching the techniques, which is standard practice in most centres. Similarly,
41 supported cough to brace chest wall will incur no cost other than physiotherapist
42 teaching the techniques and use of a pillow/towel already on the ward, which is
43 standard practice.

44 Providing advice on self-management will incur no other cost than clinician time. The
45 committee noted that most services do this, and the impact of this is likely to be
46 negligible, if any.

1 There may be more assessments for osteoporosis and bone protection. However,
2 the committee explained that this might result in a reduction in future fragility
3 fractures. Such fractures require expensive management and impose a substantial
4 burden on the health service, and any strategy which reduces such burden is likely to
5 be very cost-effective. The committee also noted that most services are currently
6 undertaking such assessments, which would not represent a change in practice.

7 **Other factors the committee took into account**

8 The committee were aware that older patients have worse outcomes than younger
9 people and that admission under non-trauma teams remains common for older
10 people and that this can affect delivery of appropriate care. However, they agreed
11 that the recommendations are appropriate for both younger and older adults and
12 envisage that they will result in improved care for both groups of adults. The
13 committee discussed that people may experience body image issues after significant
14 chest deformities. This issue is not covered by the current review, but rather by the
15 review about psychological and psychosocial interventions.

16 **Recommendations supported by this evidence review**

17 This evidence review supports recommendations 1.17.1, 1.17.2, 1.17.3, 1.17.4,
18 1.17.5, 1.17.6, 1.17.7, 1.17.8, 1.17.9, 1.17.10, 1.17.11 and 1.17.12 in the NICE
19 guideline.

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2

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24 Using an incentive spirometer reduces pulmonary complications in patients with
25 traumatic rib fractures: a randomized controlled trial, *Trials*, 20, 797, 2019

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28 paravertebral block versus intravenous patient controlled analgesia for pain treatment
29 in patients with multiple rib fractures. *Journal of International Medical Research* 2017,
30 Vol. 45(6) 2085–2091

31 **Evidence for children and young people**

32 A systematic review of the literature was conducted, but no studies were identified
33 which were applicable to this review questions

Appendices

Appendix A – Review protocols

Review protocol for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

Table 4: Review protocol for specific programmes and packages in chest injury for adults

Field	Content
PROSPERO registration number	CRD42019129989
Review title	Specific programmes and packages for adults with chest injury
Review question	For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?
Objective	To examine the effectiveness of specific rehabilitation programmes and packages among adults with complex rehabilitation needs after traumatic injury that involves chest injury
Searches	<p>The following databases will be searched:</p> <ul style="list-style-type: none"> • Cochrane Central Register of Controlled Trials (CENTRAL) • Cochrane Database of Systematic Reviews (CDSR) • Embase • MEDLINE <p>Searches will be restricted by:</p> <ul style="list-style-type: none"> • Date: 1995 onwards as there has been significant change in practice since then • English language • Human studies <p>See appendix B for the full search strategies.</p>
Condition or domain being studied	<p>Complex rehabilitation needs resulting from traumatic injury</p> <p>‘Complex rehab needs’ refers to ‘multiple needs, and will always involve coordinated multidisciplinary input from 2 or more allied health professional disciplines, and also include the following:</p> <ul style="list-style-type: none"> • Vocational or educational social support for the person to return to their previous functional level, including return to work, school or college • Emotional, psychological and psychosocial support

Field	Content
	<ul style="list-style-type: none"> • Equipment or adaptations • Ongoing recovery from injury that may change the person’s rehabilitation needs (for example, restrictions of weight bearing, cast immobilisation in feature clinic)Further surgery and readmissions to hospital <p>Traumatic injury is defined as traumatic injury that requires admission to hospital at the time of injury.’</p>
Population	<p>Inclusion: Adults (aged 18 years or above) with complex rehabilitation needs resulting from traumatic injury that requires admission to hospital and includes chest injury</p> <p>Exclusion:</p> <ul style="list-style-type: none"> • Adults with complex rehabilitation needs resulting from traumatic brain injury (including anoxic brain injury, for example, drowning and strangulation) • Adults with traumatic injuries who do not have complex rehabilitation needs and/or do not require admission to hospital • Adults with complex rehabilitation needs resulting from traumatic injury that involves chest injury who are admitted to the ICU
Intervention	<p>Standard care consisting of at least 2 of the followings: physiotherapy [range of movement exercises, exercises to maintain muscle function, respiratory management, mobilisation and training with mobilisation aids such as crutches or frame], occupational therapy assessment, identification and support of activities of daily living through training or equipment (e.g. raised toilet seats, back rest, bed lever); in addition to at least one of the following</p> <ul style="list-style-type: none"> • Cardio-pulmonary rehab (including cycling, aerobic exercise, swimming) • Early pain management (i.e., rib fixation, intercostal or paravertebral nerve blocks, thoracic epidural) • Specific respiratory interventions i.e, incentive spirometry, relaxation, ACBT (Active cycle breathing technique) intermittent positive pressure breathing <p>Exclusion:</p> <ul style="list-style-type: none"> • Rehabilitation packages and programmes relating to traumatic brain injury, sight loss and hearing loss • Social care interventions (for example, home care or personal assistance) • Long-term care and rehabilitation packages for people with long-term care needs • Specific pain management interventions
Comparator	<p>1) Standard care consisting of at least 2 of the following: physiotherapy [range of movement exercises, exercises to</p>

Field	Content
	<p>maintain muscle function, respiratory management, mobilisation and training with mobilisation aids such as crutches or frame], occupational therapy assessment, identification and support of activities of daily living through training or equipment (e.g. raised toilet seats, back rest, bed lever).</p> <p>2) Studies that employ the same intervention program as listed under ‘interventions’ but vary it in terms of any of the following:</p> <ul style="list-style-type: none"> • Frequency • Intensity • Timing
Types of study to be included	<ul style="list-style-type: none"> • Systematic review of RCTs • Randomised controlled trial <p>If no RCT data are available for an intervention, evidence from the followings will be considered in order</p> <ul style="list-style-type: none"> • Cluster-randomised trial • Systematic review of non-randomised studies • Comparative prospective cohort studies with N≥100 per treatment arm • Comparative retrospective cohort studies with N≥100 per treatment arm
Other exclusion criteria	<p>Study design:</p> <ul style="list-style-type: none"> • Cross-over design • Case-controls • Cross-sectional • Case series and case reports • Audits <p>Language:</p> <ul style="list-style-type: none"> • Non-English <p>Publication status:</p> <ul style="list-style-type: none"> • Abstract only
Context	<p>Settings -</p> <p>Inclusion:</p>

Field	Content
	<ul style="list-style-type: none"> All inpatient, outpatient and community settings in which rehabilitation services following traumatic injury are provided <p>Exclusion:</p> <ul style="list-style-type: none"> Accident and emergency departments Critical care units Prisons
Primary outcomes (critical outcomes)	<p>Critical</p> <ul style="list-style-type: none"> Overall quality of life (EURO-QoL 5D 3L, SF-36, SF-12, SF-6D) Changes in activity of daily living (Barthel ADL index, COPM, EADL-Test, Katz, OARS, PAT, PSMS) Pain (VAS) <p>Timeframe for the follow-up will be 0-18 months. This will be grouped into short-term (0-6 months) and long-term (>6-18 months).</p>
Secondary outcomes (important outcomes)	<p>Important:</p> <ul style="list-style-type: none"> Patient acceptability (any direct measure) Return to work or education Changes in mood (Depression measures: BDI, DAS, HADS, PH-Q9) Changes in mobility (any measure) <p>Timeframe for the follow-up will be 0-18 months. This will be grouped into short-term (0-6 months) and long-term (>6-18 months).</p>
Data extraction (selection and coding)	<p>All references identified by the searches and from other sources will be uploaded into STAR and de-duplicated. 100% of the abstracts will be reviewed by two reviewers, with any disagreements resolved by discussion or, if necessary, a third independent reviewer. The full text of potentially eligible studies will be retrieved and will be assessed in line with the criteria outlined above. A standardised form will be used to extract data from studies (see Developing NICE guidelines: the manual section 6.4).</p>
Risk of bias (quality assessment)	<p>Risk of bias will be assessed using the appropriate checklist as described in Developing NICE guidelines: the manual.</p>
Strategy for data synthesis	<p>NGA STAR software will be used for generating bibliographies/citations, study sifting and data extraction. If pairwise meta-analyses are undertaken, they will be performed using Cochrane Review Manager (RevMan). 'GRADEpro' will be used to assess the quality of evidence for each outcome.</p>

Field	Content																					
Analysis of sub-groups	<p>The following subgroups will be considered:</p> <ul style="list-style-type: none"> - Frail versus not frail <p>If there is heterogeneity, we will also look at the following subgroups to try to identify the source of it.</p> <ul style="list-style-type: none"> • People with pre-existing physical and/or mental health conditions (including substance misuse), physical and learning disability versus no pre-existing condition • People who require safeguarding versus no safeguarding 																					
Type and method of review	Intervention																					
Language	English																					
Country	England																					
Anticipated or actual start date	10/01/2019																					
Anticipated completion date	24/11/2020																					
Stage of review at time of this submission	<table border="1"> <thead> <tr> <th>Review stage</th> <th>Started</th> <th>Completed</th> </tr> </thead> <tbody> <tr> <td>Preliminary searches</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Piloting of the study selection process</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Formal screening of search results against eligibility criteria</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Data extraction</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Risk of bias (quality) assessment</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Data analysis</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> </tbody> </table>	Review stage	Started	Completed	Preliminary searches	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Piloting of the study selection process	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Formal screening of search results against eligibility criteria	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Data extraction	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Risk of bias (quality) assessment	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Data analysis	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
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Data extraction	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																				
Risk of bias (quality) assessment	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																				
Data analysis	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																				
Named contact	National Guideline Alliance																					
Review team members	National Guideline Alliance																					
Funding sources/sponsor	This systematic review is being completed by the National Guideline Alliance which receives funding from NICE.																					
Conflicts of interest	All guideline committee members and anyone who has direct input into NICE guidelines (including the evidence review team and expert witnesses) must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any relevant interests, or changes to interests, will also be declared																					

Field	Content
	publicly at the start of each guideline committee meeting. Before each meeting, any potential conflicts of interest will be considered by the guideline committee Chair and a senior member of the development team. Any decisions to exclude a person from all or part of a meeting will be documented. Any changes to a member's declaration of interests will be recorded in the minutes of the meeting. Declarations of interests will be published with the final guideline.
Collaborators	Development of this systematic review will be overseen by an advisory committee who will use the review to inform the development of evidence-based recommendations in line with section 3 of Developing NICE guidelines: the manual. Members of the guideline committee are available on the NICE website: https://www.nice.org.uk/guidance/indevelopment/gid-ng10105
Other registration details	
Reference/URL for published protocol	https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=129989
Dissemination plans	
Keywords	
Details of existing review of same topic by same authors	
Current review status	
Additional information	
Details of final publication	www.nice.org.uk

ADL: Activities of daily living; BDI: Beck depression inventory; COPM: Canadian Occupational Performance Measure; DAS: Disability assessment schedule; EADL-test: Erlangen Activities of Daily Living test; EURO-QoL 5D 3L: EuroQol 5 dimensions and 3 levels; HADS: Hospital anxiety and depression scale; OARS: Oxford athroplasty early recovery score; PAT: Performance ADL test; PH-Q9: Patient health questionnaire with 9 questions; PSMS: Physical self-maintenance scale; SF-12: 12 item short-form survey; SF-36: 36 item short-form survey; SF-6D: 6-dimension short-form

Review protocol for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

Table 5: Review protocol for specific programmes and packages in chest injury for children and young people

Field	Content
PROSPERO registration number	CRD42019129984
Review title	Specific programmes and packages for children and young people with chest injury
Review question	For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what

Field	Content
Objective	<p>specific rehabilitation programmes and packages are effective and acceptable?</p> <p>To examine the effectiveness of specific rehabilitation programmes and packages among children and young people with complex rehabilitation needs after traumatic injury that involves chest injury</p>
Searches	<p>The following databases will be searched:</p> <ul style="list-style-type: none"> • Cochrane Central Register of Controlled Trials (CENTRAL) • Cochrane Database of Systematic Reviews (CDSR) • Embase • MEDLINE <p>Searches will be restricted by:</p> <ul style="list-style-type: none"> • Date: 1995 onwards as there has been significant change in practice since then • English language • Human studies <p>See appendix B for the full search strategies.</p>
Condition or domain being studied	<p>Complex rehabilitation needs resulting from traumatic injury</p> <p>‘Complex rehab needs’ refers to ‘multiple needs, and will always involve coordinated multidisciplinary input from 2 or more allied health professional disciplines, and also include the following:</p> <ul style="list-style-type: none"> • Vocational or educational social support for the person to return to their previous functional level, including return to work, school or college • Emotional, psychological and psychosocial support • Equipment or adaptations • Ongoing recovery from injury that may change the person’s rehabilitation needs (for example, restrictions of weight bearing, cast immobilisation in feature clinic) • Further surgery and readmissions to hospital <p>Traumatic injury is defined as traumatic injury that requires admission to hospital at the time of injury.’</p>
Population	<p>Inclusion: Children and young people (aged below 18 years) with complex rehabilitation needs resulting from traumatic injury that requires admission to hospital and includes chest injury</p> <p>Exclusion:</p> <ul style="list-style-type: none"> • Children and young people with complex rehabilitation needs resulting from traumatic brain injury (including anoxic brain injury, for example, drowning and strangulation) • Children and young people with traumatic injuries who do not have complex rehabilitation needs and/or do not require admission to hospital

Field	Content
	<ul style="list-style-type: none"> Children and young people with complex rehabilitation needs resulting from traumatic injury that involves chest injury who are admitted to the PICU
Intervention	<p>Standard care consisting of at least 2 of the followings: physiotherapy [range of movement exercises, exercises to maintain muscle function, respiratory management, mobilisation and training with mobilisation aids such as crutches or frame], occupational therapy assessment, identification and support of activities of daily living through training or equipment (e.g. raised toilet seats, back rest, bed lever); in addition to at least one of the following</p> <ul style="list-style-type: none"> Cardio-pulmonary rehab (including cycling, aerobic exercise, swimming) Early pain management (i.e., rib fixation, intercostal or paravertebral nerve blocks, thoracic epidural) Specific respiratory interventions i.e, incentive spirometry, relaxation, ACBT (Active cycle breathing technique) intermittent positive pressure breathing School-based educational interventions (ergonomics) Specialist play therapy <p>Exclusion:</p> <ul style="list-style-type: none"> Rehabilitation packages and programmes relating to traumatic brain injury, sight loss and hearing loss Social care interventions (for example, home care or personal assistance) Long-term care and rehabilitation packages for people with long-term care needs Specific pain management interventions
Comparator	<p>1) Standard care consisting of at least 2 of the following: physiotherapy [range of movement exercises, exercises to maintain muscle function, respiratory management, mobilisation and training with mobilisation aids such as crutches or frame], occupational therapy assessment, identification and support of activities of daily living through training or equipment (e.g. raised toilet seats, back rest, bed lever).</p> <p>2) Studies that employ the same intervention program as listed under 'interventions' but vary it in terms of any of the following:</p> <ul style="list-style-type: none"> Frequency Intensity Timing
Types of study to be included	<ul style="list-style-type: none"> Systematic review of RCTs Randomised controlled trial <p>If no RCT data are available for an intervention, evidence from the followings will be considered in order</p> <ul style="list-style-type: none"> Cluster-randomised trial Systematic review of non-randomised studies

Field	Content
	<ul style="list-style-type: none"> • Comparative prospective cohort studies with N≥100 per treatment arm • Comparative retrospective cohort studies with N≥100 per treatment arm
Other exclusion criteria	<p>Study design:</p> <ul style="list-style-type: none"> • Cross-over design • Case-controls • Cross-sectional • Case series and case reports • Audits <p>Language:</p> <ul style="list-style-type: none"> • Non-English <p>Publication status:</p> <ul style="list-style-type: none"> • Abstract only
Context	<p>Settings - Inclusion:</p> <ul style="list-style-type: none"> • All inpatient, outpatient and community settings in which rehabilitation services following traumatic injury are provided <p>Exclusion:</p> <ul style="list-style-type: none"> • Accident and emergency departments • Critical care units • Prisons
Primary outcomes (critical outcomes)	<p>Critical:</p> <ul style="list-style-type: none"> • Overall quality of life (CHQ-CF80, CHQ-PF-50, PEDS-QL, EURO-QoL 5D 3L, SF-36, SF-12, SF-6D) • Changes in mobility (WeeFIM, any measure) • Pain (VAS, any measure) <p>Timeframe for the follow-up will be 0-18 months. This will be grouped into short-term (0-6 months) and long-term (more</p>

Field	Content
	than 6 months-18 months). Important:
Secondary outcomes (important outcomes)	<ul style="list-style-type: none"> • Patient and families and carers' acceptability (any direct measure; if not reported, but patient satisfaction is, this will be reported instead) • Return to nursery, education, training or work • Changes in mood [Any measure, Depression measures – HADS, PH-Q9, BDI, DAS] • Changes in activity of daily living (e.g., COPM, Barthel ADL index, Katz, PSMS, OARS, PAT, E-ADL-Test) <p>Timeframe for the follow-up will be 0-18 months. This will be grouped into short-term (0-6 months) and long-term (more than 6 months-18 months).</p>
Data extraction (selection and coding)	All references identified by the searches and from other sources will be uploaded into STAR and de-duplicated. 100% of the abstracts will be reviewed by two reviewers, with any disagreements resolved by discussion or, if necessary, a third independent reviewer. The full text of potentially eligible studies will be retrieved and will be assessed in line with the criteria outlined above. A standardised form will be used to extract data from studies (see Developing NICE guidelines: the manual section 6.4).
Risk of bias (quality) assessment	Risk of bias will be assessed using the appropriate checklist as described in Developing NICE guidelines: the manual.
Strategy for data synthesis	<p>NGA STAR software will be used for generating bibliographies/citations, study sifting and data extraction.</p> <p>If pairwise meta-analyses are undertaken, they will be performed using Cochrane Review Manager (RevMan).</p> <p>'GRADEpro' will be used to assess the quality of evidence for each outcome.</p>
Analysis of sub-groups	<p>No subgroups were specified for this question for stratification of the data, but if there is heterogeneity, we will look at the following subgroups to try to identify the source of it:.</p> <ul style="list-style-type: none"> • Children and young people with pre-existing physical and/or mental health conditions (including substance misuse), physical and learning disability, or prematurity versus no preexisting conditions • Children and young people who are suspected of sustaining non-accidental injuries versus accidental injuries • Children and young people whose parents are very involved in their rehabilitation/recovery (e.g., by staying overnight in hospital) versus not involved • Age (0-3 versus 4-7 versus 8-12 versus 13-17)

Field	Content																					
Type and method of review	Intervention																					
Language	English																					
Country	England																					
Anticipated or actual start date	10/01/2019																					
Anticipated completion date	24/11/2020																					
Stage of review at time of this submission	<table border="1"> <thead> <tr> <th>Review stage</th> <th>Started</th> <th>Completed</th> </tr> </thead> <tbody> <tr> <td>Preliminary searches</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Piloting of the study selection process</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Formal screening of search results against eligibility criteria</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Data extraction</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Risk of bias (quality) assessment</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>Data analysis</td> <td><input checked="" type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> </tbody> </table>	Review stage	Started	Completed	Preliminary searches	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Piloting of the study selection process	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Formal screening of search results against eligibility criteria	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Data extraction	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Risk of bias (quality) assessment	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Data analysis	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Review stage	Started	Completed																				
Preliminary searches	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																				
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Data extraction	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																				
Risk of bias (quality) assessment	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																				
Data analysis	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																				
Named contact	National Guideline Alliance																					
Review team members	National Guideline Alliance																					
Funding sources/sponsor	This systematic review is being completed by the National Guideline Alliance which receives funding from NICE.																					
Conflicts of interest	All guideline committee members and anyone who has direct input into NICE guidelines (including the evidence review team and expert witnesses) must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any relevant interests, or changes to interests, will also be declared publicly at the start of each guideline committee meeting. Before each meeting, any potential conflicts of interest will be considered by the guideline committee Chair and a senior member of the development team. Any decisions to exclude a person from all or part of a meeting will be documented. Any changes to a member's declaration of interests will be recorded in the minutes of the meeting. Declarations of interests will be published with the final guideline.																					
Collaborators	Development of this systematic review will be overseen by an advisory committee who will use the review to inform the development of evidence-based recommendations in line with section 3 of Developing NICE guidelines: the manual. Members of the guideline committee are available on the NICE website: https://www.nice.org.uk/guidance/indevelopment/gid-ng10105																					

Field	Content
Other registration details	
Reference/URL for published protocol	https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=129984
Dissemination plans	
Keywords	
Details of existing review of same topic by same authors	
Current review status	
Additional information	
Details of final publication	www.nice.org.uk

Barthel ADL index: Barthel Index for Activities of Daily Living; BDI: Beck's Depression Inventory; CHQ-CF80: a self-report measure of child health questionnaires; CHQ-PF-50: a measure of child health questionnaires for parents; COPM: Canadian Occupational Performance Measure; DASS: Depression Anxiety Stress Scales; E-ADL-Test: Erlangen Activities of Daily Living-Test; EQ-5D-Y: an child-friendly EQ-5D version for measuring quality of life; HADS: Hospital Anxiety and Depression Scale; Katz: a tool to assess independence in activities of daily living; OARS: Older Americans Resources and Services; OTs: occupational therapists; PAT: Performance ADL Test; Peds-QL: Pediatric Quality of Life Inventory ;PHQ-9: Patient health questionnaire; PSMS: Physical Self-Maintenance Scale; PT: physical therapists; SF-6D: short-form six-dimension to assess the cost-effectiveness of health care interventions; SF-12: a short-form survey with 12 questionnaires selected from SF-36 to create 2 scales to assess mental and physical functioning and overall health-related quality of life; SF-36: Short form health survey-36; VAS: visual analog scale; WeeFIM: standardized measure of functional independence for use in children

Appendix B – Literature search strategies

Literature search strategies for review questions:

C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

A combined search was conducted for both review questions.

