

**A short report for
Universitätsklinikum Schleswig-Holstein/Campus Kiel
on Shared Decision Making
for Implant Removal after Osteosynthesis**



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TABLE OF CONTENTS

TABLE OF CONTENTS	3
LIST OF TABLES	4
LIST OF FIGURES	4
LIST OF ABBREVIATIONS	5
1. PROJECT OBJECTIVES	6
2. METHODS.....	7
2.1 INCLUSION CRITERIA	7
2.2 LITERATURE SEARCHES	8
2.3 SEARCH SOURCES	9
2.4 METHODS OF STUDY SELECTION.....	9
3. RESULTS	10
3.1 LITERATURE SEARCHES AND INCLUSION ASSESSMENT	10
3.2 OVERVIEW OF INCLUDED STUDIES.....	12
3.3 COMPARISON WITH OTHER REVIEWS	18
4. DISCUSSION.....	19
4.1 SUMMARY OF MAIN FINDINGS.....	19
5. CONCLUSION	20
6. REFERENCES	21
APPENDIX 1: SEARCH STRATEGIES	23

LIST OF TABLES

Table 1: Study characteristics	13
Table 2: Study designs and reasons for exclusion	14
Table 3: Definitions of evidence grades based on the potential relevance for a full SDM	15
Table 4: Evidence available on FAQ 1-3	16
Table 5: Evidence available on FAQ 4	16

LIST OF FIGURES

Figure 1: PRISMA Study Selection Process	11
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LIST OF ABBREVIATIONS

AAOS	American Academy of Orthopaedic Surgeons
AOFAOS	American Orthopedic Foot Ankle Society hindfoot score
AWMF	Arbeitsgemeinschaft der wissenschaftlichen medizinischen Fachgesellschaften
CDSR	Cochrane Database of Systematic Reviews
CRD	Centre for Reviews and Dissemination
DARE	Database of Abstracts of Reviews of Effects
DGU	Deutsche Gesellschaft für Unfallchirurgie
FAOS	Foot and ankle outcomes score
FAQ	Frequently asked question
G-I-N	Guidelines International Network
HTA	Health Technology Assessment
KSR	Kleijnen Systematic Reviews
MA	Meta-analysis
NA	Not applicable
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NR	Not reported
OMAS	Olerud–Molander Ankle Score
QoL	Quality of life
RCT	Randomised controlled trial
SDM	Shared decision making
SFOPH	Swiss Federal Office of Public Health
SMFA	Short Musculoskeletal Function Assessment Questionnaire
SR	Systematic review

1. PROJECT OBJECTIVES

A key aim of the research project “Making SDM a reality” is to create interactive websites to inform patients as part of shared decision making (SDM).

To support this, Kleijnen Systematic Reviews Ltd (KSR) has prepared an overview of the evidence that may be available to inform shared decision making around the topic of implant removal after osteosynthesis.

The objective of this brief report is to present an overview of the characteristics of studies reporting on effects of implant removal after osteosynthesis compared to non-removal of implants that would be available to inform shared decision making on this topic.

2. METHODS

2.1 INCLUSION CRITERIA

PICOS	Inclusion Criteria
Population	Adult patients with implants following osteosynthesis considering removal of implants
Intervention	Surgical removal of implants (done with minimally invasive techniques, if possible)
Control	Non-removal of implants
Outcomes	• Description of treatment or procedure • Length of hospital stay (ambulatory or in hospital) • Resolution of symptoms • Pain (e.g. time to pain relief) • Function • Other symptoms: • Time to return to usual activity • Time off work/return to work • Time off driving/return to driving • Short term complications • Remaining pieces of implant/metal pieces • Immediate re-fracture • Instability of bone due to early transplant removal • No improvement of symptoms • New surgery related complications
Study design	Systematic Reviews (SR)/Meta-Analyses (MA) of Randomised Controlled Trials (RCTs), or of studies of lower evidence levels (non-randomised/observational studies), if needed. If no SRs/MAs are available, respective primary studies would have been systematically searched
Effect modification / Subgroups	Should there be any indication of a specific effect modification or subgroup of patients from the evidence review, these should be reported.

