Sacroiliac Joint Fusion

Assessing Signals for Update

November 10, 2020

Health Technology Assessment Program (HTA)

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This report is based on research conducted by the RTI–University of North Carolina Evidence-based Practice Center through a contract between RTI International and the State of Washington Health Care Authority (HCA). The findings and conclusions in this document are those of the authors, who are responsible for its contents. The findings and conclusions do not represent the views of the Washington HCA and no statement in this report should be construed as an official position of Washington HCA.

The information in this report is intended to help the State of Washington's independent Health Technology Clinical Committee make well-informed coverage determinations. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information (i.e., in the context of available resources and circumstances presented by individual patients).

None of the individuals involved in producing this report reported any financial or nonfinancial conflicts of interest regarding the topic presented in this report.

Acknowledgments

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Contents

List of Appendices

List of Figures

List of Tables

List of Abbreviations

AE	Adverse event
ADL	Activities of daily living
CCS	Controlled cohort studies
CPT	Current procedural terminology
CQ	Cost question
CT	Computerized tomography
DSIJQ	Denver Sacroiliac Joint Questionnaire
EQ	Efficacy question
EQ-5D	EuroQOL measure of generic health status
FDA	Food and Drug Administration
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HCA	Health Care Authority
HTA	Health technology assessment
iMIA	iFuse Implant System Minimally Invasive Arthrodesis
INSITE	Investigation of Sacroiliac Fusion Treatment
LOIS	Long Term Outcomes from INSITE and SIFI
MeSH	Medical subject headings
MIS	Minimally invasive surgery
MI-SIJF	Minimally invasive sacroiliac joint fusion
NS	Not statistically significant
ODI	Oswestry Disability Index
R	Retrospective
RCT	Randomized controlled trial
P	Prospective
PT	Physical therapy
QOL	Quality of life
SALLY	Study of Bone Growth in the Sacroiliac Joint after Minimally Invasive Surgery with Titanium Implants
SF-12 PCS	Short-Form 12 physical component score
SI	Sacroiliac
SIF	Sacroiliac fusion
SIFI	Sacroiliac Joint Fusion with iFuse Implant System
SIJ	Sacroiliac joint
SIJF	Sacroiliac joint fusion
SQ	Safety question
VAS	Visual analogue scale

Executive Summary

The State of Washington's Health Technology Assessment Program published a 2018 health technology assessment (HTA) titled "Sacroiliac Joint Fusion" that was conducted by the RTI-University of North Carolina Evidence-based Practice Center. This HTA found that minimally invasive sacroiliac (SI) joint fusion surgery with the iFuse Implant System is probably more effective than conservative management among patients meeting standardized diagnostic criteria for SI joint pain or dysfunction. This finding was based on *moderate-certainty evidence* from 2 randomized controlled trials (RCTs) that this surgery reduces pain and improves function and quality of life more than conservative management at up to 6 months follow-up, and *very low-certainty evidence* from 1 controlled cohort study that it improves pain and disability more than conservative management at up to 3.5 years of follow-up. This report also concluded with *low-certainty evidence* from 2 RCTs and *very low-certainty evidence* from 1 controlled cohort study that no difference in serious adverse events between surgery and conservative management exists, though serious adverse events from surgery may be higher in usual practice based on data from uncontrolled studies. Based on *moderate-certainty evidence* from 2 RCTs and *very low-certainty evidence* from 1 controlled cohort study, the incidence of revision surgery by 2 years was estimated to be no higher than 3.4%. We conducted a signal search to determine whether current evidence suggests the need for an update to this published HTA.

We searched MEDLINE for relevant studies between January 1, 2018, and September 1, 2020, that addressed the research questions and study selection criteria used in the original HTA report (see Section 2.2). If a study met the selection criteria, we abstracted brief information about the study into a structured form. We then evaluated each study for whether it suggested signals of major changes in the evidence. We identified 11 new articles evaluating SI joint fusion that met the study selection criteria, of which 9 represented new studies. Two publications (1 RCT and 1 uncontrolled study) were articles providing outcomes at additional time points for studies that were included in the prior HTA. The remaining 9 studies (1 controlled cohort study and 8 uncontrolled studies) were new studies.