Note the searches for this review question were re-run on 12/11/2020 but with a randomized controlled trial search filter added. This was in order to capture any high level evidence published since the original search was run on 03/04/2019.

Review question search strategies

Databases: Medline; Medline Epub Ahead of Print; and Medline In-Process & Other Non-Indexed Citations

Date last searched: 03/04/2019

#	Searches
1	exp THORACIC INJURIES/
2	ACUTE LUNG INJURY/
3	((Chest? or thoracic\$ or heart? or lung? or pulmonary) adj5 (injur\$ or trauma\$)).ti,ab.
4	((Flail\$ or stove in) adj3 chest?).ti,ab.
5	((cardiac or heart) adj3 ruptur\$ adj3 trauma\$).ti,ab.
6	((heart or cardiac or myocardial) adj3 contusion?).ti,ab.
7	(rib? adj5 fractur\$).ti,ab.
8	or/1-7
9	exp EXERCISE THERAPY/
10	EXERCISE/
11	SPORTS/
12	RUNNING/ not RUNNING/in [Injuries]
13	JOGGING/ not JOGGING/in [Injuries]
14	WALKING/ not WALKING/in [Injuries]
15	STAIR CLIMBING/ not STAIR CLIMBING/in [Injuries]
16	BICYCLING/ not BICYCLING/in [Injuries]
17	SWIMMING/ not SWIMMING/in [Injuries]
18	((cardiopulmonary or cardio-pulmonary) adj5 (rehab\$ or therap\$)).ti,ab.
19	((sport\$ or exercise\$ or run\$ or jog\$ or walk\$ or bicycl\$ or cycle? or cycling or swim\$ or row? or rowing or skip\$ or aerobics or gym? or treadmill? or elliptical train\$ or cross train\$ or circuit train\$) adj10 (rehab\$ or therap\$ or program\$)).ti,ab.
20	((sport\$ or exercise\$ or run\$ or jog\$ or walk\$ or bicycl\$ or cycle? or cycling or swim\$ or row? or rowing or skip\$ or aerobics or gym? or treadmill?) adj3 train\$).ti,ab.
21	((aerobic\$ or cardio\$) adj3 exercis\$).ti,ab.
22	((resist\$ or strength\$) adj3 (train\$ or exercis\$ or program\$)).ti,ab.
23	PAIN MANAGEMENT/
24	*FRACTURE FIXATION, INTERNAL/
25	((rib? or flail) adj5 fixation?).ti,ab.
26	((operati\$ or surgical\$ or internal\$) adj3 fixation) and rib?).ti,ab.
27	(rib? adj5 splint\$).ti,ab.
28	ANALGESIA, EPIDURAL/
29	INJECTIONS, EPIDURAL/
30	ANALGESIA, PATIENT-CONTROLLED/
31	exp ANESTHESIA, CONDUCTION/

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Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

#	Searches
32	((Spinal\$ or spinous\$) adj5 analges\$).ti,ab.
33	epidural\$.ti,ab.
34	CSE.ti,ab.
35	((central\$ or regional\$) adj5 neuraxial\$ adj5 block\$).ti,ab.
36	(neuraxial\$ adj5 analges\$).ti,ab.
37	(patient? adj3 control\$ adj3 analges\$).ti,ab.
38	(an?esthe\$ adj5 (conduction or region\$ or caudal\$ or local\$ or spinal\$)).ti,ab.
39	((nerve or ganglion or plexus or neuraxial\$ or intercostal\$ or paravertebral\$) adj5 block\$).ti,ab.
40	(neuraxial\$ adj5 an?esthe\$).ti,ab.
41	(thoracic\$ adj3 (analges\$ or an?esthe\$)).ti,ab.
42	LIDOCAINE/
43	lidocaine.mp.
44	PAIN/dt [Drug Therapy]
45	BREATHING EXERCISES/
46	((breath\$ or relax\$ or respirat\$ or inhal\$ or inspirat\$ or expirat\$) adj5 (exercis\$ or technique? or train\$)).ti,ab.
47	SPIROMETRY/ and incentiv\$.ti,ab.
48	(incentiv\$ adj5 spirometr\$).ti,ab.
49	ACBT.ti,ab.
50	INTERMITTENT POSITIVE-PRESSURE BREATHING/
51	(intermittent\$ adj3 positive\$ adj3 pressure\$ adj3 breath\$).ti,ab.
52	IPPB.ti,ab.
53	REHABILITATION, VOCATIONAL/
54	(EMPLOYMENT/ or EMPLOYMENT, SUPPORTED/ or WORKPLACE/) and (ADAPTATION, PHYSIOLOGICAL/ or ACCLIMATIZATION/ or exp ADAPTATION, PSYCHOLOGICAL/ or ERGONOMICS/ or EQUIPMENT DESIGN/ or exp SELF-HELP DEVICES/)
55	((vocation\$ or workplace? or job? or employment or employee? or profession? or occupation?) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or re-integrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
56	(work\$ adj3 (place? or environment?) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or re-integrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
57	((vocation\$ or work\$ or job? or employment or employee? or profession? or occupation?) adj5 (assist\$ or self help or selfhelp) adj3 (device? or technolog\$ or aid?)).ti,ab.
58	RETURN TO WORK/
59	(return\$ adj3 work\$).ti.
60	VOCATIONAL GUIDANCE/
61	((vocation\$ or work\$ or job? or employment or employee? or profession? or occupation? or career?) adj5 (guid\$ or counsel\$)).ti,ab.
62	(EDUCATION/ or SCHOOLS/) and (ADAPTATION, PHYSIOLOGICAL/ or ACCLIMATIZATION/ or exp ADAPTATION, PSYCHOLOGICAL/ or ERGONOMICS/ or EQUIPMENT DESIGN/ or exp SELF-HELP DEVICES/)
63	((education\$ or school\$) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or re-integrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
64	((education\$ or school\$) adj5 (assist\$ or self help or selfhelp) adj3 (device? or technolog\$ or aid?)).ti,ab.
65	(return\$ adj3 (education\$ or school\$)).ti,ab.
66	PLAY THERAPY/
67	(play\$ adj3 therap\$).ti,ab.
68	or/9-67
69	8 and 68
70	limit 69 to english language
71	limit 70 to yr="1995 -Current"
72	LETTER/
73	EDITORIAL/
74	NEWS/
75	exp HISTORICAL ARTICLE/
76	ANECDOTES AS TOPIC/
77	COMMENT/
78	CASE REPORT/
79	(letter or comment*).ti.
80	or/72-79
81	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
82	80 not 81
83	ANIMALS/ not HUMANS/
84	exp ANIMALS, LABORATORY/
85	exp ANIMAL EXPERIMENTATION/
86	exp MODELS, ANIMAL/
87	exp RODENTIA/
88	(rat or rats or mouse or mice).ti.
89	or/82-88
90	71 not 89

Databases: Embase; and Embase Classic**Date last searched: 03/04/2019**

#	Searches
1	exp THORAX INJURY/
2	ACUTE LUNG INJURY/
3	exp RIB FRACTURE/
4	((Chest? or thorax or thoracic\$ or heart? or lung? or pulmonary) adj5 (injur\$ or trauma\$)).ti,ab.
5	((Flail\$ or stove in) adj3 chest?).ti,ab.
6	((cardiac or heart) adj3 ruptur\$ adj3 trauma\$).ti,ab.
7	((heart or cardiac or myocardial) adj3 contusion?).ti,ab.
8	(rib? adj5 fractur\$).ti,ab.
9	or/1-8
10	exp KINESIOTHERAPY/
11	*EXERCISE/
12	AEROBIC EXERCISE/
13	*SPORT/
14	RUNNING/
15	JOGGING/
16	WALKING/
17	STAIR CLIMBING/
18	CYCLING/
19	SWIMMING/
20	RESISTANCE TRAINING/
21	((cardiopulmonary or cardio-pulmonary) adj5 (rehab\$ or therap\$)).ti,ab.
22	((sport\$ or exercise\$ or run\$ or jog\$ or walk\$ or bicycl\$ or cycle? or cycling or swim\$ or row? or rowing or skip\$ or aerobics or gym? or treadmill? or elliptical train\$ or cross train\$ or circuit train\$) adj10 (rehab\$ or therap\$ or program\$)).ti,ab.
23	((sport\$ or exercise\$ or run\$ or jog\$ or walk\$ or bicycl\$ or cycle? or cycling or swim\$ or row? or rowing or skip\$ or aerobics or gym? or treadmill?) adj3 train\$).ti,ab.
24	((aerobic\$ or cardio\$) adj3 exercis\$).ti,ab.
25	((resist\$ or strength\$) adj3 (train\$ or exercis\$ or program\$)).ti,ab.
26	*ANALGESIA/
27	exp *FRACTURE FIXATION/
28	((rib? or flail) adj5 fixation?).ti,ab.
29	((operati\$ or surgical\$ or internal\$) adj3 fixation) and rib?).ti,ab.
30	(rib? adj5 splint\$).ti,ab.
31	EPIDURAL ANALGESIA/
32	EPIDURAL DRUG ADMINISTRATION/
33	PATIENT CONTROLLED ANALGESIA/
34	exp EPIDURAL ANESTHESIA/
35	exp LOCAL ANESTHESIA/
36	exp REGIONAL ANESTHESIA/
37	exp SPINAL ANESTHESIA/
38	((Spinal\$ or spinous\$) adj5 analges\$).ti,ab.
39	epidural\$.ti,ab.
40	CSE.ti,ab.
41	((central\$ or regional\$) adj5 neuraxial\$ adj5 block\$).ti,ab.
42	(neuraxial\$ adj5 analges\$).ti,ab.
43	(patient? adj3 control\$ adj3 analges\$).ti,ab.
44	(an?esthe\$ adj5 (conduction or region\$ or caudal\$ or local\$ or spinal\$)).ti,ab.
45	((nerve or ganglion or plexus or neuraxial\$ or intercostal\$ or paravertebral\$) adj5 block\$).ti,ab.
46	(neuraxial\$ adj5 an?esthe\$).ti,ab.
47	(thoracic\$ adj3 (analges\$ or an?esthe\$)).ti,ab.
48	LIDOCAINE/
49	lidocaine.mp.
50	*PAIN/dt [Drug Therapy]
51	BREATHING EXERCISE/
52	((breath\$ or relax\$ or respirat\$ or inhal\$ or inspirat\$ or expirat\$) adj5 (exercis\$ or technique? or train\$)).ti,ab.
53	SPIROMETRY/ and incentiv\$.ti,ab.
54	(incentiv\$ adj5 spirometr\$).ti,ab.
55	ACBT.ti,ab.
56	*INTERMITTENT POSITIVE PRESSURE VENTILATION/
57	(intermittent\$ adj3 positive\$ adj3 pressure\$ adj3 breath\$).ti,ab.
58	IPPB.ti,ab.
59	VOCATIONAL REHABILITATION/
60	JOB ADAPTATION/
61	(exp EMPLOYMENT/ or WORKPLACE/) and (ADAPTATION/ or ACCLIMATIZATION/ or exp COPING BEHAVIOR/ or ERGONOMICS/ or EQUIPMENT DESIGN/ or SELF HELP DEVICE/ or ASSISTIVE TECHNOLOGY DEVICE/)
62	((vocation\$ or workplace? or job? or employment or employee? or profession? or occupation?) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or

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Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

#	Searches
	ergonomic\$).ti,ab.
63	(work\$ adj3 (place? or environment?) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
64	((vocation\$ or work\$ or job? or employment or employee? or profession? or occupation?) adj5 (assist\$ or self help or selfhelp) adj3 (device? or technolog\$ or aid?)).ti,ab.
65	RETURN TO WORK/
66	WORK RESUMPTION/
67	(return\$ adj3 work\$).ti.
68	VOCATIONAL GUIDANCE/
69	((vocation\$ or work\$ or job? or employment or employee? or profession? or occupation? or career?) adj5 (guid\$ or counsel\$)).ti,ab.
70	(EDUCATION/ or SCHOOL/ or COLLEGE/ or COMMUNITY COLLEGE/ or HIGH SCHOOL/ or KINDERGARTEN/ or MIDDLE SCHOOL/ or NURSERY SCHOOL/ or PRIMARY SCHOOL) and (ADAPTATION/ or ACCLIMATIZATION/ or exp COPING BEHAVIOR/ or ERGONOMICS/ or EQUIPMENT DESIGN/ or SELF HELP DEVICE/ or ASSISTIVE TECHNOLOGY DEVICE/)
71	((education\$ or school\$) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
72	((education\$ or school\$) adj5 (assist\$ or self help or selfhelp) adj3 (device? or technolog\$ or aid?)).ti,ab.
73	(return\$ adj3 (education\$ or school\$)).ti,ab.
74	PLAY THERAPY/
75	(play\$ adj3 therap\$).ti,ab.
76	or/10-75
77	9 and 76
78	limit 77 to english language
79	limit 78 to yr="1995 -Current"
80	letter.pt. or LETTER/
81	note.pt.
82	editorial.pt.
83	CASE REPORT/ or CASE STUDY/
84	(letter or comment*).ti.
85	or/80-84
86	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
87	85 not 86
88	ANIMAL/ not HUMAN/
89	NONHUMAN/
90	exp ANIMAL EXPERIMENT/
91	exp EXPERIMENTAL ANIMAL/
92	ANIMAL MODEL/
93	exp RODENT/
94	(rat or rats or mouse or mice).ti.
95	or/87-94
96	79 not 95

Databases: Cochrane Central Register of Controlled Trials; and Cochrane Database of Systematic Reviews

Date last searched: 03/04/2019

#	Searches
#1	[mh "THORACIC INJURIES"]
#2	[mh ^"ACUTE LUNG INJURY"]
#3	((Chest* or thoracic* or heart* or lung* or pulmonary) near/5 (injur* or trauma*)):ti,ab
#4	((Flail* or stove in) near/3 chest*):ti,ab
#5	((cardiac or heart) near/3 ruptur* near/3 trauma*):ti,ab
#6	((heart or cardiac or myocardial) near/3 contusion*):ti,ab
#7	(rib* near/5 fractur*):ti,ab
#8	#1 or #2 or #3 or #4 or #5 or #6 or #7
#9	[mh "EXERCISE THERAPY"]
#10	[mh ^EXERCISE]
#11	[mh ^SPORTS]
#12	[mh ^RUNNING]
#13	[mh ^JOGGING]
#14	[mh ^WALKING]
#15	[mh ^"STAIR CLIMBING"]
#16	[mh ^BICYCLING]
#17	[mh ^SWIMMING]
#18	((cardiopulmonary or cardio-pulmonary) near/5 (rehab* or therap*)):ti,ab
#19	((sport* or exercise* or run* or jog* or walk* or bicycl* or cycle* or cycling or swim* or row* or rowing or skip* or

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Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

#	Searches
	aerobics or gym* or treadmill* or elliptical train* or cross train* or circuit train*) near/10 (rehab* or therap* or program*):ti,ab
#20	((sport* or exercise* or run* or jog* or walk* or bicycl* or cycle* or cycling or swim* or row* or rowing or skip* or aerobics or gym* or treadmill*) near/3 train*):ti,ab
#21	((aerobic* or cardio*) near/3 exercis*):ti,ab
#22	((resist* or strength*) near/3 (train* or exercis* or program*)):ti,ab
#23	[mh ^"PAIN MANAGEMENT"]
#24	[mh ^"FRACTURE FIXATION, INTERNAL"]
#25	((rib* or flail) near/5 fixation*):ti,ab
#26	((operati* or surgical* or internal*) near/3 fixation) and rib*):ti,ab
#27	(rib* near/5 splint*):ti,ab
#28	[mh ^"ANALGESIA, EPIDURAL"]
#29	[mh ^"INJECTIONS, EPIDURAL"]
#30	[mh ^"ANALGESIA, PATIENT-CONTROLLED"]
#31	[mh "ANESTHESIA, CONDUCTION"]
#32	((Spinal* or spinous*) near/5 analges*):ti,ab
#33	epidural*:ti,ab
#34	CSE:ti,ab
#35	((central* or regional*) near/5 neuraxial* near/5 block*):ti,ab
#36	(neuraxial* near/5 analges*):ti,ab
#37	(patient* near/3 control* near/3 analges*):ti,ab
#38	((anesthe* or anaesthe*) near/5 (conduction or region* or caudal* or local* or spinal*)):ti,ab
#39	((nerve or ganglion or plexus or neuraxial* or intercostal* or paravertebral*) near/5 block*):ti,ab
#40	(neuraxial* near/5 (anesthe* or anaesthe*)):ti,ab
#41	(thoracic* near/3 (analges* or anesthe* or anaesthe*)):ti,ab
#42	[mh ^LIDOCAINE]
#43	lidocaine:ti,ab
#44	[mh ^PAIN/dt]
#45	[mh ^"BREATHING EXERCISES"]
#46	((breath* or relax* or respirat* or inhal* or inspirat* or expirat*) near/5 (exercis* or technique* or train*)):ti,ab
#47	[mh ^SPIROMETRY]
#48	(Incentiv* near/5 spirometr*):ti,ab
#49	ACBT:ti,ab
#50	[mh ^"INTERMITTENT POSITIVE-PRESSURE BREATHING"]
#51	(intermittent* near/3 positive* near/3 pressure* near/3 breath*):ti,ab
#52	IPPB:ti,ab
#53	[mh ^"REHABILITATION, VOCATIONAL"]
#54	[mh ^EMPLOYMENT]
#55	[mh ^"EMPLOYMENT, SUPPORTED"]
#56	[mh ^WORKPLACE]
#57	#54 or #55 or #56
#58	[mh ^"ADAPTATION, PHYSIOLOGICAL"]
#59	[mh ^ACCLIMATIZATION]
#60	[mh "ADAPTATION, PSYCHOLOGICAL"]
#61	[mh ^ERGONOMICS]
#62	[mh ^"EQUIPMENT DESIGN"]
#63	[mh "SELF-HELP DEVICES"]
#64	#58 or #59 or #60 or #61 or #62 or #63
#65	#57 and #64
#66	((vocation* or workplace* or job* or employment or employee* or profession* or occupation*) near/5 (rehab* or support* or adjust* or adapt* or chang* or re-integrat* or re-integrat* or facilitat* or intervention* or equipment or ergonomic*)):ti,ab
#67	(work* near/3 (place* or environment*) near/5 (rehab* or support* or adjust* or adapt* or chang* or re-integrat* or re-integrat* or facilitat* or intervention* or equipment or ergonomic*)):ti,ab
#68	((vocation* or work* or job* or employment or employee* or profession* or occupation*) near/5 (assist* or self help or selfhelp) near/3 (device* or technolog* or aid*)):ti,ab
#69	[mh ^"RETURN TO WORK"]
#70	(return* near/3 work*):ti
#71	[mh ^"VOCATIONAL GUIDANCE"]
#72	((vocation* or work* or job* or employment or employee* or profession* or occupation* or career*) near/5 (guid* or counsel*)):ti,ab
#73	[mh ^"EDUCATION"]
#74	[mh ^"SCHOOLS"]
#75	#73 or #74
#76	#75 and #64
#77	((education* or school*) near/5 (rehab* or support* or adjust* or adapt* or chang* or re-integrat* or re-integrat* or facilitat* or intervention* or equipment or ergonomic*)):ti,ab
#78	((education* or school*) near/5 (assist* or self help or selfhelp) near/3 (device* or technolog* or aid*)):ti,ab
#79	(return* near/3 (education* or school*)):ti,ab
#80	[mh ^"PLAY THERAPY"]
#81	(play* near/3 therap*):ti,ab

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Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

#	Searches
#82	#9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49 or #50 or #51 or #52 or #53 or #65 or #66 or #67 or #68 or #69 or #70 or #71 or #72 or #76 or #77 or #78 or #79 or #80 or #81
#83	#8 and #82
#84	#8 and #82 with Cochrane Library publication date Between Jan 1995 and Apr 2019, in Cochrane Reviews, Cochrane Protocols
#85	#8 and #82 with Publication Year from 1995 to 2019, in Trials

Health economics search strategies

Databases: Medline; Medline Epub Ahead of Print; and Medline In-Process & Other Non-Indexed Citations

Date last searched: 03/05/2019

#	Searches
1	ECONOMICS/
2	VALUE OF LIFE/
3	exp "COSTS AND COST ANALYSIS"/
4	exp ECONOMICS, HOSPITAL/
5	exp ECONOMICS, MEDICAL/
6	exp RESOURCE ALLOCATION/
7	ECONOMICS, NURSING/
8	ECONOMICS, PHARMACEUTICAL/
9	exp "FEES AND CHARGES"/
10	exp BUDGETS/
11	budget*.ti,ab.
12	cost*.ti,ab.
13	(economic* or pharmaco?economic*).ti,ab.
14	(price* or pricing*).ti,ab.
15	(financ* or fee or fees or expenditure* or saving*).ti,ab.
16	(value adj2 (money or monetary)).ti,ab.
17	resourc* allocat*.ti,ab.
18	(fund or funds or funding* or funded).ti,ab.
19	(ration or rations or rationing* or rationed).ti,ab.
20	ec.fs.
21	or/1-20
22	exp THORACIC INJURIES/
23	ACUTE LUNG INJURY/
24	((Chest? or thoracic\$ or heart? or lung? or pulmonary) adj5 (injur\$ or trauma\$)).ti,ab.
25	((Flail\$ or stove in) adj3 chest?).ti,ab.
26	((cardiac or heart) adj3 ruptur\$ adj3 trauma\$).ti,ab.
27	((heart or cardiac or myocardial) adj3 contusion?).ti,ab.
28	(rib? adj5 fractur\$).ti,ab.
29	or/22-28
30	exp EXERCISE THERAPY/
31	EXERCISE/
32	SPORTS/
33	RUNNING/ not RUNNING/in [Injuries]
34	JOGGING/ not JOGGING/in [Injuries]
35	WALKING/ not WALKING/in [Injuries]
36	STAIR CLIMBING/ not STAIR CLIMBING/in [Injuries]
37	BICYCLING/ not BICYCLING/in [Injuries]
38	SWIMMING/ not SWIMMING/in [Injuries]
39	((cardiopulmonary or cardio-pulmonary) adj5 (rehab\$ or therap\$)).ti,ab.
40	((sport\$ or exercise\$ or run\$ or jog\$ or walk\$ or bicycl\$ or cycle? or cycling or swim\$ or row? or rowing or skip\$ or aerobics or gym? or treadmill? or elliptical train\$ or cross train\$ or circuit train\$) adj10 (rehab\$ or therap\$ or program\$)).ti,ab.
41	((sport\$ or exercise\$ or run\$ or jog\$ or walk\$ or bicycl\$ or cycle? or cycling or swim\$ or row? or rowing or skip\$ or aerobics or gym? or treadmill?) adj3 train\$).ti,ab.
42	((aerobic\$ or cardio\$) adj3 exercis\$).ti,ab.
43	((resist\$ or strength\$) adj3 (train\$ or exercis\$ or program\$)).ti,ab.
44	PAIN MANAGEMENT/
45	*FRACTURE FIXATION, INTERNAL/
46	((rib? or flail) adj5 fixation?).ti,ab.
47	((operati\$ or surgical\$ or internal\$) adj3 fixation) and rib?).ti,ab.