MA = meta-analysis; RCT = randomised control trial; SR = systematic review

Population

Guidelines recommend that patients only consider implant removal if there is a good reason for removal. According to the German Guideline (DGU 012-004),¹ patients may consider removal if they have either:

- complaints/symptoms caused by the implant
- functional limitations caused by the implant
- psychological limitations caused by the implant
- allergic reactions to the implant (metal allergy)
- or combinations of these

Intervention/control

There are no exclusion criteria but general contraindications to undergoing re-surgery include: limited/endangered soft tissue coverage, comprehensive surgery needed with prohibitively high associated access risk, and large volume hip implants in elderly people. These contraindications may limit the population eligible for this intervention.

Outcomes

Outcomes of interest are sorted by the following frequently asked questions (FAQs):

1. FAQ1: What does it involve?
 - a. Description of treatment or procedure
 - b. Length of hospital stay (ambulatory or in hospital)
2. FAQ2: Will my symptoms get better?
 - a. Resolution of symptoms
 - b. Pain (e.g. time to pain relief)
 - c. Function
 - d. Other
3. FAQ3: When will I recover (from anaesthesia)?
 - a. Time to return to usual activity
 - b. Time off work/return to work
 - c. Time off driving/return to driving
4. FAQ4: What are the risks?
 - a. Short term complications
 - b. Remaining pieces of implant/metal pieces
 - c. Immediate re-fracture
 - d. Instability of bone due to early transplant removal
 - e. No improvement of symptoms
 - f. New surgery related complications (e.g. nerve/vascular lesions, intraoperative fractures, bleedings, infections) late complications (e.g. re-fracture with the need for another osteosynthesis, late infections, intense scar formation, functional impairment at fracture/implant site)

2.2 LITERATURE SEARCHES

Literature searches were conducted on 12 and 13 March 2019 to identify relevant systematic reviews, meta-analyses and evidence-based guidelines on implant removal following osteosynthesis.

The search strategies were developed specifically for each database and the keywords adapted according to the configuration of each database. Searches were limited by date range for systematic reviews and guidelines to 2012-2019. Searches were not limited by language or publication status.

2.3 SEARCH SOURCES

Systematic reviews and guidelines

The following systematic review specific databases were searched from 2012 to present:

- Cochrane Database of Systematic Reviews (CDSR) (Wiley): 2012-2019/03/Iss3
- Database of Abstracts of Reviews of Effects (DARE) (CRD): 2012-2015/03
- Health Technology Assessment (HTA) database (CRD): 2012-2018/03
- KSR Evidence (Internet): up to 2019/03/12 <https://ksrevidence.com/>
- Epistemonikos (Internet): 2012-2019/03/13

The following guidelines resources were searched from 2012 to present:

- Guidelines International Network (G-I-N) (Internet): up to 2019/03/12
<http://www.g-i-n.net/library/international-guidelines-library>
- NHS Evidence (Internet): 2012/01/01-2019/03/12
www.evidence.nhs.uk/
- ECRI Guidelines Trust (Internet): up to 2019/03/12
<https://guidelines.ecri.org/>
- NICE (Internet): up to 2019/03/12
<https://www.nice.org.uk/>

Full details of all search strategies are presented in Appendix 1.

Handling of citations

Identified references from the bibliographic database searches were downloaded into EndNote bibliographic management software for further assessment and handling.

Supplementary searches

No additional searches were performed.

2.4 METHODS OF STUDY SELECTION

Two reviewers independently inspected the title and abstract of each reference identified by the searches and determined the potential relevance of each article. For potentially relevant articles, or in cases of disagreement, the full article was obtained, independently inspected, and inclusion criteria applied. Any disagreements were resolved through discussion or the intervention of a third reviewer.

For each included evidence synthesis, data were extracted by one reviewer and checked by a second reviewer. Any disagreements were resolved by consensus or the intervention of a third reviewer.