Two studies were eligible for efficacy outcomes. One RCT, included in the prior HTA, compared minimally invasive SI joint fusion with iFuse to conservative management and reported additional findings at the 2-year follow-up: the larger improvements in pain, function, and quality of life that had been observed at 6 months persisted at 2 years. A new controlled cohort study comparing iFuse to another minimally invasive procedure (Rialto) reported significant improvement in pain, function, and quality of life at 6 months when compared to preoperative values for both procedures and no difference between groups. Ten studies (1 RCT, 1 controlled cohort, 8 uncontrolled studies) reported safety outcomes, including revision surgery and overall adverse events; the frequency of events varied across studies but was generally consistent with the previous HTA. Adverse events were more frequent with open procedures than with minimally invasive procedures. One new study reported cost outcomes, but these could

not be compared to results reported in the previous HTA because of differences in the methods used.

The preponderance of new evidence identified in this signal search reports on minimally invasive SI joint fusion procedures, with the most evidence for the iFuse system. Newly identified evidence from 11 studies is consistent with findings from the prior HTA report. We did not identify any signals indicating a need to update the prior HTA report, such as evidence of opposing findings, substantial harms, superior new treatments, or other major changes in the evidence.

Full Report

1. Introduction

The State of Washington's Health Technology Assessment (HTA) Program published a health technology assessment (HTA) titled "Sacroiliac Joint Fusion" on December 7, 2018.[1] The independent Health Technology Clinical Committee evaluated the findings of this HTA and made an initial coverage determination at its January 18, 2019, meeting, with final adoption of the determination on May 17, 2019. The Committee's Coverage Decision for sacroiliac (SI) joint fusion is summarized in Section 1.1 below. At the request of the state's HTA program, we conducted a signal search to determine whether evidence suggesting a need for an update to the previous HTA is warranted. This report summarizes the findings of this signal search.

1.1 Coverage Determination 2019

In adults 18 years old or older with chronic SI joint pain related to degenerative sacroiliitis or SI joint disruption, minimally invasive and open SI joint fusion procedures is not a covered benefit. The rationale for the committee's decision was as follows:

> Based on the deliberations of key health outcomes the committee decided that it had the most complete information: a comprehensive and current evidence report, public comments, and state agency utilization information. The committee decided that the current evidence on sacroiliac joint fusion is sufficient to make a determination on this topic. The committee discussed and voted on the evidence for the use of sacroiliac joint fusion. The committee considered the evidence and gave greatest weight to the evidence it determined, based on objective factors, to be the most valid and reliable. Based on these findings, the committee voted to not cover minimally invasive or open sacroiliac joint fusion for sacroiliac chronic joint pain related to degenerative sacroiliitis and/or sacroiliac joint disruption for adults 18 years old and older.[1(p2)]

The committee's determination was not consistent with the UK National Institute for Health and Care Excellence (NICE) and AIM Specialty Health guidance. The committee's determination included consideration of local, clinical expert considerations related to the complexities of revision surgeries; concerns related to diffusion; and uncertainty of evidence for safety and cost-effectiveness.

1.2 Key Findings From 2018 HTA

The key questions from the original HTA included the following:

Efficacy Question 1 (EQ1). What is the effectiveness and comparative effectiveness of SI joint fusion surgery on health outcomes?

> **Effectiveness Question (EQ1a):** What is the comparative effectiveness of various SI joint fusion surgeries on intermediate efficacy outcomes?