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

#	Searches
48	(rib? adj5 splint\$).ti,ab.
49	ANALGESIA, EPIDURAL/
50	INJECTIONS, EPIDURAL/
51	ANALGESIA, PATIENT-CONTROLLED/
52	exp ANESTHESIA, CONDUCTION/
53	((Spinal\$ or spinous\$) adj5 analges\$).ti,ab.
54	epidural\$.ti,ab.
55	CSE.ti,ab.
56	((central\$ or regional\$) adj5 neuraxial\$ adj5 block\$).ti,ab.
57	(neuraxial\$ adj5 analges\$).ti,ab.
58	(patient? adj3 control\$ adj3 analges\$).ti,ab.
59	(an?esthe\$ adj5 (conduction or region\$ or caudal\$ or local\$ or spinal\$)).ti,ab.
60	((nerve or ganglion or plexus or neuraxial\$ or intercostal\$ or paravertebral\$) adj5 block\$).ti,ab.
61	(neuraxial\$ adj5 an?esthe\$).ti,ab.
62	(thoracic\$ adj3 (analges\$ or an?esthe\$)).ti,ab.
63	LIDOCAINE/
64	lidocaine.mp.
65	PAIN/dt [Drug Therapy]
66	BREATHING EXERCISES/
67	((breath\$ or relax\$ or respirat\$ or inhal\$ or inspirat\$ or expirat\$) adj5 (exercis\$ or technique? or train\$)).ti,ab.
68	SPIROMETRY/ and incentiv\$.ti,ab.
69	(incentiv\$ adj5 spirometr\$).ti,ab.
70	ACBT.ti,ab.
71	INTERMITTENT POSITIVE-PRESSURE BREATHING/
72	(intermittent\$ adj3 positive\$ adj3 pressure\$ adj3 breath\$).ti,ab.
73	IPPB.ti,ab.
74	REHABILITATION, VOCATIONAL/
75	(EMPLOYMENT/ or EMPLOYMENT, SUPPORTED/ or WORKPLACE/) and (ADAPTATION, PHYSIOLOGICAL/ or ACCLIMATIZATION/ or exp ADAPTATION, PSYCHOLOGICAL/ or ERGONOMICS/ or EQUIPMENT DESIGN/ or exp SELF-HELP DEVICES/)
76	((vocation\$ or workplace? or job? or employment or employee? or profession? or occupation?) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
77	(work\$ adj3 (place? or environment?) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
78	((vocation\$ or work\$ or job? or employment or employee? or profession? or occupation?) adj5 (assist\$ or self help or selfhelp) adj3 (device? or technolog\$ or aid?)).ti,ab.
79	RETURN TO WORK/
80	(return\$ adj3 work\$).ti.
81	VOCATIONAL GUIDANCE/
82	((vocation\$ or work\$ or job? or employment or employee? or profession? or occupation? or career?) adj5 (guid\$ or counsel\$)).ti,ab.
83	(EDUCATION/ or SCHOOLS/) and (ADAPTATION, PHYSIOLOGICAL/ or ACCLIMATIZATION/ or exp ADAPTATION, PSYCHOLOGICAL/ or ERGONOMICS/ or EQUIPMENT DESIGN/ or exp SELF-HELP DEVICES/)
84	((education\$ or school\$) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
85	((education\$ or school\$) adj5 (assist\$ or self help or selfhelp) adj3 (device? or technolog\$ or aid?)).ti,ab.
86	(return\$ adj3 (education\$ or school\$)).ti,ab.
87	PLAY THERAPY/
88	(play\$ adj3 therap\$).ti,ab.
89	or/30-88
90	29 and 89
91	limit 90 to english language
92	limit 91 to yr="1995 -Current"
93	LETTER/
94	EDITORIAL/
95	NEWS/
96	exp HISTORICAL ARTICLE/
97	ANECDOTES AS TOPIC/
98	COMMENT/
99	CASE REPORT/
100	(letter or comment*).ti.
101	or/93-100
102	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
103	101 not 102
104	ANIMALS/ not HUMANS/
105	exp ANIMALS, LABORATORY/
106	exp ANIMAL EXPERIMENTATION/
107	exp MODELS, ANIMAL/
108	exp RODENTIA/
109	(rat or rats or mouse or mice).ti.

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

#	Searches
110	or/103-109
111	92 not 110
112	21 and 111

Databases: Embase; and Embase Classic

Date last searched: 03/05/2019

#	Searches
1	HEALTH ECONOMICS/
2	exp ECONOMIC EVALUATION/
3	exp HEALTH CARE COST/
4	exp FEE/
5	BUDGET/
6	FUNDING/
7	RESOURCE ALLOCATION/
8	budget*.ti,ab.
9	cost*.ti,ab.
10	(economic* or pharmaco?economic*).ti,ab.
11	(price* or pricing*).ti,ab.
12	(financ* or fee or fees or expenditure* or saving*).ti,ab.
13	(value adj2 (money or monetary)).ti,ab.
14	resourc* allocat*.ti,ab.
15	(fund or funds or funding* or funded).ti,ab.
16	(ration or rations or rationing* or rationed).ti,ab.
17	or/1-16
18	exp THORAX INJURY/
19	ACUTE LUNG INJURY/
20	exp RIB FRACTURE/
21	((Chest? or thorax or thoracic\$ or heart? or lung? or pulmonary) adj5 (injur\$ or trauma\$)).ti,ab.
22	((Flail\$ or stove in) adj3 chest?).ti,ab.
23	((cardiac or heart) adj3 ruptur\$ adj3 trauma\$).ti,ab.
24	((heart or cardiac or myocardial) adj3 contusion?).ti,ab.
25	(rib? adj5 fractur\$).ti,ab.
26	or/18-25
27	exp KINESIOTHERAPY/
28	*EXERCISE/
29	AEROBIC EXERCISE/
30	*SPORT/
31	RUNNING/
32	JOGGING/
33	WALKING/
34	STAIR CLIMBING/
35	CYCLING/
36	SWIMMING/
37	RESISTANCE TRAINING/
38	((cardiopulmonary or cardio-pulmonary) adj5 (rehab\$ or therap\$)).ti,ab.
39	((sport\$ or exercise\$ or run\$ or jog\$ or walk\$ or bicycl\$ or cycle? or cycling or swim\$ or row? or rowing or skip\$ or aerobics or gym? or treadmill? or elliptical train\$ or cross train\$ or circuit train\$) adj10 (rehab\$ or therap\$ or program\$)).ti,ab.
40	((sport\$ or exercise\$ or run\$ or jog\$ or walk\$ or bicycl\$ or cycle? or cycling or swim\$ or row? or rowing or skip\$ or aerobics or gym? or treadmill?) adj3 train\$).ti,ab.
41	((aerobic\$ or cardio\$) adj3 exercis\$).ti,ab.
42	((resist\$ or strength\$) adj3 (train\$ or exercis\$ or program\$)).ti,ab.
43	*ANALGESIA/
44	exp *FRACTURE FIXATION/
45	((rib? or flail) adj5 fixation?).ti,ab.
46	((operati\$ or surgical\$ or internal\$) adj3 fixation) and rib?).ti,ab.
47	(rib? adj5 splint\$).ti,ab.
48	EPIDURAL ANALGESIA/
49	EPIDURAL DRUG ADMINISTRATION/
50	PATIENT CONTROLLED ANALGESIA/
51	exp EPIDURAL ANESTHESIA/
52	exp LOCAL ANESTHESIA/
53	exp REGIONAL ANESTHESIA/
54	exp SPINAL ANESTHESIA/
55	((Spinal\$ or spinous\$) adj5 analges\$).ti,ab.
56	epidural\$.ti,ab.

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Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

#	Searches
57	CSE.ti,ab.
58	((central\$ or regional\$) adj5 neuraxial\$ adj5 block\$).ti,ab.
59	(neuraxial\$ adj5 analges\$).ti,ab.
60	(patient? adj3 control\$ adj3 analges\$).ti,ab.
61	(an?esthe\$ adj5 (conduction or region\$ or caudal\$ or local\$ or spinal\$)).ti,ab.
62	((nerve or ganglion or plexus or neuraxial\$ or intercostal\$ or paravertebral\$) adj5 block\$).ti,ab.
63	(neuraxial\$ adj5 an?esthe\$).ti,ab.
64	(thoracic\$ adj3 (analges\$ or an?esthe\$)).ti,ab.
65	LIDOCAINE/
66	lidocaine.mp.
67	*PAIN/dt [Drug Therapy]
68	BREATHING EXERCISE/
69	((breath\$ or relax\$ or respirat\$ or inhal\$ or inspirat\$ or expirat\$) adj5 (exercis\$ or technique? or train\$)).ti,ab.
70	SPIROMETRY/ and incentiv\$.ti,ab.
71	(incentiv\$ adj5 spirometr\$).ti,ab.
72	ACBT.ti,ab.
73	*INTERMITTENT POSITIVE PRESSURE VENTILATION/
74	(intermittent\$ adj3 positive\$ adj3 pressure\$ adj3 breath\$).ti,ab.
75	IPPB.ti,ab.
76	VOCATIONAL REHABILITATION/
77	JOB ADAPTATION/
78	(exp EMPLOYMENT/ or WORKPLACE/) and (ADAPTATION/ or ACCLIMATIZATION/ or exp COPING BEHAVIOR/ or ERGONOMICS/ or EQUIPMENT DESIGN/ or SELF HELP DEVICE/ or ASSISTIVE TECHNOLOGY DEVICE/)
79	((vocation\$ or workplace? or job? or employment or employee? or profession? or occupation?) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
80	(work\$ adj3 (place? or environment?) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
81	((vocation\$ or work\$ or job? or employment or employee? or profession? or occupation?) adj5 (assist\$ or self help or selfhelp) adj3 (device? or technolog\$ or aid?)).ti,ab.
82	RETURN TO WORK/
83	WORK RESUMPTION/
84	(return\$ adj3 work\$).ti.
85	VOCATIONAL GUIDANCE/
86	((vocation\$ or work\$ or job? or employment or employee? or profession? or occupation? or career?) adj5 (guid\$ or counsel\$)).ti,ab.
87	(EDUCATION/ or SCHOOL/ or COLLEGE/ or COMMUNITY COLLEGE/ or HIGH SCHOOL/ or KINDERGARTEN/ or MIDDLE SCHOOL/ or NURSERY SCHOOL/ or PRIMARY SCHOOL/) and (ADAPTATION/ or ACCLIMATIZATION/ or exp COPING BEHAVIOR/ or ERGONOMICS/ or EQUIPMENT DESIGN/ or SELF HELP DEVICE/ or ASSISTIVE TECHNOLOGY DEVICE/)
88	((education\$ or school\$) adj5 (rehab\$ or support\$ or adjust\$ or adapt\$ or chang\$ or reintegrat\$ or re-integrat\$ or facilitat\$ or intervention? or equipment or ergonomic\$)).ti,ab.
89	((education\$ or school\$) adj5 (assist\$ or self help or selfhelp) adj3 (device? or technolog\$ or aid?)).ti,ab.
90	(return\$ adj3 (education\$ or school\$)).ti,ab.
91	PLAY THERAPY/
92	(play\$ adj3 therap\$).ti,ab.
93	or/27-92
94	26 and 93
95	limit 94 to english language
96	limit 95 to yr="1995 -Current"
97	letter.pt. or LETTER/
98	note.pt.
99	editorial.pt.
100	CASE REPORT/ or CASE STUDY/
101	(letter or comment*).ti.
102	or/97-101
103	RANDOMIZED CONTROLLED TRIAL/ or random*.ti,ab.
104	102 not 103
105	ANIMAL/ not HUMAN/
106	NONHUMAN/
107	exp ANIMAL EXPERIMENT/
108	exp EXPERIMENTAL ANIMAL/
109	ANIMAL MODEL/
110	exp RODENT/
111	(rat or rats or mouse or mice).ti.
112	or/104-111
113	96 not 112
114	17 and 113

Database: Cochrane Central Register of Controlled Trials**Date last searched: 03/05/2019**

#	Searches
#1	[mh ^"ECONOMICS"]
#2	[mh "VALUE OF LIFE"]
#3	[mh "COSTS AND COST ANALYSIS"]
#4	[mh "ECONOMICS, HOSPITAL"]
#5	[mh "ECONOMICS, MEDICAL"]
#6	[mh "RESOURCE ALLOCATION"]
#7	[mh ^"ECONOMICS, NURSING"]
#8	[mh "ECONOMICS, PHARMACEUTICAL"]
#9	[mh "FEES AND CHARGES"]
#10	[mh "BUDGETS"]
#11	budget*:ti,ab
#12	cost*:ti,ab
#13	(economic* or pharmaco?economic*):ti,ab
#14	(price* or pricing*):ti,ab
#15	(financ* or fee or fees or expenditure* or saving*):ti,ab
#16	(value near/2 (money or monetary)):ti,ab
#17	resourc* allocat*:ti,ab
#18	(fund or funds or funding* or funded):ti,ab
#19	(ration or rations or rationing* or rationed) .ti,ab.
#20	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19
#21	[mh "THORACIC INJURIES"]
#22	[mh ^"ACUTE LUNG INJURY"]
#23	((Chest* or thoracic* or heart* or lung* or pulmonary) near/5 (injur* or trauma*)):ti,ab
#24	((Flail* or stove in) near/3 chest*):ti,ab
#25	((cardiac or heart) near/3 ruptur* near/3 trauma*):ti,ab
#26	((heart or cardiac or myocardial) near/3 contusion*):ti,ab
#27	(rib* near/5 fractur*):ti,ab
#28	#21 or #22 or #23 or #24 or #25 or #26 or #27
#29	[mh "EXERCISE THERAPY"]
#30	[mh ^EXERCISE]
#31	[mh ^SPORTS]
#32	[mh ^RUNNING]
#33	[mh ^JOGGING]
#34	[mh ^WALKING]
#35	[mh ^"STAIR CLIMBING"]
#36	[mh ^BICYCLING]
#37	[mh ^SWIMMING]
#38	((cardiopulmonary or cardio-pulmonary) near/5 (rehab* or therap*)):ti,ab
#39	((sport* or exercise* or run* or jog* or walk* or bicycl* or cycle* or cycling or swim* or row* or rowing or skip* or aerobics or gym* or treadmill* or elliptical train* or cross train* or circuit train*) near/10 (rehab* or therap* or program*)):ti,ab
#40	((sport* or exercise* or run* or jog* or walk* or bicycl* or cycle* or cycling or swim* or row* or rowing or skip* or aerobics or gym* or treadmill*) near/3 train*):ti,ab
#41	((aerobic* or cardio*) near/3 exercis*):ti,ab
#42	((resist* or strength*) near/3 (train* or exercis* or program*)):ti,ab
#43	[mh ^"PAIN MANAGEMENT"]
#44	[mh ^"FRACTURE FIXATION, INTERNAL"]
#45	((rib* or flail) near/5 fixation*):ti,ab
#46	((operati* or surgical* or internal*) near/3 fixation) and rib*):ti,ab
#47	(rib* near/5 splint*):ti,ab
#48	[mh ^"ANALGESIA, EPIDURAL"]
#49	[mh ^"INJECTIONS, EPIDURAL"]
#50	[mh ^"ANALGESIA, PATIENT-CONTROLLED"]
#51	[mh "ANESTHESIA, CONDUCTION"]
#52	((Spinal* or spinous*) near/5 analges*):ti,ab
#53	epidural*:ti,ab
#54	CSE:ti,ab
#55	((central* or regional*) near/5 neuraxial* near/5 block*):ti,ab
#56	(neuraxial* near/5 analges*):ti,ab
#57	(patient* near/3 control* near/3 analges*):ti,ab
#58	((anesthe* or anaesthe*) near/5 (conduction or region* or caudal* or local* or spinal*)):ti,ab
#59	((nerve or ganglion or plexus or neuraxial* or intercostal* or paravertebral*) near/5 block*):ti,ab
#60	(neuraxial* near/5 (anesthe* or anaesthe*)):ti,ab
#61	(thoracic* near/3 (analges* or anesthe* or anaesthe*)):ti,ab
#62	[mh ^LIDOCAINE]
#63	lidocaine:ti,ab

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

#	Searches
#64	[mh ^PAIN/dt]
#65	[mh ^"BREATHING EXERCISES"]
#66	((breath* or relax* or respirat* or inhal* or inspirat* or expirat*) near/5 (exercis* or technique* or train*)):ti,ab
#67	[mh ^SPIROMETRY]
#68	(incentiv* near/5 spirometr*):ti,ab
#69	ACBT:ti,ab
#70	[mh ^"INTERMITTENT POSITIVE-PRESSURE BREATHING"]
#71	(intermittent* near/3 positive* near/3 pressure* near/3 breath*):ti,ab
#72	IPPB:ti,ab
#73	[mh ^"REHABILITATION, VOCATIONAL"]
#74	[mh ^EMPLOYMENT]
#75	[mh ^"EMPLOYMENT, SUPPORTED"]
#76	[mh ^WORKPLACE]
#77	#74 or #75 or #76
#78	[mh ^"ADAPTATION, PHYSIOLOGICAL"]
#79	[mh ^ACCLIMATIZATION]
#80	[mh "ADAPTATION, PSYCHOLOGICAL"]
#81	[mh ^ERGONOMICS]
#82	[mh ^"EQUIPMENT DESIGN"]
#83	[mh "SELF-HELP DEVICES"]
#84	#78 or #79 or #80 or #81 or #82 or #83
#85	#77 and #84
#86	((vocation* or workplace* or job* or employment or employee* or profession* or occupation*) near/5 (rehab* or support* or adjust* or adapt* or chang* or reintegrat* or re-integrat* or facilitat* or intervention* or equipment or ergonomic*)):ti,ab
#87	(work* near/3 (place* or environment*) near/5 (rehab* or support* or adjust* or adapt* or chang* or reintegrat* or re-integrat* or facilitat* or intervention* or equipment or ergonomic*)):ti,ab
#88	((vocation* or work* or job* or employment or employee* or profession* or occupation*) near/5 (assist* or self help or selfhelp) near/3 (device* or technolog* or aid*)):ti,ab
#89	[mh ^"RETURN TO WORK"]
#90	(return* near/3 work*):ti
#91	[mh ^"VOCATIONAL GUIDANCE"]
#92	((vocation* or work* or job* or employment or employee* or profession* or occupation* or career*) near/5 (guid* or counsel*)):ti,ab
#93	[mh ^"EDUCATION"]
#94	[mh ^"SCHOOLS"]
#95	#93 or #94
#96	#95 and #84
#97	((education* or school*) near/5 (rehab* or support* or adjust* or adapt* or chang* or reintegrat* or re-integrat* or facilitat* or intervention* or equipment or ergonomic*)):ti,ab
#98	((education* or school*) near/5 (assist* or self help or selfhelp) near/3 (device* or technolog* or aid*)):ti,ab
#99	(return* near/3 (education* or school*)):ti,ab
#100	[mh ^"PLAY THERAPY"]
#101	(play* near/3 therap*):ti,ab
#102	#29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41 or #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49 or #50 or #51 or #52 or #53 or #54 or #55 or #56 or #57 or #58 or #59 or #60 or #61 or #62 or #63 or #64 or #65 or #66 or #67 or #68 or #69 or #70 or #71 or #72 or #73 or #85 or #86 or #87 or #88 or #89 or #90 or #91 or #92 or #96 or #97 or #98 or #99 or #100 or #101
#103	#28 and #102
#104	#28 and #102 with Publication Year from 1995 to 2019, in Trials
#105	#20 and #104

Appendix C – Clinical evidence study selection

Clinical study selection for review questions:

C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

A combined search was conducted for both review questions.