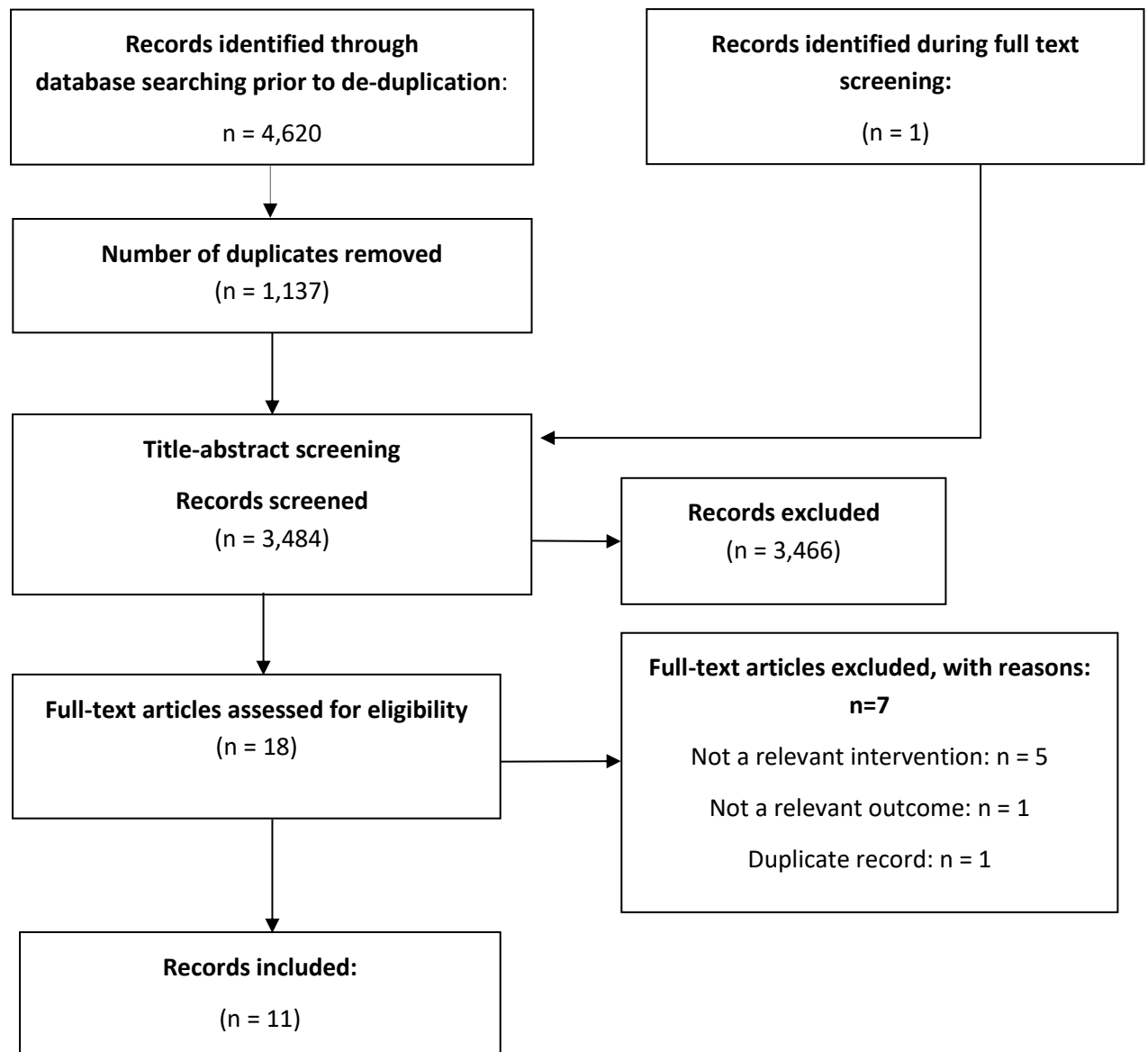
3. RESULTS

3.1 LITERATURE SEARCHES AND INCLUSION ASSESSMENT

For this brief report, systematic searches for systematic reviews, guidelines and shared decision making were conducted on 12 and 13 March 2019 to identify the study characteristics of potentially relevant studies to inform an evidence report on implant removal following osteosynthesis. A total of 4,620 references were retrieved from literature searches. One record was identified during full text screening. After de-duplication, 3,484 titles and abstracts were screened by two reviewers. Full papers were obtained for 18 citations. Of the 18 records, seven were excluded (for intervention (n=5), outcome (n=2) or duplicate record (n=1)), leaving 11 records to be formally included.

A summary of the study selection process according to modified PRISMA reporting guidelines is reported in Figure 1.

Figure 1: PRISMA Study Selection Process



3.2 OVERVIEW OF INCLUDED STUDIES

Table 1 to

Table 5 present an overview of the evidence available on implant removal.

Seven systematic reviews, three guidelines and one systematic review plus meta-analysis were available to inform the research question (Table 1). Implant locations varied and included: ankle (three studies), cranio- or maxillofacial (two studies), femoral neck (two studies), mixed locations (two studies), distal radius (one study) and scaphoid (one study) (Table 1). The reason for removal was unrestricted or not-prespecified in seven studies, not reported in two studies, due to infection in one study and due to bothersome symptoms in one study (Table 1). The total number of included patients ranged from 45 to 7,503 (Table 1).

Out of 11 records, seven evidence syntheses did not report on any randomised controlled trials (RCT), three evidence syntheses reported on a single RCT and one review reported on two RCTs. Across all publications, four RCTs²⁻⁵ were identified (Boyle 2014, Danda 2010, Høiness 2004, Moore 2006) but only one RCT (Boyle 2014) directly compared the effect of retaining or removing implants.²

Boyle 2014 focussed on syndesmotic screws in the ankle. The trial included 51 patients and assessed the effects of removal compared to non-removal on VAS-score for pain and three different functional outcomes (Olerund-Molander ankle score (OMAS), American Orthopaedic Foot and Ankle Society ankle-hindfoot score (AOFAS) and American Academy of Orthopaedic Surgeons (AAOS) foot and ankle score). Five clinical/radiological outcomes were reported (active dorsiflexion, plantar flexion, calf girth, calf girth loss and radiological tibiofibular clear space). Intra-operative and post-operative complications were also reported.

Table 3 provides definitions of the different types of evidence identified (i.e. quantitative, qualitative and unclear) and how these were applied to the overview of available evidence for FAQ 1 to 3 (Table 4) and FAQ 4 and potential new FAQs (

Table 5). Higher grade results that may be more relevant to extract were labelled as “quantitative”, results where there was some indication that at least some numeric results may be available (if primary referenced sources would be checked) were labelled as “qualitative”, while those outcomes where the utility of the evidence was unclear were labelled as “unclear”. Studies that failed to report on the FAQ of interest were labelled as “none”. None of the reviews reported subgroup analyses, so this information was not presented.

Table 1: Study characteristics

Study ID	Publication Type	Implant Location	Age	Reason for Removal	Comparator?	Total Patient #
Dingemans 2016⁶	Systematic Review	Ankle	Adults	NR	Yes - No removal (retention)	636
Schepers 2011⁷	Systematic Review	Ankle	NR	Any	Yes - No removal (retention); or other kind of implant*	472
Walley 2017⁸	Systematic Review	Ankle	NR	NR	Yes - Unclear	702
AWMF 012-001 2015⁹	Guideline	Femoral neck	Adults	Any; depending on local complaints, age, activity and implant type	NA	NA
Barquet 2017¹⁰	Systematic Review	Femoral neck	Adults	Not pre-specified	Yes - No removal	45
Cahill 2015¹¹	Systematic Review and Meta-Analysis	Cranio-maxillofacial	NR	Infection	Yes - No removal or not reported	7503
Hernandez 2016¹²	Systematic Review	Maxillofacial	Mixed	Any	No	2961
Yamamoto 2017¹³	Systematic Review	Distal radius fracture	Adults	Any	No	3690
AWMF 012-016 2015¹⁴	Guideline	Scaphoid (fracture of the hand)	NR	Bothersome symptoms (Störende Implantate)	NA	NA
Vos 2013¹⁵	Systematic Review	Unrestricted	Mixed ¹	Any	Yes - No removal (retention)	Unclear
AWMF 012-004 2018¹	Guideline	Various	Mixed	Various	NA	NA
AWMF = Arbeitsgemeinschaft der wissenschaftlichen medizinischen Fachgesellschaften; NA = not applicable; No. = number; NR = not reported. * suture wire or absorbable screws ¹ Though the authors state that children will be covered elsewhere in the journal they discuss evidence for children.						