Figure 1: Study selection flow chart: Adults

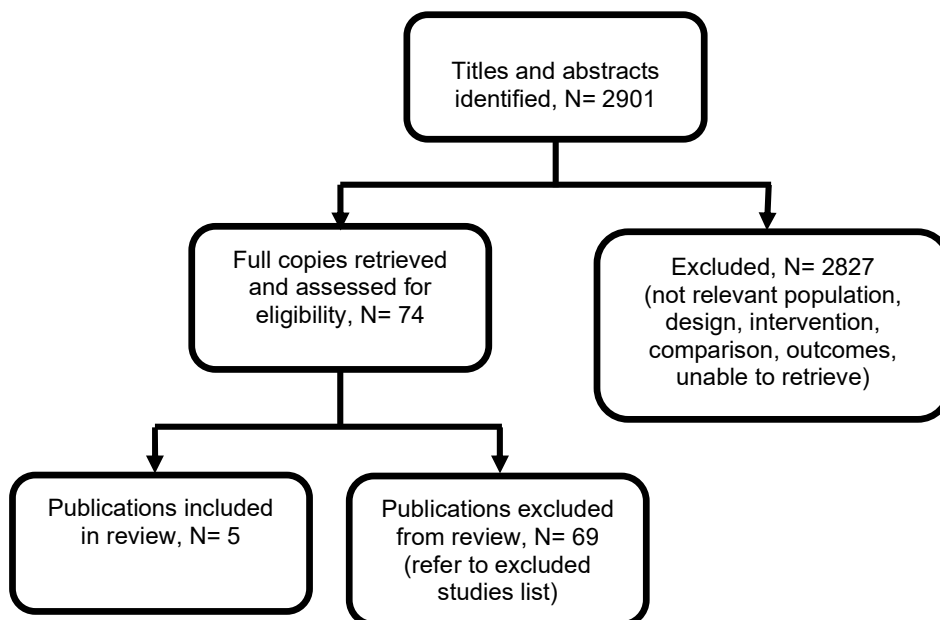
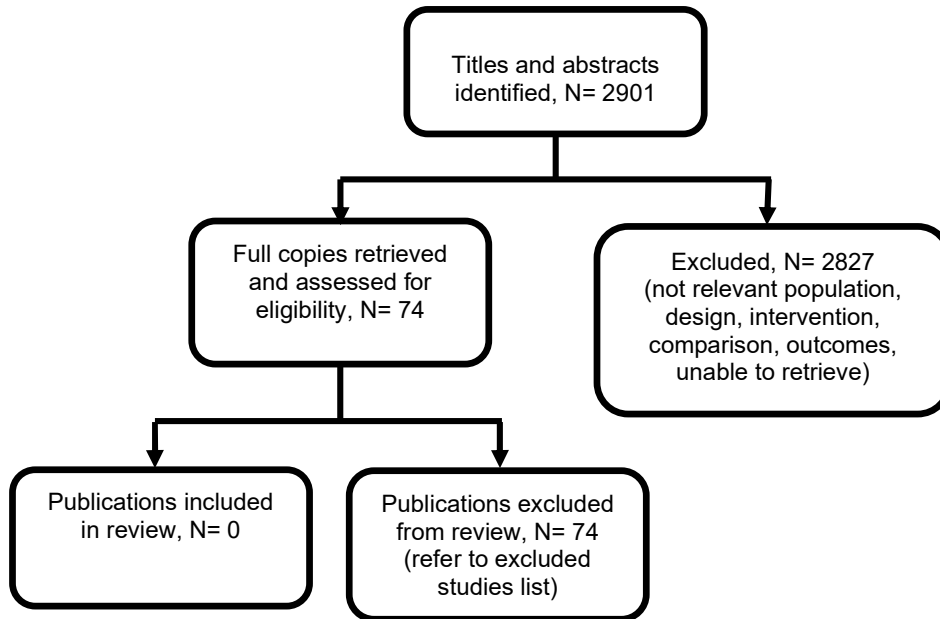


Figure 2: Study selection flow chart: Children and young people



Appendix D – Clinical evidence tables

Clinical evidence tables for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

Table 6: Clinical evidence tables

Study details	Participants	Interventions	Outcomes and Results	Comments
<p>Full citation Grammatopoulou E, Belimpasaki V, Valalas A, Michos P, Skordilis E, Koutsouki D. Active Cycle of Breathing Techniques Contributes to Pain Reduction in Patients with Rib Fractures. Hellenic Journal of Surgery 2010; 82: 1</p> <p>Ref Id 1016987</p> <p>Country/ies where the study was carried out Greece</p> <p>Study type RCT</p>	<p>Sample size N=90 (randomised and analysed)</p> <ul style="list-style-type: none"> ACBT: 45 Control: 45 <p>Characteristics Age in years [Mean (SD)]:</p> <ul style="list-style-type: none"> ACBT=59.13 (10.17) Control= 56.91 (8.86) <p>Gender (M/F):</p> <ul style="list-style-type: none"> ACBT (n): 37/8; Control (n): 33/12 <p>Smoking status (Y/N):</p> <ul style="list-style-type: none"> ACBT (n): 25/20 Control (n): 31/14 <p>Mechanism of injury (mobile accident/fall):</p> <ul style="list-style-type: none"> ACBT (n): 31/14 Control (n): 24/21 <p>Number of ribs fractured (3/4/5):</p> <ul style="list-style-type: none"> ACBT (n): 24/14/7 	<p>All patients: Analgesia consisting of (day 1-3) D-propoxyphen (HCl: 75 mg every 6 hours intramuscularly) or pethidine (HCl: 0.50 mg every 8 hours intramuscularly) and (days 4-7) paracetamol (500mg orally) and codeine phosphate (30 mg orally every 6 hours).</p> <p>Control: Routine chest physiotherapy consisting of:</p> <ul style="list-style-type: none"> - frequent positioning, - early mobilization, - effective coughing with pillow or hand support, but no rib belt support), - flow-oriented incentive spirometer (4 times a day). <p>Patients instructed "to execute deep and slow inspiration and sustain the inflation for a minimum of 3-sec. The participants performed 8 to 10 respiratory cycles per session, at a minimum, every hour, in the</p>	<p>Pain during cough (mean; SD):</p> <p>Day 1: ACBT: 8.73 (1.12) Control: 8.64 (1.07)</p> <p>Day 2: ACBT: 8.15 (1.31) Control: 8.13 (.87)</p> <p>Day 3: ACBT: 6.95 (1.38) Control: 7.29 (.92)</p> <p>Day 4: ACBT: 5.24 (1.23) Control: 6.67 (.85)</p> <p>Day 5: ACBT: 3.78 (.97) Control: 6.2 (.87)</p> <p>Day 6: ACBT: 2.58 (.72) Control: 5.42 (.86)</p>	<p>Limitations Quality assessment: Risk of bias assessed using revised Cochrane risk of bias tool (RoB 2)</p> <p><u>Domain 1: Risk of bias arising from the randomization process</u> 1.1 Was the allocation sequence random? NI stratified random sampling procedure based on number of rib fractures 1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions? NI 1.3 Did baseline differences between intervention groups suggest a problem with the randomization process? PN Risk-of-bias judgement Some concerns</p> <p><u>Domain 2: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)</u> 2.1. Were participants aware of their assigned intervention during the trial? PN aware of participation in physiotherapy</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
<p>Aim of the study “The purpose of the study was to examine the effectiveness of the active cycle of breathing techniques (ACBT) in pain reduction and in preventing pulmonary complications in patients with rib fractures.” (p. 52).</p> <p>Study dates Not reported</p> <p>Source of funding Not reported</p>	<ul style="list-style-type: none"> Control (n): 21/16/9 <p>Type of concomitant injuries (pneumothorax, pulmonary contusion, haemothorax):</p> <ul style="list-style-type: none"> ACBT (n): 25/23/21 Control (n): 18/23/15 <p>Inclusion criteria “A purposive sample of ninety-seven (97) patients with rib fractures, who had been admitted to the department of General Thoracic Surgery of the ‘KAT’ General Hospital in Athens, Greece, was invited to participate in the study. Ninety (90) patients attended the study and signed the informed consent form. The participants were over 45 years old [20] and had at least three rib fractures [21] which had occurred on the day of admission.” (p. 53) “Given that the degree of pulmonary dysfunction usually peaks at 72 hours and generally resolves within 7 days, the length</p>	<p>sitting position.” (p. 54).</p> <p>Versus</p> <p>ACBT: As the control group + ACBT (no details given) twice a day on days 1-3 and once a day on days 4-7.</p> <ul style="list-style-type: none"> Follow-up: 7 days (length of trial) 	<p>Day 7: ACBT: 1.89 (.57) Control: 4.51 (.84)</p> <p>MANOVA showed significant interaction between time and group which reflected 1) significantly lower pain in ACBT group on days 3-7 compared to control group, with no significant differences between the groups on days 1-2; 2) Each day pain was significantly lower for the ACBT group relative to the day before; and this was also the case for the control group</p>	<p>intervention program</p> <p>2.2. Were carers and people delivering the interventions aware of participants' assigned intervention during the trial? PY although the authors state that the physiotherapists who undertook the session were blinded to group allocation</p> <p>2.3. <u>If Y/PY/NI to 2.1 or 2.2:</u> Were there deviations from the intended intervention that arose because of the experimental context? PN n=45 has been analysed in each group</p> <p>2.4. <u>If Y/PY to 2.3:</u> Were these deviations from intended intervention balanced between groups? NA</p> <p>2.5 <u>If N/PN/NI to 2.4:</u> Were these deviations likely to have affected the outcome? NA</p> <p>2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention? Y</p> <p>2.7 <u>If N/PN/NI to 2.6:</u> Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomized? NA</p> <p>Risk-of-bias judgement Low risk</p> <p><u>Domain 3: Missing outcome data</u></p> <p>3.1 Were data for this outcome available for all, or nearly all, participants randomized? PY data analysed for n=45 in each group; not reported whether the 7 patients invited to participate who did not were randomised</p> <p>3.2 <u>If N/PN/NI to 3.1:</u> Is there evidence that the result was not biased by missing outcome data? N no additional analyses conducted</p>

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	<p>of hospital stay was 7 days" (p. 53)</p> <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Comatose, • required mechanical ventilation, • unstable spinal fracture or spinal cord injury, • other form of injuries (e.g., fractures of other bones, etc). 			<p>3.3 <u>If N/PN to 3.2</u>: Could missingness in the outcome depend on its true value? NI</p> <p>3.4 <u>If Y/PY/NI to 3.3</u>: Is it likely that missingness in the outcome depended on its true value? NI</p> <p>Risk-of-bias judgement High risk</p> <p><u>Domain 4: Risk of bias in measurement of the outcome</u></p> <p>4.1 Was the method of measuring the outcome inappropriate? N measured on VAS [0-10] daily during cough after physiotherapy 2 hours after analgesia</p> <p>4.2 Could measurement or ascertainment of the outcome have differed between intervention groups? PN methods appeared to be the same between the intervention groups</p> <p>4.3 <u>If N/PN/NI to 4.1 and 4.2</u>: Were outcome assessors aware of the intervention received by study participants? PN blinded outcome assessment</p> <p>4.4 <u>If Y/PY/NI to 4.3</u>: Could assessment of the outcome have been influenced by knowledge of intervention received? NA</p> <p>4.5 <u>If Y/PY/NI to 4.4</u>: Is it likely that assessment of the outcome was influenced by knowledge of intervention received? NA</p> <p>Risk-of-bias judgement Low risk</p> <p><u>Domain 5: Risk of bias in selection of the reported result</u></p> <p>5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
				<p>unblinded outcome data were available for analysis? NI</p> <p>Is the numerical result being assessed likely to have been selected, on the basis of the results, from...</p> <p>5.2. ... multiple outcome measurements (e.g. scales, definitions, time points) within the outcome domain? NI</p> <p>5.3 ... multiple analyses of the data? NI</p> <p>Risk-of-bias judgement Some concerns</p> <p><u>Overall risk of bias</u></p> <p>Risk-of-bias judgement High risk</p>
<p>Full citation Iacco A. Continuous intercostal nerve blockade for traumatic rib fractures. https://clinicaltrials.gov/ct2/show/nct02604589</p> <p>Ref Id 1002211</p> <p>Country/ies where the study was carried out USA</p> <p>Study type RCT</p>	<p>Sample size N=10 (randomised)</p> <ul style="list-style-type: none"> Block-low dose: 5 Block-high dose: 2 PCA: 3 <p>Characteristics Age in years [Mean (SD)]:</p> <ul style="list-style-type: none"> Block-low dose = 60.4 (24.93); Block-high dose = 63.5 (6.36); PCA = 61.67 (16.56) <p>Gender (M/F):</p> <ul style="list-style-type: none"> Block-low dose (n): 4/1; Block-high dose (n): 0/2; 	<p>Intercostal block-low dose: Infusion dual chamber catheter with bupivacaine 0.25% 4 ml per hour total in addition to PCA as per PCA group.</p> <p>Versus</p> <p>Intercostal block-high dose: Infusion dual chamber catheter with bupivacaine 0.5% 4 ml per hour total in addition to PCA as per PCA group</p> <p>Versus</p> <p>PCA (patient-controlled analgesia): 0.1 mg hydromorphone hydrochloride intravenous per 6 mins; with, for</p>	<p>Time to improvement in pain intensity (defined as ≥ 2 points reduction on scale from 0 (no pain) -10 (worst pain ever; mean (SD); days):</p> <p>Block-low dose: 3 (0)</p> <p>Block-high dose: 1 (0)</p> <p>PCA: 2 (0)</p>	<p>Limitations</p> <p>Quality assessment: Risk of bias assessed using revised Cochrane risk of bias tool (RoB 2)</p> <p><u>Domain 1: Risk of bias arising from the randomization process</u></p> <p>1.1 Was the allocation sequence random? NI</p> <p>1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions? NI</p> <p>1.3 Did baseline differences between intervention groups suggest a problem with the randomization process? PY but very low patient numbers</p> <p>Risk-of-bias judgement High risk</p> <p><u>Domain 2: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)</u></p>

Study details	Participants	Interventions	Outcomes and Results	Comments
<p>Aim of the study To compare the effectiveness of intercostal nerve blockade to patient-controlled analgesia in patients with two or more rib fractures due to trauma</p> <p>Study dates 2015-2016</p> <p>Source of funding Not reported</p>	<ul style="list-style-type: none"> • PCA (n): 0/3 <p>Number of ribs fractured [mean (SD)]:</p> <ul style="list-style-type: none"> • Block-low dose = 6.6 (3.7); • Block-high dose = 5 (1.4); • PCA = 4.7 (2.5) <p>Admission incentive spirometry volume [mean (SD); cc]:</p> <ul style="list-style-type: none"> • Block-low dose = 783 (630); • Block-high dose = 1567 (818); • PCA = 978 (563) <p>Admission pain score [median (range); measured on analog pain scale 1 (no pain) - 10 (worst pain ever)]:</p> <ul style="list-style-type: none"> • Block-low dose = 8 (7-10); • Block-high dose = 7 (6-9); • PCA = 8 (8-8) <p>Inclusion criteria Patients aged ≥ 18 years, able and willing</p>	<p>uncontrolled pain, boluses 0.1 mg intravenous hydromorphone up to max 2.5 mg per hour.</p>		<p>2.1. Were participants aware of their assigned intervention during the trial? Y patients unblinded</p> <p>2.2. Were carers and people delivering the interventions aware of participants' assigned intervention during the trial? N but no further details reported</p> <p>2.3. <u>If Y/PY/NI to 2.1 or 2.2</u>: Were there deviations from the intended intervention that arose because of the experimental context? NI One patient is not included in the analyses, but unclear why</p> <p>2.4. <u>If Y/PY to 2.3</u>: Were these deviations from intended intervention balanced between groups? NA</p> <p>2.5 <u>If N/PN/NI to 2.4</u>: Were these deviations likely to have affected the outcome? NA</p> <p>2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention? Y</p> <p>2.7 <u>If N/PN/NI to 2.6</u>: Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomized? NA</p> <p>Risk-of-bias judgement Some concerns</p> <p><u>Domain 3: Missing outcome data</u></p> <p>3.1 Were data for this outcome available for all, or nearly all, participants randomized? PN block-high dose only data from 1/2 patients</p> <p>3.2 <u>If N/PN/NI to 3.1</u>: Is there evidence that the result was not biased by missing outcome data? N</p> <p>3.3 <u>If N/PN to 3.2</u>: Could missingness in the</p>

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	<p>to give informed consent, admitted the trauma service at Beaumont Hospital, Royal Oak, Michigan with ≥ 2 in an anatomic pattern feasible for uni- or bilateral nerve blockade</p> <p>Exclusion criteria</p> <ul style="list-style-type: none"> • pregnancy or breastfeeding • intubation before placement of continuous infusion catheter • significant concomitant injuries that could confound the evaluation of the outcomes (eg., traumatic brain injury) • previous allergic reaction to local anaesthetic • use of epidural or paravertebral nerve blockade before evaluation of current intervention • International Normalized Ratio > 2.0 			<p>outcome depend on its true value? PY see 3. 3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value? PY see 3. Risk-of-bias judgement High risk</p> <p><u>Domain 4: Risk of bias in measurement of the outcome</u> 4.1 Was the method of measuring the outcome inappropriate? N standard pain scale 4.2 Could measurement or ascertainment of the outcome have differed between intervention groups? PN methods appeared to be the same between the intervention groups 4.3 If N/PN/NI to 4.1 and 4.2: Were outcome assessors aware of the intervention received by study participants? Y patient-assessed and patients unblinded 4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received? PY (see 4.3) 4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received? NI (it is possible, but difficult to say) Risk-of-bias judgement High risk</p> <p><u>Domain 5: Risk of bias in selection of the reported result</u> 5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
	<ul style="list-style-type: none"> unable to give informed consent 			<p>unblinded outcome data were available for analysis? Y Trial protocol registration Is the numerical result being assessed likely to have been selected, on the basis of the results, from...</p> <p>5.2. ... multiple outcome measurements (e.g. scales, definitions, time points) within the outcome domain? PN explicit definition of the outcome with pain assessed at baseline, and as a change from baseline at 24, 48, and 72 hours</p> <p>5.3 ... multiple analyses of the data? PN see 5.2</p> <p>Risk-of-bias judgement Low risk</p> <p><u>Overall risk of bias</u> Risk-of-bias judgement High risk</p> <p>Other information: Only recruited 10/375 originally estimated patients</p>
<p>Full citation Moon MR, Luchette FA, Gibson SW, Crews J, Sudarshan G, Hurst JM, Davis K, Johannigman JA, Frame SB, Fischer JE. Prospective, Randomized Comparison of Epidural Versus Parenteral Opioid Analgesia in</p>	<p>Sample size N=34 randomised, of whom 24 completed the study</p> <ul style="list-style-type: none"> Epidural: 13 PCA: 11 <p>Characteristics Age in years (measure and dispersion not given):</p> <ul style="list-style-type: none"> Epidural = 37 PCA = 40 <p>Gender (M/F):</p>	<p>Epidural: Thoracic epidural catheters in the epidural space between T5 and T7. Placement checked using a 3-ml test dose of lidocaine 1.5% with epinephrine 1:200,000 and followed by sensory testing of thoracic dermatomes 10 mins later. Subsequently, the catheter was further dosed with 50 mg fentanyl and 3 mg preservative-free morphine. "Within 1 hour after placement of the catheter, a continuous infusion of</p>	<p>Pain with coughing</p> <ul style="list-style-type: none"> Pain measured on 0 (no pain) – 10 (worst pain imaginable) verbal rating scale. Most of the pain results are read of Figure 1, which probably reports means (no measure of dispersion), although this is not clear. 	<p>Limitations</p> <p>Quality assessment: Risk of bias assessed using revised Cochrane risk of bias tool (RoB 2)</p> <p><u>Domain 1: Risk of bias arising from the randomization process</u></p> <p>1.1 Was the allocation sequence random? PY Although authors report using a "restricted scheme" without elaborating on that</p> <p>1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions? NI</p>