Table 2: Study designs and reasons for exclusion

Study ID	Publication Type	Implant Location	Total Patient #	# Included RCTs	RCT Study Names	# Other Included Studies	Other Study Types	Exclusion Criteria
Dingemans 2016⁶	Systematic Review	Ankle	636	1	Boyle 2014 ² & Høiness 2004 ³	9	Observational (case series, poor quality cohort and case-control studies)	Biomechanical studies, case reports or reviews; skeletally immature patients
Schepers 2011⁷	Systematic Review	Ankle	472	2	Høiness 2004 ³ & Moore 2006 ⁴	5	Retrospective cohort (n=5)	Case reports, biomechanical studies
Walley 2017⁸	Systematic Review	Ankle	702	1	Boyle 2014 ²	8	Retrospective reviews	NA
AWMF 012-001 2015⁹	Guideline	Femoral neck ¹	NA	0	NA	0	NA	NA
Barquet 2017¹⁰	Systematic Review	Femoral neck	45	0	NA	24	Case reports (n=19); case series (n=15); book chapter (n=1)	Cases with fractures in pathological bone, trochanteric non-union, or infectious or significant mechanical complications i.e. cut out, implant breakage, etc.
Cahill 2015¹¹	Systematic Review and Meta-Analysis	Craniomaxillofacial	7503	1	Danda 2010 ⁵	69	Case series, case reports, cohorts, chart reviews, others	Studies limited to non-trauma scenarios; Letters and commentaries
Hernandez 2016¹²	Systematic Review	Maxillofacial	2961	0	NA	15	NR	NA
Yamamoto 2017¹³	Systematic Review	Distal radius	3690	0	NA	52	NR	Follow-up shorter than 1 year; young patients (< 18 years) or elderly patients (>65 years); review articles, case reports, biomechanical and cadaveric

Study ID	Publication Type	Implant Location	Total Patient #	# Included RCTs	RCT Study Names	# Other Included Studies	Other Study Types	Exclusion Criteria
								studies; publication before Jan 2000
AWMF 012-016 2015¹⁴	Guideline	Scaphoid (fracture of the hand)	NA	0	NA	0	NA	NA
Vos 2013¹⁵	Systematic Review	Unrestricted	Unclear	0	NA	23	Observational (Unclear, 'Retrospective')(n=23)	Literature on removal of prosthesis; implants from the maxillofacial and spine area; positioning screws of the ankle
AWMF 012-004 2018¹	Guideline	Various	NA	0	NA	NA	NA	NA
# = number; AWMF = Arbeitsgemeinschaft der wissenschaftlichen medizinischen Fachgesellschaften; NA = not applicable; NR = not reported. ¹ Femoral neck fracture due to: a fall from standing height or low seat height on the greater trochanter; forced external rotation of the leg in osteoporosis (e.g. tripping over carpet); chronic overload in osteoporosis and varus position of the femoral neck; or high speed trauma with axial compression of the thigh								

Table 3: Definitions of evidence grades based on the potential relevance for a full SDM

Quantitative	Numeric results reported (e.g. reporting of the rates of complications..., statistical testing not mandatory)
Qualitative	No numeric results reported but description includes indication that numeric data were analysed (e.g. result of meta-analysis, refers to statistical testing...)
Unclear	No numeric results reported and description does NOT include indication that numeric data were analysed (e.g. result of meta-analysis, refers to statistical testing...)
None	No results presented

Table 4: Evidence available on FAQ 1-3

Study ID	Implant Location	FAQ 1: What does it involve?	FAQ2: Will my symptoms get better?				FAQ 3: Will I recover?		
			Pain	Function	Resolution of other symptoms	Other (e.g. QoL)	Time to return to usual activity	Time off work/return to work	Time off driving/ return to driving
Dingemans 2016 ⁶	Ankle	None	Qualitative	Quantitative	None	None	None	None	None
Schepers 2011 ⁷	Ankle	None	Qualitative	Qualitative	None	Qualitative: Range of movement, and various scores (FAOS, OMAS, AOFAS, SMFA)	None	None	None
Walley 2017 ⁸	Ankle	None	Unclear	Unclear	None	None	None	None	None
AWMF 012-001 2015 ⁹	Femoral neck	None	None	None	None	None	None	None	None
Barquet 2017 ¹⁰	Femoral neck	None	None	None	None	None	None	None	None
Cahill 2015 ¹¹	Craniomaxillofacial	None	None	None	None	Quantitative: infection (MA performed but no data reported)	None	None	None
Hernandez 2016 ¹²	Maxillofacial	None	None	None	None	None	None	None	None
Yamamoto 2017 ¹³	Distal radius fracture	None	None	None	None	None	None	None	None
AWMF 012-016 2015 ¹⁴	Scaphoid (fracture of the hand)	None	None	None	None	None	None	None	None
Vos 2013 ¹⁵	Unrestricted	Qualitative	Quantitative	Qualitative	None	Unclear: Patient satisfaction, QoL	None	None	None
AWMF 012-004 2018 ¹	Various	Unclear	None	None	None	None	None	None	None

AWMF = Arbeitsgemeinschaft der wissenschaftlichen medizinischen Fachgesellschaften, AOFAOS = American Orthopedic Foot Ankle Society hindfoot score, FAOS = Foot and ankle outcomes score, FAQ = frequently asked question, OMAS = Olerud–Molander Ankle Score; SMFA = Short Musculoskeletal Function Assessment Questionnaire; QoL = Quality of life

Table 5: Evidence available on FAQ 4

Study ID	Implant Location	FAQ 4: What are the risks?					Potential New FAQs
		Remaining pieces of implant/material	Immediate re-fracture	Instability of bone due to early transplant removal	No improvement of symptoms	New surgery related complications	
Dingemans 2016 ⁶	Ankle	None	None	None	None	None	None
Schepers 2011 ⁷	Ankle	None	None	None	None	None	None
Walley 2017 ⁸	Ankle	None	None	None	Unclear	Quantitative	Radiographic outcome, "clinical outcomes", Infection (for removal with and without pre-operative antibiotics)
AWMF 012-001 2015 ⁹	Femoral neck	None	None	None	None	None	List of factors that would affect the indication for removal of the implant
Barquet 2017 ¹⁰	Femoral neck	None	None	None	None	None	Incidence of femoral neck fracture following removal of hardware (1 study, 114 patients)
Cahill 2015 ¹¹	Cranio-maxillofacial	None	None	None	None	None	Hardware management
Hernandez 2016 ¹²	Maxillofacial	None	None	None	None	Quantitative	Rate of removal
Yamamoto 2017 ¹³	Distal radius fracture	None	None	None	None	Quantitative	Rate of removal
AWMF 012-016 2015 ¹⁴	Scaphoid (fracture of the hand)	None	None	None	None	None	Indications for removal
Vos 2013 ¹⁵	Unrestricted	Qualitative	Quantitative	None	Quantitative	Quantitative	Indications for removal
AWMF 012-004 2018 ¹	Various	None	None	None	None	Unclear	Indications for removal
AWMF = Arbeitsgemeinschaft der wissenschaftlichen medizinischen Fachgesellschaften; FAQ = Frequently asked question							

3.3 COMPARISON WITH OTHER REVIEWS

A recent scoping report for the Swiss Federal Office of Public Health (SFOPH) performed a scoping search on implant removal in several databases.¹⁶ Their search, which was run without a study filter in October 2018, returned more than 12,000 references. Following study screening and selection, 10 eligible studies were finally identified: one RCT, four cohort studies and five before-after studies. Of note, the single RCT was the same study that we identified (Boyle 2014).²

4. DISCUSSION

4.1 SUMMARY OF MAIN FINDINGS

Evidence on the benefit and harm of implant removal appears to be sparse. Only one RCT that directly compared the efficacy and safety for removal versus non-removal of implants was identified.² A recent scoping report for an HTA on implant removal did not identify any additional RCTs.¹⁶ It is therefore unlikely that a new search for primary studies would substantially change the amount of reliable evidence available.