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<p>Thoracic Trauma Annals of Surgery 1999; 229: 684–692</p> <p>Ref Id 1002097</p> <p>Country/ies where the study was carried out USA</p> <p>Study type RCT</p> <p>Aim of the study To compare “the effect of epidural analgesia and PCA on pain relief, pulmonary function, catechol release, and immune response in patients sustaining significant thoracic trauma.” (p. 684)</p> <p>Study dates 1996 to 1998</p> <p>Source of funding Not reported</p>	<ul style="list-style-type: none"> • Epidural (n): 8/5; • PCA (n): 6/5 <p>Injury severity score (measure and dispersion not given)</p> <ul style="list-style-type: none"> • Epidural: 26.6 • PCA: 23.4 <p>Thoracic abbreviated injury score (measure and dispersion not given)</p> <ul style="list-style-type: none"> • Epidural: 3.7 • PCA: 3.7 <p>Age, gender, injury severity score, thoracic abbreviated injury score, and hospital, intensive care unit, or floor length of stay did not differ significantly between the intervention groups.</p> <p>Inclusion criteria Patients aged 18-60 years with thoracic trauma defined as ≥ 1 of:</p> <ul style="list-style-type: none"> • ≥ 3 consecutive rib fractures, • a flail chest wall segment, • pulmonary contusion (diagnosed by 	<p>bupivacaine 0.25% (Astra) and morphine (0.005%) was initiated at a rate of 4 to 6 ml/hr using an infusion pump (Abbott, Chicago, IL).” (p. 686). The infusion rates were adjusted by staff at the acute pain clinic to optimise pain relief and minimise adverse events.</p> <p>Versus</p> <p>PCA: Before PCA, a loading dose of intravenous morphine (0.1 mg/kg), then titration by staff at the acute pain service, followed by PCA using morphine (1 mg/ml) in bolus doses of 2 mg with a lock-out duration of 10 minutes and no background infusion. Additional doses could be given if agreed by staff at the acute pain service.</p>	<p><u>Day 1:</u> Epidural: ca 5.8 PCA: ca. 7.4 Student’s t-test: $P < 0.05$</p> <p><u>Day 2:</u> Epidural: ca 6 PCA: 6.2 Student’s t-test: Not significant</p> <p><u>Day 3:</u> Epidural: 3.8 PCA: ca. 6.2 Student’s t-test: $P < 0.05$</p>	<p>1.3 Did baseline differences between intervention groups suggest a problem with the randomization process? PN No differences in reported characteristics Risk-of-bias judgement Some concerns</p> <p><u>Domain 2: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)</u></p> <p>2.1. Were participants aware of their assigned intervention during the trial? NI</p> <p>2.2. Were carers and people delivering the interventions aware of participants' assigned intervention during the trial? NI</p> <p>2.3. <u>If Y/PY/NI to 2.1 or 2.2:</u> Were there deviations from the intended intervention that arose because of the experimental context? NI</p> <p>2.4. <u>If Y/PY to 2.3:</u> Were these deviations from intended intervention balanced between groups? NA</p> <p>2.5 <u>If N/PN/NI to 2.4:</u> Were these deviations likely to have affected the outcome? NA</p> <p>2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention? Y</p> <p>2.7 <u>If N/PN/NI to 2.6:</u> Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomized? NA Risk-of-bias judgement Some concerns</p> <p><u>Domain 3: Missing outcome data</u></p>

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	<p>mechanism of injury, arterial blood gases, and chest radiograph or noted on CT),</p> <ul style="list-style-type: none"> • sternal fracture. <p>Exclusion criteria Patients with:</p> <ul style="list-style-type: none"> • contraindications to epidural catheter placement (coagulopathy, infection at insertion site, sepsis, or hypovolemic shock), • morbid obesity (100 lb more than ideal body weight), • spinal cord injury above T10, • Glasgow Coma Score < 15, • adrenal insufficiency, • use of steroids within 6 months before injury, • need for vasoactive agents to support blood pressure, • immunodeficiency disease, • pregnancy, 			<p>3.1 Were data for this outcome available for all, or nearly all, participants randomized? N Data available for a max of 24/34 randomised patients</p> <p>3.2 If N/PN/NI to 3.1: Is there evidence that the result was not biased by missing outcome data? N No additional analyses presented</p> <p>3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value? Y No detailed exclusion reasons given</p> <p>3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value? PY Feasible that patients dropped out due to their health status Risk-of-bias judgement High risk</p> <p><u>Domain 4: Risk of bias in measurement of the outcome</u></p> <p>4.1 Was the method of measuring the outcome inappropriate? PN Assessed by staff, not the patients. Not much detail other than “nursing staff trained in pain-assessment techniques” (p. 686) reported</p> <p>4.2 Could measurement or ascertainment of the outcome have differed between intervention groups? PN Methods appeared to be the same between the intervention groups</p> <p>4.3 If N/PN/NI to 4.1 and 4.2: Were outcome assessors aware of the intervention received by study participants? NI Unclear if any blinding was undertaken</p> <p>4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by</p>

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	<ul style="list-style-type: none"> inability to communicate effectively, history of allergy to local anaesthetics or opioids 			<p>knowledge of intervention received? PY No placebo control so the staff could probably see which intervention the patients received</p> <p>4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received? NI</p> <p>Risk-of-bias judgement High risk</p> <p><u>Domain 5: Risk of bias in selection of the reported result</u></p> <p>5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis? NI</p> <p>Is the numerical result being assessed likely to have been selected, on the basis of the results, from...</p> <p>5.2 ... multiple outcome measurements (e.g. scales, definitions, time points) within the outcome domain? PY The authors report that “Dynamic pain scoring (<i>i.e.</i>, at rest, on deep inspiration, and on movement) was performed at each time point.” (p. 686), but do only report pain on coughing.</p> <p>5.3 ... multiple analyses of the data? Y see 5.2 and “Other information”</p> <p>Risk-of-bias judgement High risk</p> <p><u>Overall risk of bias</u></p> <p>Risk-of-bias judgement High risk</p> <p>Other information: Students t-test used when it should be ANOVA which results in alpha-</p>

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				level inflation that we cannot adjust for given the fact that no absolute p-values reported, only “p<0.05”.
<p>Full citation Sum SK, Peng YC, Yin SY, Huang PF., Wang, YC, Chen TP, Tung HH, Yeh CH. Using an incentive spirometer reduces pulmonary complications in patients with traumatic rib fractures: a randomized controlled trial, <i>Trials</i>, 20, 797, 2019</p> <p>Ref Id 1286099</p> <p>Country/ies where the study was carried out China</p> <p>Study type RCT</p> <p>Aim of the study “This study</p>	<p>Sample size N=50 (randomised)</p> <ul style="list-style-type: none"> Incentive spirometer (IS): 24 Control (no IS): 26 <p>Characteristics Age in years (mean (SD)):</p> <ul style="list-style-type: none"> IS = 56 (13.9) Control = 54.5 (15.2) <p>Gender (M/F):</p> <ul style="list-style-type: none"> IS (n): 17/7; Control (n): 17/9 <p>Injury severity score (mean (SD))</p> <ul style="list-style-type: none"> IS: 8.1 (3.8) Control: 8.2 (3.8) <p>Number of ribs fractured (<3 / ≥ 3)</p> <ul style="list-style-type: none"> IS (n): 6/18 Control (n): 5/21 <p>Number of ribs fractured (mean(SD))</p> <ul style="list-style-type: none"> IS: 3.79 (2.21) Control: 4.08 (1.94) <p>These characteristics, height, weight BMI, initial blood laboratory data, smoking status,</p>	<p>Incentive spirometer (IS): Flow-oriented tri-flow spirometer, with clearly visible results (the three floating balls indicating inspiratory flows of 600, 900, and 1200 ml/s). After demonstration of how to use the IS in a seated or semi-seated position, the patients were instructed to maintain a sustained maximal inspiration for 3–5 seconds before exhalation, ten times per hour, for ≥8 hours a day.</p> <p>Versus</p> <p>Control: No incentive spirometer used. No further details.</p> <p>“All patients were managed with the same oral analgesic protocol.” (p. 2), not further specified.</p>	<p>Chest pain (measured on numeric rating scale) 1st day/admission (mean (SD)) IS: 4.46 (1.38) Control: 4.23 (1.45)</p> <p>Chest pain (measured on numeric rating scale) 2nd day (mean (SD)) IS: 3.13 (0.95) Control: 3.38 (1.7)</p> <p>Chest pain (measured on numeric rating scale) 5th day (mean (SD)) IS: 2.73 (1.17) Control: 3 (1.48)</p>	<p>Limitations Quality assessment: Risk of bias assessed using revised Cochrane risk of bias tool (RoB 2)</p> <p><u>Domain 1: Risk of bias arising from the randomization process</u></p> <p>1.1 Was the allocation sequence random? NI allocation described as random, but no details given</p> <p>1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions? NI study reports using the sealed envelope technique, but gives no further details</p> <p>1.3 Did baseline differences between intervention groups suggest a problem with the randomization process? PN No significant differences observed in reported characteristics Risk-of-bias judgement: Some concerns</p> <p><u>Domain 2: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)</u></p> <p>2.1. Were participants aware of their assigned intervention during the trial? PY No information about blinding and no placebo used</p> <p>2.2. Were carers and people delivering the</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
<p>explored the effects of using an IS [incentive spirometer] on lung function and pulmonary complication rate in rib fracture patients. (p. 2)</p> <p>Study dates 2014-2017</p> <p>Source of funding “This work was supported by grants CMRPG 2E0221 (to YCP) and CMRPG 2F0212 (to CHY) from Chang Gung Memorial Hospital, Keelung.” (p. 7)</p>	<p>site of injury, associated injuries, diabetes mellitus, hypertension, heart disease, kidney disease, anti-platelet/coagulant use before trauma and trauma mechanism did not differ significantly between the groups.</p> <p>Inclusion criteria Female or male adult patients aged > 18 years, with ≥ 1 traumatic rib fracture on chest X-ray or CT.</p> <p>Exclusion criteria Patients who were unconscious, had a history of COPD or asthma, or an injury severity score ≥ 16.</p>			<p>interventions aware of participants' assigned intervention during the trial? PY see 2.1</p> <p>2.3. <u>If Y/PY/NI to 2.1 or 2.2</u>: Were there deviations from the intended intervention that arose because of the experimental context? NI</p> <p>2.4. <u>If Y/PY to 2.3</u>: Were these deviations from intended intervention balanced between groups? NA</p> <p>2.5 <u>If N/PN/NI to 2.4</u>: Were these deviations likely to have affected the outcome? NA</p> <p>2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention? PY Students t-test or chi-squared used when it should be ANOVA (alpha-level inflation)</p> <p>2.7 <u>If N/PN/NI to 2.6</u>: Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomized? NA</p> <p>Risk-of-bias judgement: High risk</p> <p><u>Domain 3: Missing outcome data</u></p> <p>3.1 Were data for this outcome available for all, or nearly all, participants randomized? NI the study does not report that all randomised patients completed the study</p> <p>3.2 <u>If N/PN/NI to 3.1</u>: Is there evidence that the result was not biased by missing outcome data? N No information reported re any missing data or not.</p> <p>3.3 <u>If N/PN to 3.2</u>: Could missingness in the outcome depend on its true value? NI</p> <p>3.4 <u>If Y/PY/NI to 3.3</u>: Is it likely that missingness in the outcome depended on its</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
				<p>true value? NI Risk-of-bias judgement Some concerns</p> <p><u>Domain 4: Risk of bias in measurement of the outcome</u> 4.1 Was the method of measuring the outcome inappropriate? N Pain assessed using NRS (although not further defined than to state that acceptable pain is NRS < 4. 4.2 Could measurement or ascertainment of the outcome have differed between intervention groups? PN Pain appears to have been measured the same way in each group 4.3 <u>If N/PN/NI to 4.1 and 4.2:</u> Were outcome assessors aware of the intervention received by study participants? PY though no information actually reported. 4.4 <u>If Y/PY/NI to 4.3:</u> Could assessment of the outcome have been influenced by knowledge of intervention received? PY 4.5 <u>If Y/PY/NI to 4.4:</u> Is it likely that assessment of the outcome was influenced by knowledge of intervention received? NI Risk-of-bias judgement High risk</p> <p><u>Domain 5: Risk of bias in selection of the reported result</u> 5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis? NI Is the numerical result being assessed likely to have been selected, on the basis of the</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
				<p>results, from...</p> <p>5.2. ... multiple outcome measurements (e.g. scales, definitions, time points) within the outcome domain? PN Data from multiple time points presented</p> <p>5.3 ... multiple analyses of the data? NI</p> <p>Risk-of-bias judgement Some concerns</p> <p><u>Overall risk of bias</u> Risk-of-bias judgement High risk</p> <p>Other information: None</p>
<p>Full citation Yeying G, Liyong Y, Yuebo C, Yu Z, Guangao Y, Weihi M, Liu Jun Z Thoracic paravertebral block versus intravenous patient controlled analgesia for pain treatment in patients with multiple rib fractures. Journal of International Medical Research 2017, Vol. 45(6) 2085–2091</p> <p>Ref Id 1003104</p>	<p>Sample size N=90 (randomised)</p> <ul style="list-style-type: none"> Block: 45 PCA: 45 <p>Characteristics Age in years (mean (SD)):</p> <ul style="list-style-type: none"> Block = 39.1 (8.9) PCA = 41.2 (9.7) <p>Gender (M/F):</p> <ul style="list-style-type: none"> Block (n): 29/16; PCA (n): 31/14 <p>Injury severity score (mean (SD))</p> <ul style="list-style-type: none"> Block: 14.2 (5.1) PCA: 13.7 (5.5) <p>Abbreviated injury score (mean (SD))</p> <ul style="list-style-type: none"> Block: 3.1 (0.8) PCA: 3 (0.9) <p>Number of ribs fractured</p>	<p>Paravertebral block: Ultrasound-guided needle insertion with slow injection of 15 ml of 0.5% ropivacaine followed by insertion of 24-gauge, 30-cm catheter 3-4 cm beyond the needle tip and injection of 15 ml of 0.5% ropivacaine. "The solution in the TPVB [thoracic paravertebral block] pump contained 250mL of 0.2% ropivacaine, and the continuous infusion rate was set at 5 mL/h. The bolus dose was 5mL and the lockout interval was 15 minutes." (p. 2087)</p> <p>Versus</p> <p>PCA: Sufentanil 2 mg/kg diluted in normal saline at a volume of 100 ml; continuous delivery</p>	<p>Pain at rest (mean (SD)) <u>Baseline:</u> Block: 7.6 (2.2) PCA: 7.8 (2.1)</p> <p><u>60 mins post-analgesia:</u> Block: 3.9 (1.3) PCA: 4.9 (1.5) Student's t-test: P<0.05</p> <p><u>1 day post-analgesia:</u> Block: 3.4 (1) PCA: 4.1 (1.2) Student's t-test: P<0.05</p> <p><u>2 days post-analgesia:</u> Block: 2.8 (0.9) PCA: 3 (1)</p>	<p>Limitations Quality assessment: Risk of bias assessed using revised Cochrane risk of bias tool (RoB 2)</p> <p><u>Domain 1: Risk of bias arising from the randomization process</u></p> <p>1.1 Was the allocation sequence random? NI allocation described as random, but no details given</p> <p>1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions? NI study reports using the sealed envelope technique, but gives no further details</p> <p>1.3 Did baseline differences between intervention groups suggest a problem with the randomization process? PN No significant differences observed in reported characteristics</p> <p>Risk-of-bias judgement Some concerns</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
<p>Country/ies where the study was carried out China</p> <p>Study type RCT</p> <p>Aim of the study “To assess the effect of thoracic paravertebral block (PVB) on pain management and preservation of pulmonary function compared with intravenous, patient-controlled analgesia (IVPCA) in patients with multiple rib fractures (MRFs).” (p. 2085)</p> <p>Study dates 2015-2016</p> <p>Source of funding No funding received</p>	<p>(mean (SD))</p> <ul style="list-style-type: none"> • Block: 3.9 (1.2) • PCA: 4.1 (1.4) <p>These characteristics and weight did not differ significantly between the groups.</p> <p>Inclusion criteria Female or male adult patients with ≥ 3 unilateral fractured ribs.</p> <p>Exclusion criteria Patients aged below 18 or above 70 years with severe head injury, unconsciousness, body mass index ≥ 35, thoracic or abdominal visceral injuries, unstable cardiac status, severe liver or kidney disease, coagulopathy, spinal or pelvic fracture, infection at the puncture site or allergy to local anaesthetics.</p>	<p>dose = 2 ml per hour, and the bolus dose = 2 ml with a 15-min lockout time.</p> <p>“For each patient, oral acetaminophen (500 mg) was provided every 12 hours. Low-dose tramadol 1 mg/kg was administered when the visual analogue scale (VAS) score was greater than 4 as rescue analgesia.” (p. 2087) unclear of this applied only to PCA or to all patients</p>	<p>Student’s t-test: Not significant</p> <p><u>3 days post-analgesia:</u> Block: 2.1 (0.5) PCA: 2.2 (0.6) Student’s t-test: Not significant</p> <p>Pain on coughing (mean (SD)) <u>Baseline:</u> Block: 7.9 (2) PCA: 8 (2.2)</p> <p><u>60 mins post-analgesia:</u> Block: 4.5 (1.6) PCA: 5.6 (1.7) Student’s t-test: P<0.05</p> <p><u>1 day post-analgesia:</u> Block: 3.9 (1.1) PCA: 4.5 (1.3) Student’s t-test: P<0.05</p> <p><u>2 days post-analgesia:</u> Block: 3.3 (0.8) PCA: 3.5 (0.9) Student’s t-test: P<0.05</p> <p><u>3 days post-analgesia:</u> Block: 2.7 (0.6)</p>	<p><u>Domain 2: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)</u></p> <p>2.1. Were participants aware of their assigned intervention during the trial? PY No information about blinding and no placebo used</p> <p>2.2. Were carers and people delivering the interventions aware of participants' assigned intervention during the trial? PY see 2.1</p> <p>2.3. <u>If Y/PY/NI to 2.1 or 2.2:</u> Were there deviations from the intended intervention that arose because of the experimental context? NI</p> <p>2.4. <u>If Y/PY to 2.3:</u> Were these deviations from intended intervention balanced between groups? NA</p> <p>2.5 <u>If N/PN/NI to 2.4:</u> Were these deviations likely to have affected the outcome? NA</p> <p>2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention? PY Students t-test used when it should be ANOVA (alpha-level inflation)</p> <p>2.7 <u>If N/PN/NI to 2.6:</u> Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomized? NA</p> <p>Risk-of-bias judgement High risk</p> <p><u>Domain 3: Missing outcome data</u></p> <p>3.1 Were data for this outcome available for all, or nearly all, participants randomized? NI the study does not report that all randomised patients completed the study</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
			PCA: 2.8 (0.7) Student's t-test: P<0.05	<p>3.2 <u>If N/PN/NI to 3.1</u>: Is there evidence that the result was not biased by missing outcome data? N No information reported re any missing data or not.</p> <p>3.3 <u>If N/PN to 3.2</u>: Could missingness in the outcome depend on its true value? NI</p> <p>3.4 <u>If Y/PY/NI to 3.3</u>: Is it likely that missingness in the outcome depended on its true value? NI</p> <p>Risk-of-bias judgement Some concerns</p> <p><u>Domain 4: Risk of bias in measurement of the outcome</u></p> <p>4.1 Was the method of measuring the outcome inappropriate? N Pain assessed using VAS (0 no pain -10 worst imaginable pain)</p> <p>4.2 Could measurement or ascertainment of the outcome have differed between intervention groups? PN Pain appears to have been measured the same way in each group</p> <p>4.3 <u>If N/PN/NI to 4.1 and 4.2</u>: Were outcome assessors aware of the intervention received by study participants? PY Nurses collecting data described as blinded, but not the patients, no placebo was used, and unclear whether nurses or patients rated pain.</p> <p>4.4 <u>If Y/PY/NI to 4.3</u>: Could assessment of the outcome have been influenced by knowledge of intervention received? PY</p> <p>4.5 <u>If Y/PY/NI to 4.4</u>: Is it likely that assessment of the outcome was influenced by knowledge of intervention received? NI</p> <p>Risk-of-bias judgement High risk</p>

Study details	Participants	Interventions	Outcomes and Results	Comments
				<p><u>Domain 5: Risk of bias in selection of the reported result</u></p> <p>5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis? NI Is the numerical result being assessed likely to have been selected, on the basis of the results, from...</p> <p>5.2. ... multiple outcome measurements (e.g. scales, definitions, time points) within the outcome domain? PN Data from multiple time points presented</p> <p>5.3 ... multiple analyses of the data? NI, but see "Other information"</p> <p>Risk-of-bias judgement Some concerns</p> <p><u>Overall risk of bias</u> Risk-of-bias judgement High risk</p> <p>Other information: Students t-test used when it should be ANOVA which results in alpha-level inflation that we cannot adjust for given the fact that no absolute p-values reported, only "p<0.05".</p>

F: Female; NI: No information; M: Male; N: Number; PCA: Patient-controlled analgesia; PN: Probably no; PY: Probably yes; SD: Standard deviation; RCT: Randomised controlled trial

Clinical evidence tables for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No evidence was identified which was applicable to this review question.

Appendix E – Forest plots

Forest plots for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No meta-analyses were performed as the interventions or outcomes were either not sufficiently similar to allow them to be combined or they were not reported by more than one study.

Forest plots for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No evidence was identified which was applicable to this review question.

Appendix F – GRADE tables

GRADE tables for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

Table 7: Clinical evidence profile for active cycle breathing techniques + routine chest physiotherapy versus routine chest physiotherapy for adults with complex rehabilitation needs after traumatic injury that involves chest injury

Quality assessment							No of patients		Effect ³		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Active cycle breathing techniques + routine chest physiotherapy	Routine chest physiotherapy	Active cycle breathing techniques + routine chest physiotherapy (mean; SD)	Routine chest physiotherapy (mean; SD)		
Pain during cough (follow-up 7 days; scale of 0-10; better indicated by lower values)												
1 (Grammatopoulou 2010)	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	45	45	Day 1: 8.73; 1.12 Day 2: 8.15; 1.31 Day 3: 6.95; 1.38 Day 4: 5.24; 1.23 Day 5: 3.78; 0.97 Day 6: 2.58; 0.72 Day 7: 1.89; 0.57	Day 1: 8.64; 1.07 Day 2: 8.13; 0.87 Day 3: 7.29; 0.92 Day 4: 6.67; 0.85 Day 5: 6.2; 0.87 Day 6: 5.42; 0.86 Day 7: 4.51; 0.84	VERY LOW	CRITICAL

MID: Minimal important difference; SD: Standard deviation

¹ Very serious risk of bias in the evidence contributing to the outcome as per RoB 2.

² Imprecision could not be assessed using MID's due to the (factorial) design of the study, and was instead assessed using the sample size: The result was not downgraded if $n \geq 400$, if $n = 399-200$, the result was downgraded 1 level, and if $n < 200$ the result was downgraded by 2 levels.

³ The authors analysed the data with a 2 (group) by 7 (days) factorial MANOVA (pain, body temperature and the count of white blood cells as dependent variables) which revealed a significant multivariate interaction, which for pain during cough reflected 1) significantly lower pain in the 'Active cycle breathing techniques + routine chest physiotherapy' group on days 3-7 compared to the 'routine chest physiotherapy' group, with no significant differences between the groups on days 1-2; and 2) Each day pain was significantly lower for the 'Active cycle breathing techniques + routine chest physiotherapy' group relative to the day before; and this was also the case for the 'routine chest physiotherapy' group

Table 8: Clinical evidence profile for intercostal block versus patient-controlled analgesia for adults with complex rehabilitation needs after traumatic injury that involves chest injury

Quality assessment							No of patients		Effect ³		Quality	Importance
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Quality assessment							No of patients		Effect ³		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Thoracic epidural	Patient controlled analgesia	Thoracic epidural (mean)	Patient controlled analgesia (mean)		
Time to improvement in pain intensity (days) - high dose in intercostal block (follow-up 3 days; Better indicated by lower values)												
1 (Iacco 2016)	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	1	3	1; 0	2; 0	VERY LOW	CRITICAL
Time to improvement in pain intensity (days) - low dose in intercostal block (follow-up 3 days; Better indicated by lower values)												
1 (Iacco 2016)	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	5	3	3; 0	2; 0	VERY LOW	CRITICAL

MID: Minimal important difference; SD: Standard deviation

¹ Very serious risk of bias in the evidence contributing to the outcome as per RoB 2.

² Imprecision could not be assessed using MID's due to the (factorial) design of the study, and was instead assessed using the sample size: The result was not downgraded if n ≥ 400, if n = 399-200, the result was downgraded 1 level, and if n < 200 the result was downgraded by 2 levels.

³ No inferential analyses performed due to the low number of participants and 0 SDs.

Table 9: Clinical evidence profile for thoracic epidural versus patient-controlled analgesia for adults with complex rehabilitation needs after traumatic injury that involves chest injury

Quality assessment							No of patients		Effect ³		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Thoracic epidural	Patient controlled analgesia	Thoracic epidural (mean)	Patient controlled analgesia (mean)		
Pain during cough (follow-up 3 days; scale 0-10; better indicated by lower values)												
1 (Moon 1999)	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	13	11	Day 1: ca 5.8 Day 2: ca 6 Day 3: 3.8	Day 1: ca 7.4 Day 2: 6.2 Day 3: ca 6.2	VERY LOW	CRITICAL

Ca: Circa; MID: Minimal important difference

¹ Very serious risk of bias in the evidence contributing to the outcome as per RoB 2.

² Imprecision could not be assessed using MID's due to the (factorial) design of the study, and was instead assessed using the sample size: The result was not downgraded if n ≥ 400, if n = 399-200, the result was downgraded 1 level, and if n < 200 the result was downgraded by 2 levels.

³ The means preceded by "ca" are read from Figure 1 in the publication. The authors have not reported or depicted any measure of variability of the data and have analysed the results using 3 Students t-tests without reporting the exact p-values. This analysis strategy is incorrect (results should have been analysed with a mixed 2 (group) by 3 (day) factorial ANOVA) and results in alpha-level inflation. The absence of the exact p-values precludes our adjusting the significance level and the results should therefore be interpreted with extreme caution: The authors report that the Students t-test was significant on days 1 and 3, but not on day 2, at p < 0.05.

Table 10: Clinical evidence profile for incentive spirometer + standard analgesic care versus standard analgesic care alone for adults with complex rehabilitation needs after traumatic injury that involves chest injury

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Incentive spirometer + standard analgesic care	Standard analgesic care alone	Relative (95% CI)	Absolute		
Chest pain day 2 (scale 0 or 1-10; better indicated by lower values)												
1 (Sum 2019)	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	24	26	-	MD 0.25 lower (1.01 lower to 0.51 higher)	VERY LOW	CRITICAL
Chest pain day 5 (scale 0 or 1-10; better indicated by lower values)												
1 (Sum 2019)	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	24	26	-	MD 0.27 lower (1.01 lower to 0.47 higher)	VERY LOW	CRITICAL

MID: Minimal important difference

¹ Very serious risk of bias in the evidence contributing to the outcome as per RoB 2.

² 95% CI crosses 1 MID (+/-0.725)

Table 11: Clinical evidence profile for paravertebral block versus patient-controlled analgesia for adults with complex rehabilitation needs after traumatic injury that involves chest injury

Quality assessment							No of patients		Effect ³		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Paravertebral block	Patient controlled analgesia	Paravertebral block (mean; SD)	Patient controlled analgesia (mean; SD)		
Pain at rest (follow-up 3 days; scale 0-10; better indicated by lower values)												
1 (Yeying 2017)	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	45	45	Baseline: 7.6; 2.2 60 mins: 3.9; 1.3 1 day: 3.4; 1 2 days: 2.8; 0.9 3 days: 2.1; 0.5	Baseline: 7.8; 2.1 60 mins: 4.9; 1.5 1 day: 4.1; 1.2 2 days: 3; 1 3 days: 2.2; 0.6	VERY LOW	CRITICAL
Pain during cough (follow-up 3 days; scale 0-10; better indicated by lower values)												
1 (Yeying 2017)	randomised trials	very serious ¹	no serious inconsistency	no serious indirectness	very serious ²	none	45	45	Baseline: 7.9; 2 60 mins: 4.5; 1.6 1 day: 3.9; 1.1	Baseline: 8; 2.2 60 mins: 5.6; 1.7 1 day: 4.5; 1.3	VERY LOW	CRITICAL

Quality assessment							No of patients		Effect ³		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Paravertebral block	Patient controlled analgesia	Paravertebral block (mean; SD)	Patient controlled analgesia (mean; SD)		
									2 day: 3.3; 0.8 3 days: 2.7; 0.6	1 day: 3.5; 0.9 2 days: 2.8; 0.7		

MID: Minimal important difference; Mins: Minutes; SD: Standard deviation

¹ Very serious risk of bias in the evidence contributing to the outcome as per RoB 2.

² Imprecision could not be assessed using MID's due to the (factorial) design of the study, and was instead assessed using the sample size: The result was not downgraded if $n \geq 400$, if $n = 399 - 200$, the result was downgraded 1 level, and if $n < 200$ the result was downgraded by 2 levels.

³ The authors have analysed the results using Students t-tests without reporting the exact p-values. This analysis strategy is incorrect (results should have been analysed with a mixed 2 (group) by 5 (time) factorial ANOVA) and results in alpha-level inflation. The absence of the exact p-values precludes our adjusting the significance level and the results should therefore be interpreted with extreme caution: The authors report that for pain at rest the Students t-test was significant 60 minutes and 1 day, but not 2 or 3 days, after analgesia, at $p < 0.05$; and that for pain during cough the Students t-test was significant 60 minutes, 1 day, 2 days and 3 days after analgesia, at $p < 0.05$.

GRADE tables for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No evidence was identified which was applicable to this review question.

Appendix G – Economic evidence study selection

Economic study selection for:

C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

A combined search was conducted for both review questions.

Figure 3: Study selection flow chart: Adults

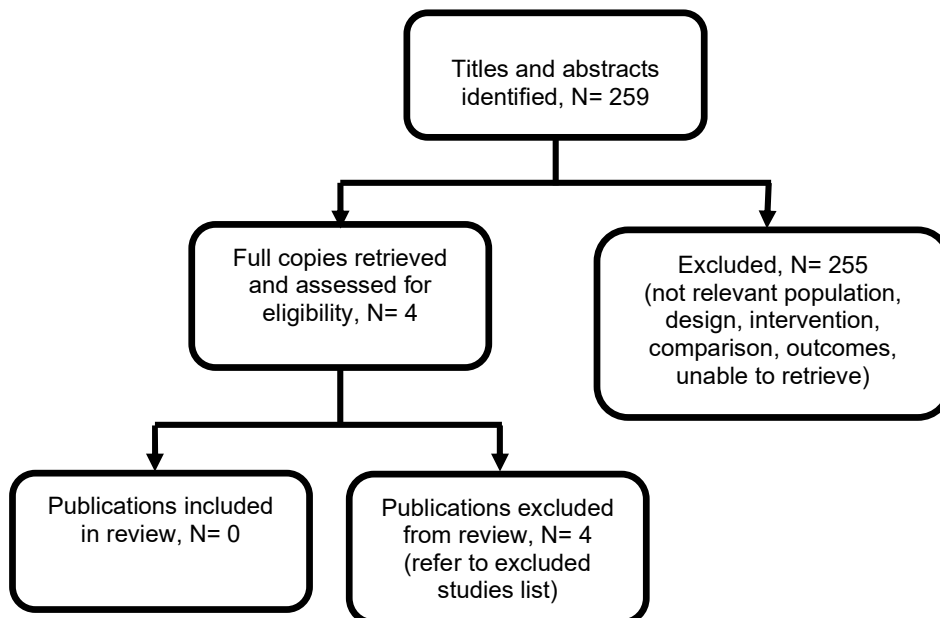
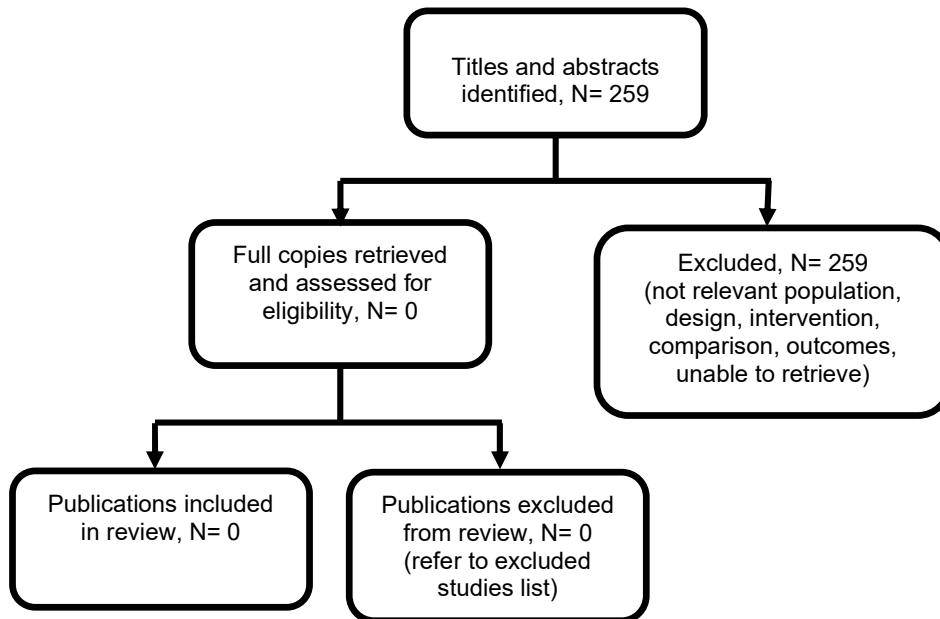


Figure 4: Study selection flow chart: Children and young people



Appendix H – Economic evidence tables

Economic evidence tables for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No economic studies were identified which were applicable to this review question.

Economic evidence tables for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No economic studies were identified which were applicable to this review question.

Appendix I – Economic evidence profiles

Economic evidence profiles for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No economic studies were identified which were applicable to this review question.

Economic evidence profiles for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No economic studies were identified which were applicable to this review question

Appendix J – Economic analysis

Economic evidence tables for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No economic analysis was undertaken for this review question.

Economic evidence tables for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No economic analysis was undertaken for this review question.

Appendix K – Excluded studies

Excluded clinical and economic studies for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

Clinical studies

Table 12: Excluded studies and reasons for their exclusion

Study	Reason for Exclusion
Abdelrahman, A. M. F., Omara, Afas, Elzohry, A. A. M., Safety and efficacy of oral melatonin when combined with thoracic epidural analgesia in patients with bilateral multiple fracture ribs, <i>Local and regional anesthesia</i> , 13, 21–28, 2020	Intervention/comparison not in PICO: thoracic epidural analgesia +/- melatonin tablets
Agamohamdi, Dawood, Montazer, Majid, Hoseini, Maryam, Haghdoost, Mehdi, Farzin, Haleh, A Comparison of Continuous Thoracic Epidural Analgesia with Bupivacaine Versus Bupivacaine and Dexmedetomidine for Pain Control in Patients with Multiple Rib Fractures, <i>Anesthesiology and pain medicine</i> , 8, e60805, 2018	Comparison not in PICO (epidural versus epidural)
Alar, T., Gedik, I. E., Kara, M., The effects of analgesic treatment and chest physiotherapy on the complications of the patients with rib fractures that arise from blunt chest trauma, <i>Ulusal Travma ve Acil Cerrahi Dergisi</i> , 26, 531-537, 2020	Population not in PICO: "Patients who were diagnosed with isolated RF [rib fracture] secondary to blunt TT [thoracic trauma] who presented to Çanakkale Onsekiz Mart University School of Medicine Hospital's Emergency Department and Thoracic Surgery outpatient clinics in the first 24 hours following the trauma" (p. 532); 52/114 (45.6%) patients were hospitalized. Outcomes not in PICO.
Aldrete, J. A., Aldrete, A. M., Jorge, A. V., Ambulatory, pain-free treatment of multiple rib fractures from blunt trauma: A preliminary report, <i>Pain Digest</i> , 9, 113-117, 1999	Non-randomised study, n=52
Andrews, J., Sathe, N. A., Krishnaswami, S., Melissa, L., Nonpharmacologic airway clearance techniques in hospitalized patients: A systematic review, <i>Respiratory Care</i> , 58, 2160-2186, 2013	Systematic review, included studies checked for relevance
Baker, Edward James, Lee, Geraldine Ann, A Retrospective Observational Study Examining the Effect of Thoracic Epidural and Patient Controlled Analgesia on Short-term Outcomes in Blunt Thoracic Trauma Injuries, <i>Medicine</i> , 95, e2374, 2016	Non randomised study, n<100 in relevant intervention groups
Batomen Kuimi, Brice Lionel, Lague, Antoine, Boucher, Valerie, Guimont, Chantal, Chauny, Jean-Marc, Shields, Jean-Francois, Vanier, Laurent, Plourde, Miville, Emond, Marcel, Potential benefits of incentive spirometry following a rib fracture: a propensity score analysis, <i>CJEM</i> , 1-4, 2019	Setting not in PICO (emergency department)
Battle, Ceri, O'Neill, Claire, Toghil, Hannah, Newey, Luke, Hutchings, Hayley, EarLy Exercise in blunt Chest wall Trauma: a feasibility trial (ELECT Trial),	Intervention (thoracic/shoulder girdle exercises delivered by physiotherapist consisting of consisted of shoulder active

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
Emergency medicine journal : EMJ, 2020	range of movement exercises trunk active side-flexion, rotation, forward flexion and extension range of movement exercises (all within limits of pain)) and outcomes (preset feasibility criteria) not in PICO
Beks, Reinier B., Peek, Jesse, de Jong, Mirjam B., Wessem, Karlijn J. P., Oner, Cumhuri F., Hietbrink, Falco, Leenen, Luke P. H., Groenwold, Rolf H. H., Houwert, Roderick M., Fixation of flail chest or multiple rib fractures: current evidence and how to proceed. A systematic review and meta-analysis, European journal of trauma and emergency surgery : official publication of the European Trauma Society, 45, 631-644, 2019	Systematic review, included studies checked for relevance
Bellabarba, C., Fisher, C., Chapman, J. R., Dettori, J. R., Norvell, D. C., Does early fracture fixation of thoracolumbar spine fractures decrease morbidity or mortality?, Spine, 35, S138-S145, 2010	Population/intervention not in PICO (early fixation of spine fractures)
Bulger, E. M., Arneson, M. A., Mock, C. N., Jurkovich, G. J., Rib fractures in the elderly, The Journal of trauma, 48, 1040-7, 2000	Non randomised study, n<100 in relevant intervention groups; analyses not in PICO
Bulger, Eileen M., Edwards, Thomas, Klotz, Patricia, Jurkovich, Gregory J., Epidural analgesia improves outcome after multiple rib fractures, Surgery, 136, 426-30, 2004	Outcomes not in PICO
Carrier, Francois M., Turgeon, Alexis F., Nicole, Pierre C., Trepanier, Claude A., Fergusson, Dean A., Thauvette, Daniel, Lessard, Martin R., Effect of epidural analgesia in patients with traumatic rib fractures: a systematic review and meta-analysis of randomized controlled trials, Canadian journal of anaesthesia = Journal canadien d'anesthesie, 56, 230-42, 2009	Systematic review, included studies checked for relevance
de Godoy, V. C., Zanetti, N. M., Johnston, C., Manual hyperinflation in airway clearance in pediatric patients: a systematic review, Revista Brasileira de terapia intensiva, 25, 258-262, 2013	Systematic review, included studies checked for relevance
Dehghan, Niloofar, de Mestral, Charles, McKee, Michael D., Schemitsch, Emil H., Nathens, Avery, Flail chest injuries: a review of outcomes and treatment practices from the National Trauma Data Bank, The journal of trauma and acute care surgery, 76, 462-8, 2014	Analyses/outcomes not in PICO
Doben, Andrew R., Eriksson, Evert A., Denlinger, Chadrick E., Leon, Stuart M., Couillard, Deborah J., Fakhry, Samir M., Minshall, Christian T., Surgical rib fixation for flail chest deformity improves liberation from mechanical ventilation, Journal of Critical Care, 29, 139-43, 2014	Non-randomised study, n=21
Doss, N. W., Veliyaniparambil, I., Krishnan, R., Gintautas, J., Abadir, A. R., Continuous thoracic epidural ropivacaine drips for multiple rib fractures, Proceedings of the Western Pharmacology Society, 42, 99-100, 1999	Population not in PICO (ICU patients); non-comparative study; n=57
Drahos, Andrew, Nowack, Timothy, Fitzgerald, Michael, Christie, D. Benjamin, Longterm Postoperative Hardware Complications after Open	Non-randomised study, n = 156