Going down the evidence hierarchy, we identified several primary (non-RCT) studies that may provide additional evidence to inform the research question of interest. However, the quality of this evidence would likely be subject to substantial confounding and bias due to the lack of similarity in several key study characteristics, such as implant type and implant condition (intact vs. broken). Thus, while there are some indications where numeric data may be available to inform some of the FAQs, the type and quality of the data would have to be checked in most instances through a rigorous review of the primary studies cited.

The locations of the implants being assessed varied widely. Most of the evidence seemed to be available on syndesmotic screws at the ankle. For this indication, there were reports that the need for removal was driven by the number and type of screws applied, so it is possible that the evidence base is even smaller than it might seem at first glance.

5. CONCLUSION

The current report gives a brief overview of the type of evidence available for the various FAQs based on a review of recent evidence syntheses. This approach is less comprehensive than a systematic review of primary sources. However, based on a recent scoping report, it seems unlikely that a more extensive search would yield additional reliable evidence. The classification of the type of evidence available into quantitative and qualitative without assessing the primary sources can only be considered tentative. A review of the primary studies would be needed for a definite assessment of the type and quality of the available evidence.

6. REFERENCES

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APPENDIX 1: SEARCH STRATEGIES

Database	Dates	Results
CDSR	2012 – 2019/03/Iss3	198
CDSR Protocols	2012 – 2019/03/Iss3	24
DARE	2012 – 2015/03	209
HTA	2012 - 2018/03	29
KSR Evidence	up to 2019/03/12	1579
Epistemonikos	2012-2019/03/13	1129
NHS Evidence	2012/01/01- 2019/03/12	1050
NICE	up to 2019/03/12	170
GIN	up to 2019/03/12	113
ECRI	up to 2019/03/12	119
Total		4620
Total after de-duplication		3483

Cochrane Database of Systematic Reviews (CDSR) (Wiley): up to 2019/03/Iss3

Cochrane Database of Systematic Reviews Protocols (Wiley): up to 2019/03/Iss3

Searched: 12.3.19

- #1 MeSH descriptor: [Fracture Fixation, Internal] explode all trees 1216
- #2 (Osteosynthesis or Osteosyntheses or gleitosteosynthesis or "osteo synthesis") 883
- #3 (bone* or fracture*) near/2 (device* or hardware or implant* or fix* or pin or pins or pinned or pinning or nail* or screw* or plate* or reduction* or wire* or anchor*) 5213
- #4 intramedullary near/2 nailing* 512
- #5 MeSH descriptor: [Internal Fixators] explode all trees 1553
- #6 Internal near/2 (Fixator* or fixation*) 1858
- #7 ((device* or hardware or implant* or pin or pins or nail* or screw* or plate* or wire* or anchor*) near/2 remov*) 1463
- #8 MeSH descriptor: [Device Removal] explode all trees 392
- #9 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 with Cochrane Library publication date Between Jan 2012 and Mar 2019 4578

CDSR search retrieved 198 records

CDSR protocols search retrieved 24 records

Database of Abstracts of Reviews of Effects (DARE) (CRD): up to 2015/03

Health Technology Assessment (HTA) database (CRD): up to 2018/03

Searched: 12.3.19

- 1 MeSH DESCRIPTOR Fracture Fixation, Internal EXPLODE ALL TREES 212
- 2 (Osteosynthesis or Osteosyntheses or gleitosteosynthesis or "osteo synthesis") 13
- 3 ((bone* or fracture*) NEAR2 (device* or hardware or implant* or fix* or pin or pins or pinned or pinning or nail* or screw* or plate* or reduction* or wire* or anchor*)) 511
- 4 (intramedullary NEAR2 nailing*) 45
- 5 MeSH DESCRIPTOR Internal Fixators EXPLODE ALL TREES 247
- 6 (Internal NEAR2 (Fixator* or fixation*)) 142