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
Rib Fixation, The American surgeon, 84, e317-e319, 2018	
Duch, P., Moller, M. H., Epidural analgesia in patients with traumatic rib fractures: a systematic review of randomised controlled trials, Acta Anaesthesiologica Scandinavica, 59, 698-709, 2015	Systematic review, included studies checked for relevance
Farquhar, J., Almahrabi, Y., Slobogean, G., Slobogean, B., Garraway, N., Simons, R. K., Hameed, S. M., No benefit to surgical fixation of flail chest injuries compared with modern comprehensive management: results of a retrospective cohort study, Canadian journal of surgery. Journal canadien de chirurgie, 59, 299-303, 2016	Non-randomised study, n = 55
Fitzpatrick, D. C., Denard, P. J., Phelan, D., Long, W. B., Madey, S. M., Bottlang, M., Operative stabilization of flail chest injuries: review of literature and fixation options, European journal of trauma and emergency surgery : official publication of the European Trauma Society, 36, 427-33, 2010	Narrative review
Gabram, S. G. A., Schwartz, R. J., Jacobs, L. M., Lawrence, D., Murphy, M. A., Morrow, J. S., Hopkins, J. S., Knauft, R. F., Flint, L., Clinical management of blunt trauma patients with unilateral rib fractures: A randomized trial, World Journal of Surgery, 19, 388-393, 1995	Study undertaken 1990-1992 (outside the date limit of 1995 onwards)
Gage, Alexis, Rivara, Frederick, Wang, Jin, Jurkovich, Gregory J., Arbabi, Saman, The effect of epidural placement in patients after blunt thoracic trauma, The journal of trauma and acute care surgery, 76, 39-6, 2014	Outcomes not in PICO
Galvagno, Samuel Michael, Jr., Smith, Charles E., Varon, Albert J., Hasenboehler, Erik A., Sultan, Shahnaz, Shaefer, Gregory, To, Kathleen B., Fox, Adam D., Alley, Darrell E. R., Ditillo, Michael, Joseph, Bellal A., Robinson, Bryce R. H., Haut, Elliot R., Pain management for blunt thoracic trauma: A joint practice management guideline from the Eastern Association for the Surgery of Trauma and Trauma Anesthesiology Society, The journal of trauma and acute care surgery, 81, 936-951, 2016	Systematic review, included studies checked for relevance
Granetzny, A., El-Aal, M. A., Emam, E., Shalaby, A., Boseila, A., Surgical versus conservative treatment of flail chest. Evaluation of the pulmonary status, Interactive Cardiovascular and Thoracic Surgery, 4, 583-587, 2005	Outcomes not in PICO
Harrington, D. T., Phillips, B., Machan, J., Zacharias, N., Velmahos, G. C., Rosenblatt, M. S., Winston, E., Patterson, L., Desjardins, S., Winchell, R., Brotman, S., Churyla, A., Schulz, J. T., Maung, A. A., Davis, K. A., Factors associated with survival following blunt chest trauma in older patients: Results from a large regional trauma cooperative, Archives of Surgery, 145, 432-437, 2010	Analyses and outcomes not in PICO
Hashemzadeh, Shahryar, Hashemzadeh, Khosrov, Hosseinzadeh, Hamzeh, Aligholipour Maleki, Raheleh, Golzari, Samad E. J., Comparison thoracic epidural and intercostal block to improve ventilation	Population not in PICO ("who were admitted in ICU")

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
parameters and reduce pain in patients with multiple rib fractures, <i>Journal of cardiovascular and thoracic research</i> , 3, 87-91, 2011	
Heidari, S., Kamali, A., Esfehiani, S. R., Amini, M., Comparison of epidural block and apotel in controlling pain among patients with rib fracture, <i>International Journal of Pharmaceutical Research</i> , 11, 2019	British library cannot match article
Hwang, Eun Gu, Lee, Yunjung, Effectiveness of intercostal nerve block for management of pain in rib fracture patients, <i>Journal of exercise rehabilitation</i> , 10, 241-4, 2014	Non-randomised study, n=54
Ingoe, Helen Ma, Coleman, Elizabeth, Eardley, William, Rangan, Amar, Hewitt, Catherine, McDaid, Catriona, Systematic review of systematic reviews for effectiveness of internal fixation for flail chest and rib fractures in adults, <i>BMJ open</i> , 9, e023444, 2019	Systematic review, included studies checked for relevance
Interiano, Angela, Using elastomeric infusion pumps for traumatic rib fracture pain, <i>Nursing</i> , 42, 65-7, 2012	Narrative review
Jack, J. M., McLellan, E., Versyck, B., Englesakis, M. F., Chin, K. J., The role of serratus anterior plane and pectoral nerves blocks in cardiac surgery, thoracic surgery and trauma: a qualitative systematic review, <i>Anaesthesia</i> , 75, 1372-1385, 2020	Systematic review, included studies checked for relevance
Kamali, A., Broujerdi, G. N., Bagheri, H., Comparing epidural block and intercostal block in patients with 3-4 broken ribs following chest cage blunt trauma, <i>Annals of Tropical Medicine and Public Health</i> , 10, 850-854, 2017	Comparison not in PICO (intercostal block versus epidural)
Kasotakis, George, Hasenboehler, Erik A., Streib, Erik W., Patel, Nimitt, Patel, Mayur B., Alarcon, Louis, Bosarge, Patrick L., Love, Joseph, Haut, Elliott R., Como, John J., Operative fixation of rib fractures after blunt trauma: A practice management guideline from the Eastern Association for the Surgery of Trauma, <i>The journal of trauma and acute care surgery</i> , 82, 618-626, 2017	Systematic review, included studies checked for relevance
Khandelwal, Gaurav, Mathur, R. K., Shukla, Sumit, Maheshwari, Ankur, A prospective single center study to assess the impact of surgical stabilization in patients with rib fracture, <i>International journal of surgery (London, England)</i> , 9, 478-81, 2011	Non-randomised study, n=61
Kim, J. H., Park, H. K., Jeon, S. Y., Oh, D. W., Park, H. J., Park, W. J., Initial effect of an elastic chest band during inspiratory exercise on chest function improvement in people with limited rib mobility: a randomized controlled pilot trial, <i>Physiotherapy research international</i> , 17, 208â 213, 2012	Population not in PICO (people with limited rib mobility)
Kourouche, Sarah, Buckley, Thomas, Munroe, Belinda, Curtis, Kate, Development of a blunt chest injury care bundle: An integrative review, <i>Injury</i> , 49, 1008-1023, 2018	Systematic review, included studies checked for relevance and one study found and included (Grammatopoulou 2010)
Liu, Tao, Liu, Peng, Chen, Jiajun, Xie, Jie, Yang, Fan, Liao, Yiliu, A Randomized Controlled Trial of Surgical Rib Fixation in Polytrauma Patients With Flail Chest, <i>The Journal of surgical research</i> , 242, 223-230, 2019	Population not in PICO: ICU patients
Liu, Xin, Xiong, Kai, Surgical management versus	Outcomes not in PICO

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
non-surgical management of rib fractures in chest trauma: a systematic review and meta-analysis, <i>Journal of cardiothoracic surgery</i> , 14, 45, 2019	
Long, Rui, Tian, Junying, Wu, Shasha, Li, Yang, Yang, Xiuhua, Fei, Jun, Clinical efficacy of surgical versus conservative treatment for multiple rib fractures: A meta-analysis of randomized controlled trials, <i>International journal of surgery (London, England)</i> , 83, 79-88, 2020	Systematic review, included studies checked for relevance
Magnone, Stefano, Allievi, Niccolo, Pisano, Michele, Rib fractures fixation: Always worthwhile?, <i>The journal of trauma and acute care surgery</i> , 85, 652, 2018	Letter to the editor, no original data
Marasco, Silvana F., Davies, Andrew R., Cooper, Jamie, Varma, Dinesh, Bennett, Victoria, Nevill, Rachael, Lee, Geraldine, Bailey, Michael, Fitzgerald, Mark, Prospective randomized controlled trial of operative rib fixation in traumatic flail chest, <i>Journal of the American College of Surgeons</i> , 216, 924-32, 2013	Population not in PICO (ICU patients; "Forty-six patients with traumatic flail chest injury receiving invasive mechanical ventilation were enrolled in the study. Patients were enrolled only if they were ventilator dependent with no prospect of successful weaning within the next 48 hours")
Mayberry, John, Early stabilization of flail chest with locked plate fixation, <i>Journal of Orthopaedic Trauma</i> , 25, 648, 2011	Commentary, no original data
McIlwaine, M., Physiotherapy and airway clearance techniques and devices, <i>Paediatric Respiratory Reviews</i> , 7, S220-S222, 2006	Narrative review
Mekhail, N. A., Intercostal analgesia: Continuous regional blockade for acute pain, <i>Pain Digest</i> , 6, 364-367, 1996	Narrative review
Mohta, M., Verma, P., Saxena, A. Kr, Sethi, A. K., Tyagi, A., Girotra, G., Prospective, randomized comparison of continuous thoracic epidural and thoracic paravertebral infusion in patients with unilateral multiple fractured ribs - A pilot study, <i>Journal of Trauma - Injury, Infection and Critical Care</i> , 66, 1096-1101, 2009	Comparison not in PICO (thoracic epidural versus thoracic paravertebral infusion)
Murata, Y., Kanaya, K., Wada, H., Wada, K., Shiba, M., Hatta, S., Kato, K., Kato, Y., Interscalene brachial plexus block for scapular and upper chest pain due to cervical radiculopathy: a randomized controlled clinical trial, <i>Journal of orthopaedic science</i> , 17, 515-520, 2012	Population not in PICO (patients with cervical radicular pain for 14-15 ± 17-18 months).
Naidoo, Kamil, Hanbali, Layth, Bates, Peter, The natural history of flail chest injuries, <i>Chinese journal of traumatology = Zhonghua chuang shang za zhi</i> , 20, 293-296, 2017	Non-randomised study, n < 100 in one of the two treatment groups, outcomes not in PICO
Norum, H. M., Breivik, H., A systematic review of comparative studies indicates that paravertebral block is neither superior nor safer than epidural analgesia for pain after thoracotomy, <i>Scandinavian Journal of Pain</i> , 1, 12-23, 2010	Systematic review, included studies checked for relevance
Okoye, O., Horn, C., Pieper, M., Putty, B., Naughton, D., Freeman, C., Impact of rib fixation on outcomes in mechanically ventilated blunt trauma patients, <i>Critical Care Medicine</i> , 43, 2, 2015	Published as abstract only

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
Overend, T. J., Anderson, C. M., Lucy, S. D., Bhatia, C., Jonsson, B. I., Timmermans, C., The effect of incentive spirometry on postoperative pulmonary complications: A systematic review, <i>Chest</i> , 120, 971-978, 2001	Systematic review, included studies checked for relevance
Parris, R., Scabie, B., Epidural analgesia/anaesthesia versus systemic intravenous opioid analgesia in the management of blunt thoracic trauma, <i>Emergency Medicine Journal</i> , 24, 848, 2007	Semi-systematic review, included studies checked for relevance
Parris, Richard, Towards evidence based emergency medicine: best BETs from the Manchester Royal Infirmary. Epidural analgesia/anaesthesia versus systemic intravenous opioid analgesia in the management of blunt thoracic trauma, <i>Emergency medicine journal : EMJ</i> , 24, 848-9, 2007	Duplicate
Peek, Jesse, Smeeing, Diederik P. J., Hietbrink, Falco, Houwert, Roderick M., Marsman, Marije, de Jong, Mirjam B., Comparison of analgesic interventions for traumatic rib fractures: a systematic review and meta-analysis, <i>European journal of trauma and emergency surgery : official publication of the European Trauma Society</i> , 2018	Systematic review, included studies checked for relevance
Pieracci, F. M., Leasia, K., Bauman, Z., Eriksson, E. A., Lottenberg, L., Majercik, S., Powell, L., Sarani, B., Semon, G., Thomas, B., Zhao, F., Dyke, C., Doben, A. R., A multicenter, prospective, controlled clinical trial of surgical stabilization of rib fractures in patients with severe, nonflail fracture patterns (Chest Wall Injury Society NONFLAIL), <i>Journal of Trauma and Acute Care Surgery</i> , 88, 249-257, 2020	Non-RCT based analyses (mix of randomised [n=23] and non-randomised [n=87] patient data)
Pieracci, Fredric M., Ali-Osman, Francis, Mangram, Alicia, Majercik, Sarah, White, Thomas W., Doben, Andrew R., Re: Rib fractures fixation: Always worthwhile?, <i>The journal of trauma and acute care surgery</i> , 85, 1134-1135, 2018	Response to letter
Pieracci, Fredric M., Rodil, Maria, Stovall, Robert T., Johnson, Jeffrey L., Biffl, Walter L., Mauffrey, Cyril, Moore, Ernest E., Jurkovich, Gregory J., Surgical stabilization of severe rib fractures, <i>The journal of trauma and acute care surgery</i> , 78, 883-7, 2015	Narrative review
Raman, J., Onsager, D., Straus, D., Rib osteotomy and fixation: Enabling technique for better minithoracotomy exposure in cardiac and thoracic procedures, <i>Journal of Thoracic and Cardiovascular Surgery</i> , 139, 1083-1085, 2010	Narrative review
Rovina, Nikoletta, Koutsoukou, Antonia, Koulouris, Nikolaos, Therapeutic exercise in improving acute lung injury: a long distance to be covered, <i>Annals of translational medicine</i> , 3, 273, 2015	Editorial
Scalea, T. M., Optimal timing of fracture fixation: Have we learned anything in the past 20 years?, <i>Journal of Trauma - Injury, Infection and Critical Care</i> , 65, 253-260, 2008	Narrative review
Schulte, Katharina, Whitaker, Donald, Attia, Rizwan, In patients with acute flail chest does surgical rib fixation improve outcomes in terms of morbidity and	Systematic review, included studies checked for relevance

Study	Reason for Exclusion
mortality?, Interactive Cardiovascular and Thoracic Surgery, 23, 314-9, 2016	
Simon, B., Ebert, J., Bokhari, F., Capella, J., Emhoff, T., Hayward, T., Rodriguez, A., Smith, L., Management of pulmonary contusion and flail chest: An eastern association for the surgery of trauma practice management guideline, Journal of Trauma and Acute Care Surgery, 73, S351-S361, 2012	Systematic review, included studies checked for relevance
Singh, Shalendra, Jacob, Mathews, Hasnain, S., Krishnakumar, Mathangi, Comparison between continuous thoracic epidural block and continuous thoracic paravertebral block in the management of thoracic trauma, Medical journal, Armed Forces India, 73, 146-151, 2017	Comparison not in PICO (thoracic epidural block versus thoracic paravertebral block)
Unsworth, Annalise, Curtis, Kate, Asha, Stephen Edward, Treatments for blunt chest trauma and their impact on patient outcomes and health service delivery, Scandinavian journal of trauma, resuscitation and emergency medicine, 23, 17, 2015	Systematic review, included studies checked for relevance
Vallier, H. A., Wang, X., Moore, T. A., Wilber, J. H., Como, J. J., Timing of orthopaedic surgery in multiple trauma patients: Development of a protocol for early appropriate care, Journal of Orthopaedic Trauma, 27, 543-551, 2013	Outcomes not in PICO
Velasquez, Mauricio, Ordonez, Carlos A., Parra, Michael W., Dominguez, Andres, Puyana, Juan C., Operative versus Nonoperative Management of Multiple Rib Fractures, The American surgeon, 82, e103-5, 2016	Non-randomised study, n=40
Womack, J., Pearson, J. D., Walker, I. A., Stephens, N. M., Goodman, B. A., Safety, complications and clinical outcome after ultrasound-guided paravertebral catheter insertion for rib fracture analgesia: a single-centre retrospective observational study, Anaesthesia, 2019	Outcomes not in PICO
Yeung, J. H. Y., Gates, S., Naidu, B. V., Wilson, M. J. A., Gao Smith, F., Paravertebral block versus thoracic epidural for patients undergoing thoracotomy, Cochrane Database of Systematic Reviews, 2016	Comparison not in PICO (paravertebral block versus thoracic epidural)
Zhang, Lihong, Liu, Weifeng, You, Haiping, Chen, Zhiyuan, Xu, Liming, He, Hefan, Assessing the analgesic efficacy of oral epigallocatechin-3-gallate on epidural catheter analgesia in patients after surgical stabilisation of multiple rib fractures: a prospective double-blind, placebo-controlled clinical trial, Pharmaceutical biology, 58, 741-744, 2020	Comparison/intervention not in PICO: Epidural /-oral epigallocatechin-3- gallate

Economic studies

Table 13: Excluded studies and reasons for their exclusion

Study	Reason for Exclusion
Jensen, C. D., Stark, J. T., Jacobson, L. E., Powers, J. M., Leslie, K. L., Kinsella-Shaw, J. M., et al., Implications of thoracic epidural analgesia on hospital charges in rib fracture patients. Pain Medicine, 19, 160-168, 2017	Population not in PICO (mixed ICU and non-ICU patients)

Study	Reason for Exclusion
Kocher, G. J., Sharafi, S., Azenha, L. F., & Schmid, R. A., Chest wall stabilization in ventilator-dependent traumatic flail chest patients: who benefits, <i>European journal of cardio-thoracic surgery</i> , 51, 696-701, 2017	Population not in PICO (ICU patients)
Majercik, S., Wilson, E., Gardner, S., Granger, S., VanBoerum, D. H., & White, T. W., In-hospital outcomes and costs of surgical stabilization versus nonoperative management of severe rib fractures, <i>Journal of Trauma and Acute Care Surgery</i> , 79, 533-539, 2015	Population not in PICO (mixed ICU and non-ICU patients)
Swart, E., Laratta, J., Slobogean, G., & Mehta, S., Operative treatment of rib fractures in flail chest injuries: a meta-analysis and cost-effectiveness analysis, <i>Journal of orthopaedic trauma</i> , 31, 64-70, 2017	Population not in PICO (ICU patients)

Excluded clinical and economic studies for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

Clinical studies

Table 14: Excluded studies and reasons for their exclusion

Study	Reason for Exclusion
Abdelrahman, A. M. F., Omara, Afas, Elzohry, A. A. M., Safety and efficacy of oral melatonin when combined with thoracic epidural analgesia in patients with bilateral multiple fracture ribs, <i>Local and regional anesthesia</i> , 13, 21-28, 2020	Intervention/comparison not in PICO: thoracic epidural analgesia +/- melatonin tablets
Agamohammdi, Dawood, Montazer, Majid, Hoseini, Maryam, Haghdoost, Mehdi, Farzin, Haleh, A Comparison of Continuous Thoracic Epidural Analgesia with Bupivacaine Versus Bupivacaine and Dexmedetomidine for Pain Control in Patients with Multiple Rib Fractures, <i>Anesthesiology and pain medicine</i> , 8, e60805, 2018	Comparison not in PICO (epidural versus epidural)
Alar, T., Gedik, I. E., Kara, M., The effects of analgesic treatment and chest physiotherapy on the complications of the patients with rib fractures that arise from blunt chest trauma, <i>Ulusal Travma ve Acil Cerrahi Dergisi</i> , 26, 531-537, 2020	Population not in PICO: "Patients who were diagnosed with isolated RF [rib fracture] secondary to blunt TT [thoracic trauma] who presented to Çanakkale Onsekiz Mart University School of Medicine Hospital's Emergency Department and Thoracic Surgery outpatient clinics in the first 24 hours following the trauma" (p. 532); 52/114 (45.6%) patients were hospitalized. Outcomes not in PICO.
Aldrete, J. A., Aldrete, A. M., Jorge, A. V., Ambulatory, pain-free treatment of multiple rib fractures from blunt trauma: A preliminary report, <i>Pain Digest</i> , 9, 113-117, 1999	Non-randomised study, n=52
Andrews, J., Sathe, N. A., Krishnaswami, S., Melissa, L., Nonpharmacologic airway clearance techniques in hospitalized patients: A systematic review, <i>Respiratory Care</i> , 58, 2160-2186, 2013	Systematic review, included studies checked for relevance

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
Baker, Edward James, Lee, Geraldine Ann, A Retrospective Observational Study Examining the Effect of Thoracic Epidural and Patient Controlled Analgesia on Short-term Outcomes in Blunt Thoracic Trauma Injuries, <i>Medicine</i> , 95, e2374, 2016	Non randomised study, n<100 in relevant intervention groups
Batomen Kuimi, Brice Lionel, Lague, Antoine, Boucher, Valerie, Guimont, Chantal, Chauny, Jean-Marc, Shields, Jean-Francois, Vanier, Laurent, Plourde, Miville, Emond, Marcel, Potential benefits of incentive spirometry following a rib fracture: a propensity score analysis, <i>CJEM</i> , 1-4, 2019	Setting not in PICO (emergency department)
Battle, Ceri, O'Neill, Claire, Toghil, Hannah, Newey, Luke, Hutchings, Hayley, EarLy Exercise in blunt Chest wall Trauma: a feasibility trial (ELECT Trial), <i>Emergency medicine journal : EMJ</i> , 2020	Intervention (thoracic/shoulder girdle exercises delivered by physiotherapist consisting of consisted of shoulder active range of movement exercises trunk active side-flexion, rotation, forward flexion and extension range of movement exercises (all within limits of pain)) and outcomes (preset feasibility criteria) not in PICO
Beks, Reinier B., Peek, Jesse, de Jong, Mirjam B., Wessem, Karlijn J. P., Oner, Cumhur F., Hietbrink, Falco, Leenen, Luke P. H., Groenwold, Rolf H. H., Houwert, Roderick M., Fixation of flail chest or multiple rib fractures: current evidence and how to proceed. A systematic review and meta-analysis, <i>European journal of trauma and emergency surgery : official publication of the European Trauma Society</i> , 45, 631-644, 2019	Systematic review, included studies checked for relevance
Bellabarba, C., Fisher, C., Chapman, J. R., Dettori, J. R., Norvell, D. C., Does early fracture fixation of thoracolumbar spine fractures decrease morbidity or mortality?, <i>Spine</i> , 35, S138-S145, 2010	Population/intervention not in PICO (early fixation of spine fractures)
Bulger, E. M., Arneson, M. A., Mock, C. N., Jurkovich, G. J., Rib fractures in the elderly, <i>The Journal of trauma</i> , 48, 1040-7, 2000	Non randomised study, n<100 in relevant intervention groups; analyses not in PICO
Bulger, Eileen M., Edwards, Thomas, Klotz, Patricia, Jurkovich, Gregory J., Epidural analgesia improves outcome after multiple rib fractures, <i>Surgery</i> , 136, 426-30, 2004	Outcomes not in PICO
Carrier, Francois M., Turgeon, Alexis F., Nicole, Pierre C., Trepanier, Claude A., Fergusson, Dean A., Thauvette, Daniel, Lessard, Martin R., Effect of epidural analgesia in patients with traumatic rib fractures: a systematic review and meta-analysis of randomized controlled trials, <i>Canadian journal of anaesthesia = Journal canadien d'anesthesie</i> , 56, 230-42, 2009	Systematic review, included studies checked for relevance
de Godoy, V. C., Zanetti, N. M., Johnston, C., Manual hyperinflation in airway clearance in pediatric patients: a systematic review, <i>Revista Brasileira de terapia intensiva</i> , 25, 258-262, 2013	Systematic review, included studies checked for relevance
Dehghan, Niloofar, de Mestral, Charles, McKee, Michael D., Schemitsch, Emil H., Nathens, Avery, Flail chest injuries: a review of outcomes and treatment practices from the National Trauma Data Bank, <i>The journal of trauma and acute care surgery</i> , 76, 462-8, 2014	Analyses/outcomes not in PICO

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
Doben, Andrew R., Eriksson, Evert A., Denlinger, Chadrick E., Leon, Stuart M., Couillard, Deborah J., Fakhry, Samir M., Minshall, Christian T., Surgical rib fixation for flail chest deformity improves liberation from mechanical ventilation, <i>Journal of Critical Care</i> , 29, 139-43, 2014	Non-randomised study, n=21
Doss, N. W., Veliyaniparambil, I., Krishnan, R., Gintautas, J., Abadir, A. R., Continuous thoracic epidural ropivacaine drips for multiple rib fractures, <i>Proceedings of the Western Pharmacology Society</i> , 42, 99-100, 1999	Population not in PICO (ICU patients); non-comparative study; n=57
Drahos, Andrew, Nowack, Timothy, Fitzgerald, Michael, Christie, D. Benjamin, Longterm Postoperative Hardware Complications after Open Rib Fixation, <i>The American surgeon</i> , 84, e317-e319, 2018	Non-randomised study, n = 156
Duch, P., Moller, M. H., Epidural analgesia in patients with traumatic rib fractures: a systematic review of randomised controlled trials, <i>Acta Anaesthesiologica Scandinavica</i> , 59, 698-709, 2015	Systematic review, included studies checked for relevance
Farquhar, J., Almahrabi, Y., Slobogean, G., Slobogean, B., Garraway, N., Simons, R. K., Hameed, S. M., No benefit to surgical fixation of flail chest injuries compared with modern comprehensive management: results of a retrospective cohort study, <i>Canadian journal of surgery. Journal canadien de chirurgie</i> , 59, 299-303, 2016	Non-randomised study, n = 55
Fitzpatrick, D. C., Denard, P. J., Phelan, D., Long, W. B., Madey, S. M., Bottlang, M., Operative stabilization of flail chest injuries: review of literature and fixation options, <i>European journal of trauma and emergency surgery : official publication of the European Trauma Society</i> , 36, 427-33, 2010	Narrative review
Gabram, S. G. A., Schwartz, R. J., Jacobs, L. M., Lawrence, D., Murphy, M. A., Morrow, J. S., Hopkins, J. S., Knauft, R. F., Flint, L., Clinical management of blunt trauma patients with unilateral rib fractures: A randomized trial, <i>World Journal of Surgery</i> , 19, 388-393, 1995	Study undertaken 1990-1992 (outside the date limit of 1995 onwards)
Gage, Alexis, Rivara, Frederick, Wang, Jin, Jurkovich, Gregory J., Arbabi, Saman, The effect of epidural placement in patients after blunt thoracic trauma, <i>The journal of trauma and acute care surgery</i> , 76, 39-6, 2014	Outcomes not in PICO
Galvagno, Samuel Michael, Jr., Smith, Charles E., Varon, Albert J., Hasenboehler, Erik A., Sultan, Shahnaz, Shaefer, Gregory, To, Kathleen B., Fox, Adam D., Alley, Darrell E. R., Ditillo, Michael, Joseph, Bellal A., Robinson, Bryce R. H., Haut, Elliot R., Pain management for blunt thoracic trauma: A joint practice management guideline from the Eastern Association for the Surgery of Trauma and Trauma Anesthesiology Society, <i>The journal of trauma and acute care surgery</i> , 81, 936-951, 2016	Systematic review, included studies checked for relevance
Grammatopoulou E, Belimpasaki V, Valalas A, Michos P, Skordilis E, Koutsouki D. Active Cycle of Breathing Techniques Contributes to Pain Reduction	Population not in PICO (adults)

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
in Patients with Rib Fractures. Hellenic Journal of Surgery 2010; 82: 1	
Granetzny, A., El-Aal, M. A., Emam, E., Shalaby, A., Boseila, A., Surgical versus conservative treatment of flail chest. Evaluation of the pulmonary status, Interactive Cardiovascular and Thoracic Surgery, 4, 583-587, 2005	Outcomes not in PICO
Harrington, D. T., Phillips, B., Machan, J., Zacharias, N., Velmahos, G. C., Rosenblatt, M. S., Winston, E., Patterson, L., Desjardins, S., Winchell, R., Brotman, S., Churyla, A., Schulz, J. T., Maung, A. A., Davis, K. A., Factors associated with survival following blunt chest trauma in older patients: Results from a large regional trauma cooperative, Archives of Surgery, 145, 432-437, 2010	Analyses and outcomes not in PICO
Hashemzadeh, Shahryar, Hashemzadeh, Khosrov, Hosseinzadeh, Hamzeh, Aligholipour Maleki, Raheleh, Golzari, Samad E. J., Comparison thoracic epidural and intercostal block to improve ventilation parameters and reduce pain in patients with multiple rib fractures, Journal of cardiovascular and thoracic research, 3, 87-91, 2011	Population not in PICO (“who were admitted in ICU”)
Heidari, S., Kamali, A., Esfehiani, S. R., Amini, M., Comparison of epidural block and apotel in controlling pain among patients with rib fracture, International Journal of Pharmaceutical Research, 11, 2019	British library cannot match article
Hwang, Eun Gu, Lee, Yunjung, Effectiveness of intercostal nerve block for management of pain in rib fracture patients, Journal of exercise rehabilitation, 10, 241-4, 2014	Non-randomised study, n=54
Iacco A. Continuous intercostal nerve blockade for traumatic rib fractures. https://clinicaltrials.gov/ct2/show/nct02604589	Population not in PICO (adults)
Ingoe, Helen Ma, Coleman, Elizabeth, Eardley, William, Rangan, Amar, Hewitt, Catherine, McDaid, Catriona, Systematic review of systematic reviews for effectiveness of internal fixation for flail chest and rib fractures in adults, BMJ open, 9, e023444, 2019	Systematic review, included studies checked for relevance
Interiano, Angela, Using elastomeric infusion pumps for traumatic rib fracture pain, Nursing, 42, 65-7, 2012	Narrative review
Jack, J. M., McLellan, E., Versyck, B., Englesakis, M. F., Chin, K. J., The role of serratus anterior plane and pectoral nerves blocks in cardiac surgery, thoracic surgery and trauma: a qualitative systematic review, Anaesthesia, 75, 1372-1385, 2020	Systematic review, included studies checked for relevance
Kamali, A., Broujerdi, G. N., Bagheri, H., Comparing epidural block and intercostal block in patients with 3-4 broken ribs following chest cage blunt trauma, Annals of Tropical Medicine and Public Health, 10, 850-854, 2017	Comparison not in PICO (intercostal block versus epidural)
Kasotakis, George, Hasenboehler, Erik A., Streib, Erik W., Patel, Nimit, Patel, Mayur B., Alarcon, Louis, Bosarge, Patrick L., Love, Joseph, Haut, Elliott R., Como, John J., Operative fixation of rib fractures after blunt trauma: A practice management guideline from the Eastern Association for the Surgery of Trauma, The Journal of trauma and acute care surgery, 82,	Systematic review, included studies checked for relevance

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
618-626, 2017	
Khandelwal, Gaurav, Mathur, R. K., Shukla, Sumit, Maheshwari, Ankur, A prospective single center study to assess the impact of surgical stabilization in patients with rib fracture, International journal of surgery (London, England), 9, 478-81, 2011	Non-randomised study, n=61
Kim, J. H., Park, H. K., Jeon, S. Y., Oh, D. W., Park, H. J., Park, W. J., Initial effect of an elastic chest band during inspiratory exercise on chest function improvement in people with limited rib mobility: a randomized controlled pilot trial, Physiotherapy research international, 17, 208â 213, 2012	Population not in PICO (people with limited rib mobility)
Kourouche, Sarah, Buckley, Thomas, Munroe, Belinda, Curtis, Kate, Development of a blunt chest injury care bundle: An integrative review, Injury, 49, 1008-1023, 2018	Systematic review, included studies checked for relevance and one study found and included (Grammatopoulou 2010)
Liu, Tao, Liu, Peng, Chen, Jiajun, Xie, Jie, Yang, Fan, Liao, Yiliu, A Randomized Controlled Trial of Surgical Rib Fixation in Polytrauma Patients With Flail Chest, The Journal of surgical research, 242, 223-230, 2019	Population not in PICO: ICU patients
Liu, Xin, Xiong, Kai, Surgical management versus non-surgical management of rib fractures in chest trauma: a systematic review and meta-analysis, Journal of cardiothoracic surgery, 14, 45, 2019	Outcomes not in PICO
Long, Rui, Tian, Junying, Wu, Shasha, Li, Yang, Yang, Xiuhua, Fei, Jun, Clinical efficacy of surgical versus conservative treatment for multiple rib fractures: A meta-analysis of randomized controlled trials, International journal of surgery (London, England), 83, 79-88, 2020	Systematic review, included studies checked for relevance
Magnone, Stefano, Allievi, Niccolo, Pisano, Michele, Rib fractures fixation: Always worthwhile?, The journal of trauma and acute care surgery, 85, 652, 2018	Letter to the editor, no original data
Marasco, Silvana F., Davies, Andrew R., Cooper, Jamie, Varma, Dinesh, Bennett, Victoria, Nevill, Rachael, Lee, Geraldine, Bailey, Michael, Fitzgerald, Mark, Prospective randomized controlled trial of operative rib fixation in traumatic flail chest, Journal of the American College of Surgeons, 216, 924-32, 2013	Population not in PICO (ICU patients; "Forty-six patients with traumatic flail chest injury receiving invasive mechanical ventilation were enrolled in the study. Patients were enrolled only if they were ventilator dependent with no prospect of successful weaning within the next 48 hours")
Mayberry, John, Early stabilization of flail chest with locked plate fixation, Journal of Orthopaedic Trauma, 25, 648, 2011	Commentary, no original data
McIlwaine, M., Physiotherapy and airway clearance techniques and devices, Paediatric Respiratory Reviews, 7, S220-S222, 2006	Narrative review
Mekhail, N. A., Interpleural analgesia: Continuous regional blockade for acute pain, Pain Digest, 6, 364-367, 1996	Narrative review
Mohta, M., Verma, P., Saxena, A. Kr, Sethi, A. K., Tyagi, A., Girotra, G., Prospective, randomized comparison of continuous thoracic epidural and thoracic paravertebral infusion in patients with unilateral multiple fractured ribs - A pilot study, Journal of Trauma - Injury, Infection and Critical Care,	Comparison not in PICO (thoracic epidural versus thoracic paravertebral infusion)

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
66, 1096-1101, 2009	
Moon MR, Luchette FA, Gibson SW, Crews J, Sudarshan G, Hurst JM, Davis K, Johannigman JA, Frame SB, Fischer JE. Prospective, Randomized Comparison of Epidural <i>Versus</i> Parenteral Opioid Analgesia in Thoracic Trauma <i>Annals of Surgery</i> 1999; 229: 684–692	Population not in PICO (adults)
Murata, Y., Kanaya, K., Wada, H., Wada, K., Shiba, M., Hatta, S., Kato, K., Kato, Y., Interscalene brachial plexus block for scapular and upper chest pain due to cervical radiculopathy: a randomized controlled clinical trial. <i>Journal of orthopaedic science</i> , 17, 515â 520, 2012	Population not in PICO (patients with cervical radicular pain for 14-15 ± 17-18 months).
Naidoo, Kamil, Hanbali, Layth, Bates, Peter, The natural history of flail chest injuries, <i>Chinese journal of traumatology = Zhonghua chuang shang za zhi</i> , 20, 293-296, 2017	Non-randomised study, n < 100 in one of the two treatment groups, outcomes not in PICO
Norum, H. M., Breivik, H., A systematic review of comparative studies indicates that paravertebral block is neither superior nor safer than epidural analgesia for pain after thoracotomy, <i>Scandinavian Journal of Pain</i> , 1, 12-23, 2010	Systematic review, included studies checked for relevance
Okoye, O., Horn, C., Pieper, M., Putty, B., Naughton, D., Freeman, C., Impact of rib fixation on outcomes in mechanically ventilated blunt trauma patients, <i>Critical Care Medicine</i> , 43, 2, 2015	Published as abstract only
Overend, T. J., Anderson, C. M., Lucy, S. D., Bhatia, C., Jonsson, B. I., Timmermans, C., The effect of incentive spirometry on postoperative pulmonary complications: A systematic review, <i>Chest</i> , 120, 971-978, 2001	Systematic review, included studies checked for relevance
Parris, R., Scabie, B., Epidural analgesia/anaesthesia versus systemic intravenous opioid analgesia in the management of blunt thoracic trauma, <i>Emergency Medicine Journal</i> , 24, 848, 2007	Semi-systematic review, included studies checked for relevance
Parris, Richard, Towards evidence based emergency medicine: best BETs from the Manchester Royal Infirmary. Epidural analgesia/anaesthesia versus systemic intravenous opioid analgesia in the management of blunt thoracic trauma, <i>Emergency medicine journal : EMJ</i> , 24, 848-9, 2007	Duplicate
Peek, Jesse, Smeeing, Diederik P. J., Hietbrink, Falco, Houwert, Roderick M., Marsman, Marije, de Jong, Mirjam B., Comparison of analgesic interventions for traumatic rib fractures: a systematic review and meta-analysis, <i>European journal of trauma and emergency surgery : official publication of the European Trauma Society</i> , 2018	Systematic review, included studies checked for relevance
Pieracci, F. M., Leasia, K., Bauman, Z., Eriksson, E. A., Lottenberg, L., Majercik, S., Powell, L., Sarani, B., Semon, G., Thomas, B., Zhao, F., Dyke, C., Doben, A. R., A multicenter, prospective, controlled clinical trial of surgical stabilization of rib fractures in patients with severe, nonflail fracture patterns (Chest Wall Injury Society NONFLAIL), <i>Journal of Trauma and Acute Care Surgery</i> , 88, 249-257, 2020	Non-RCT based analyses (mix of randomised [n=23] and non-randomised [n=87] patient data)

DRAFT FOR CONSULTATION

Specific programmes and packages in chest injury for people with complex rehabilitation needs after traumatic injury

Study	Reason for Exclusion
Pieracci, Fredric M., Ali-Osman, Francis, Mangram, Alicia, Majercik, Sarah, White, Thomas W., Doben, Andrew R., Re: Rib fractures fixation: Always worthwhile?, The journal of trauma and acute care surgery, 85, 1134-1135, 2018	Response to letter
Pieracci, Fredric M., Rodil, Maria, Stovall, Robert T., Johnson, Jeffrey L., Biffl, Walter L., Mauffrey, Cyril, Moore, Ernest E., Jurkovich, Gregory J., Surgical stabilization of severe rib fractures, The journal of trauma and acute care surgery, 78, 883-7, 2015	Narrative review
Raman, J., Onsager, D., Straus, D., Rib osteotomy and fixation: Enabling technique for better minithoracotomy exposure in cardiac and thoracic procedures, Journal of Thoracic and Cardiovascular Surgery, 139, 1083-1085, 2010	Narrative review
Rovina, Nikoletta, Koutsoukou, Antonia, Koulouris, Nikolaos, Therapeutic exercise in improving acute lung injury: a long distance to be covered, Annals of translational medicine, 3, 273, 2015	Editorial
Scalea, T. M., Optimal timing of fracture fixation: Have we learned anything in the past 20 years?, Journal of Trauma - Injury, Infection and Critical Care, 65, 253-260, 2008	Narrative review
Schulte, Katharina, Whitaker, Donald, Attia, Rizwan, In patients with acute flail chest does surgical rib fixation improve outcomes in terms of morbidity and mortality?, Interactive Cardiovascular and Thoracic Surgery, 23, 314-9, 2016	Systematic review, included studies checked for relevance
Simon, B., Ebert, J., Bokhari, F., Capella, J., Emhoff, T., Hayward, T., Rodriguez, A., Smith, L., Management of pulmonary contusion and flail chest: An eastern association for the surgery of trauma practice management guideline, Journal of Trauma and Acute Care Surgery, 73, S351-S361, 2012	Systematic review, included studies checked for relevance
Singh, Shalendra, Jacob, Mathews, Hasnain, S., Krishnakumar, Mathangi, Comparison between continuous thoracic epidural block and continuous thoracic paravertebral block in the management of thoracic trauma, Medical journal, Armed Forces India, 73, 146-151, 2017	Comparison not in PICO (thoracic epidural block versus thoracic paravertebral block)
Sum, S. K., Peng, Y. C., Yin, S. Y., Huang, P. F., Wang, Y. C., Chen, T. P., Tung, H. H., Yeh, C. H., Using an incentive spirometer reduces pulmonary complications in patients with traumatic rib fractures: a randomized controlled trial, Trials, 20, 797, 2019	Population not in PICO (adults)
Unsworth, Annalise, Curtis, Kate, Asha, Stephen Edward, Treatments for blunt chest trauma and their impact on patient outcomes and health service delivery, Scandinavian journal of trauma, resuscitation and emergency medicine, 23, 17, 2015	Systematic review, included studies checked for relevance
Vallier, H. A., Wang, X., Moore, T. A., Wilber, J. H., Como, J. J., Timing of orthopaedic surgery in multiple trauma patients: Development of a protocol for early appropriate care, Journal of Orthopaedic Trauma, 27, 543-551, 2013	Outcomes not in PICO
Velasquez, Mauricio, Ordonez, Carlos A., Parra,	Non-randomised study, n=40

Study	Reason for Exclusion
Michael W., Dominguez, Andres, Puyana, Juan C., Operative versus Nonoperative Management of Multiple Rib Fractures, <i>The American surgeon</i> , 82, e103-5, 2016	
Womack, J., Pearson, J. D., Walker, I. A., Stephens, N. M., Goodman, B. A., Safety, complications and clinical outcome after ultrasound-guided paravertebral catheter insertion for rib fracture analgesia: a single-centre retrospective observational study, <i>Anaesthesia</i> , 2019	Outcomes not in PICO
Yeung, J. H. Y., Gates, S., Naidu, B. V., Wilson, M. J. A., Gao Smith, F., Paravertebral block versus thoracic epidural for patients undergoing thoracotomy, <i>Cochrane Database of Systematic Reviews</i> , 2016	Comparison not in PICO (paravertebral block versus thoracic epidural)
Yeying G, Liyong Y, Yuebo C, Yu Z, Guangao Y, Weihu M, Liujun Z Thoracic paravertebral block versus intravenous patient controlled analgesia for pain treatment in patients with multiple rib fractures. <i>Journal of International Medical Research</i> 2017, Vol. 45(6) 2085–2091	Population not in PICO (adults)
Zhang, Lihong, Liu, Weifeng, You, Haiping, Chen, Zhiyuan, Xu, Liming, He, Hefan, Assessing the analgesic efficacy of oral epigallocatechin-3-gallate on epidural catheter analgesia in patients after surgical stabilisation of multiple rib fractures: a prospective double-blind, placebo-controlled clinical trial, <i>Pharmaceutical biology</i> , 58, 741-744, 2020	Comparison/intervention not in PICO: Epidural /-oral epigallocatechin-3- gallate

Economic studies

A systematic review of the literature was conducted, but no studies were identified which were applicable to this review questions

Appendix L – Research recommendations

Research recommendations for review question: C.4a For adults with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No research recommendations was made for this review question.

Research recommendations for review question: C.4b For children and young people with complex rehabilitation needs after traumatic injury that involves chest injury, what specific rehabilitation programmes and packages are effective and acceptable?

No research recommendations was made for this review question.