7 (((device* or hardware or implant* or pin or pins or nail* or screw* or plate* or wire* or anchor*) NEAR2 remov*)) 102
 8 MeSH DESCRIPTOR Device Removal EXPLODE ALL TREES 46
 9 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 668
 10 (#9) FROM 2012 TO 2019 293
 11 (#10) IN DARE FROM 2012 TO 2019 209
 12 (#10) IN HTA FROM 2012 TO 2019 29

KSR Evidence (Internet): up to 2019/03/12

<https://ksrevidence.com/>

Searched: 12.3.19

1 (Osteosynthesis or Osteosyntheses or gleitosteosynthesis or "osteo synthesis") in All text 103
 2 (fracture* or bone*) and (device* or hardware or implant* or pin or pins or pinned or pinning or nail* or screw* or plate* or wire* or anchor*) in All text 1231
 3 (remov*) and (device* or hardware or implant* or pin or pins or nail* or screw* or plate* or wire* or anchor*) in All text 329
 4 (Internal Fixator* or Internal fixation*) in All text 254
 5 #1 or #2 or #3 or #4 1579

Epistemonikos (Internet): up to 2019/03/13

<https://www.epistemonikos.org/en/>

Searched: 13.3.19

(title:((Osteosynthesis OR Osteosyntheses OR gleitosteosynthesis OR "osteo synthesis") OR ((fracture*) AND (device* OR hardware OR implant* OR pin OR pins OR pinned OR pinning OR nail* OR screw* OR plate* OR wire* OR anchor*)) OR ((remov*) AND (device* OR hardware OR implant* OR pin OR pins OR nail* OR screw* OR plate* OR wire* OR anchor*))) OR abstract:((Osteosynthesis OR Osteosyntheses OR gleitosteosynthesis OR "osteo synthesis") OR ((fracture*) AND (device* OR hardware OR implant* OR pin OR pins OR pinned OR pinning OR nail* OR screw* OR plate* OR wire* OR anchor*)) OR ((remov*) AND (device* OR hardware OR implant* OR pin OR pins OR nail* OR screw* OR plate* OR wire* OR anchor*)))) [Filters: classification=systematic-review, min_year=2012, max_year=2019] **1,129 records**

NHS Evidence Search: limited to guidance and SRs only (Internet)

<https://www.evidence.nhs.uk/> : 2012/01/01- 2019/03/12

Searched: 12.3.19

Keywords	Results limits to guidance and SRs (1/1/2012-12/3/2019)
Osteosynthes*	52
fracture* and (device* or hardware or implant* or pin or pins or pinned or pinning	998

Keywords	Results limits to guidance and SRs (1/1/2012-12/3/2019)
or nail* or screw* or plate* or wire* or anchor*)	
Total	1050
Total after duplicates removed in mini enl	1016 (34 dupes removed)

National Institute for Health and Care Excellence (NICE): limited to guidance (Internet)
<https://www.nice.org.uk/>: up to 2019/03/12
Searched 12.3.19

Keywords	Results limits to guidance
Osteosynthesis OR Osteosyntheses	0
Fracture OR fractures	148
Removal AND (device OR devices OR implant OR implants OR hardware)	22/138 (116 removed as non-relevant material)
Total	170

International Guideline Library (GIN) (Internet) (<https://www.g-i-n.net/home>): up to 2019/03/12
Searched: 12.3.19

Keywords	Hits
Osteosynthesis OR Osteosyntheses	1
Fracture OR fractures	112
Total	113

ECRI Institute Guidelines Trust (Internet) <https://guidelines.ecri.org/>: up to 2019/03/12
Searched: 12.3.19

Keywords	Hits
Fracture	57
fractures	62
Osteosynthesis	0
Osteosyntheses	0
Total	119