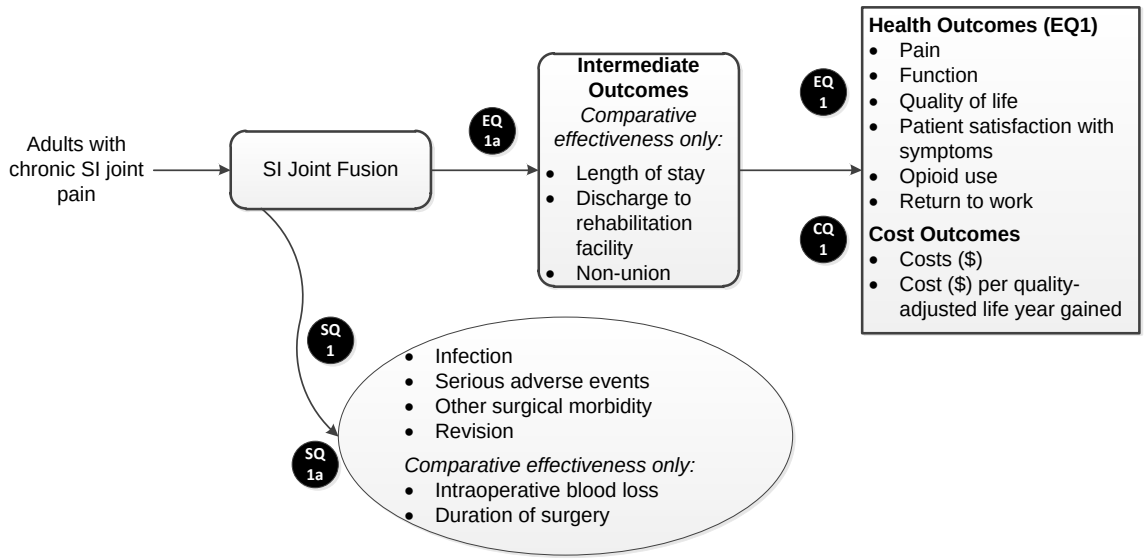
Safety Question 1 (SQ1). What is the safety of SI joint fusion surgery?

> **Safety Question 1a (SQ1a):** What is the comparative effectiveness of various SI joint fusion surgeries on intermediate safety outcomes?

Cost Question 1 (CQ1). What is the cost and cost-effectiveness of SI joint fusion surgery?

We also used the following analytic framework (***Figure 1***) to guide the 2019 HTA:

Figure 1. Analytic framework for HTA on SI joint fusion



Abbreviations: CQ = cost question; EQ = efficacy question; HTA = health technology assessment; SI = sacroiliac; SQ = safety question.

Detailed study selection criteria are available in the full report. In brief, we included randomized controlled trials (RCTs), controlled trials, and controlled cohort studies (CCS) for all research questions. We also included uncontrolled trials or cohort studies for the safety research question. We rated individual study risk of bias using standard rating instruments, and graded the certainty of evidence for each comparison and outcome domain using the Grading of Recommendations Assessment, Development and Evaluation approach.[2]

The 2018 HTA included 43 primary research studies published between 1987 and 2018. Eight studies (2 RCTs, 6 CCSs) provided evidence on efficacy or comparative effectiveness (EQ1), 39 studies (2 RCTs, 5 CCSs, and 32 uncontrolled studies) provided evidence on safety (SQ1), and 3 studies provided evidence on costs or cost-effectiveness (CQ1). Controlled studies enrolled participants based on standardized diagnostic criteria for chronic SI joint pain and dysfunction, including physical exam criteria, radiographic tests excluding other pathology, and pain relief in response to diagnostic SI joint injection under imaging guidance.

Two RCTs and 6 CCSs reported on efficacy and safety outcomes. The evidence maps comparing minimally invasive SI joint fusion with iFuse to conservative management, open SI joint fusion

to conservative management, and minimally invasive SI joint fusion (iFuse) to open SI joint fusion are depicted in ***Figure 2***.

For the comparison of iFuse to conservative management, the evidence was *moderate-certainty* for benefit on pain, function/disability, and quality of life at up to 6 months from 2 RCTs, and *very low-certainty* for benefit on pain and disability at up to 3.5 years in the CCS. This report also concluded with *low-certainty evidence* from 2 RCTs and *very low-certainty evidence* from 1 CCS that no difference in serious adverse events between surgery and conservative management exists, though serious adverse events from surgery were not frequent in controlled studies and they may be higher in usual practice based on data from uncontrolled studies. Based on *moderate-certainty evidence* from 2 RCTs and *very low-certainty evidence* from 1 CCS, the incidence of revision surgery by 2 years was estimated to be no higher than 3.4%.

The evidence comparing open SI joint fusion to conservative management based on 1 CCS was *very low certainty* for no difference in pain, physical function, or quality of life over the long term (11 to 23 years) and the evidence comparing iFuse to open SI joint fusion based on 3 CCSs was *very low certainty*, with some evidence of benefit on pain and length of hospital stay for iFuse, but no difference or mixed findings on physical function, adverse events, and revision surgery outcomes.

Figure 2. Evidence maps from 2018 HTA on SI joint fusion

Minimally invasive SI joint fusion (iFuse) vs. conservative management (top panel)
Open SI joint fusion (iFuse) vs. conservative management (bottom panel)

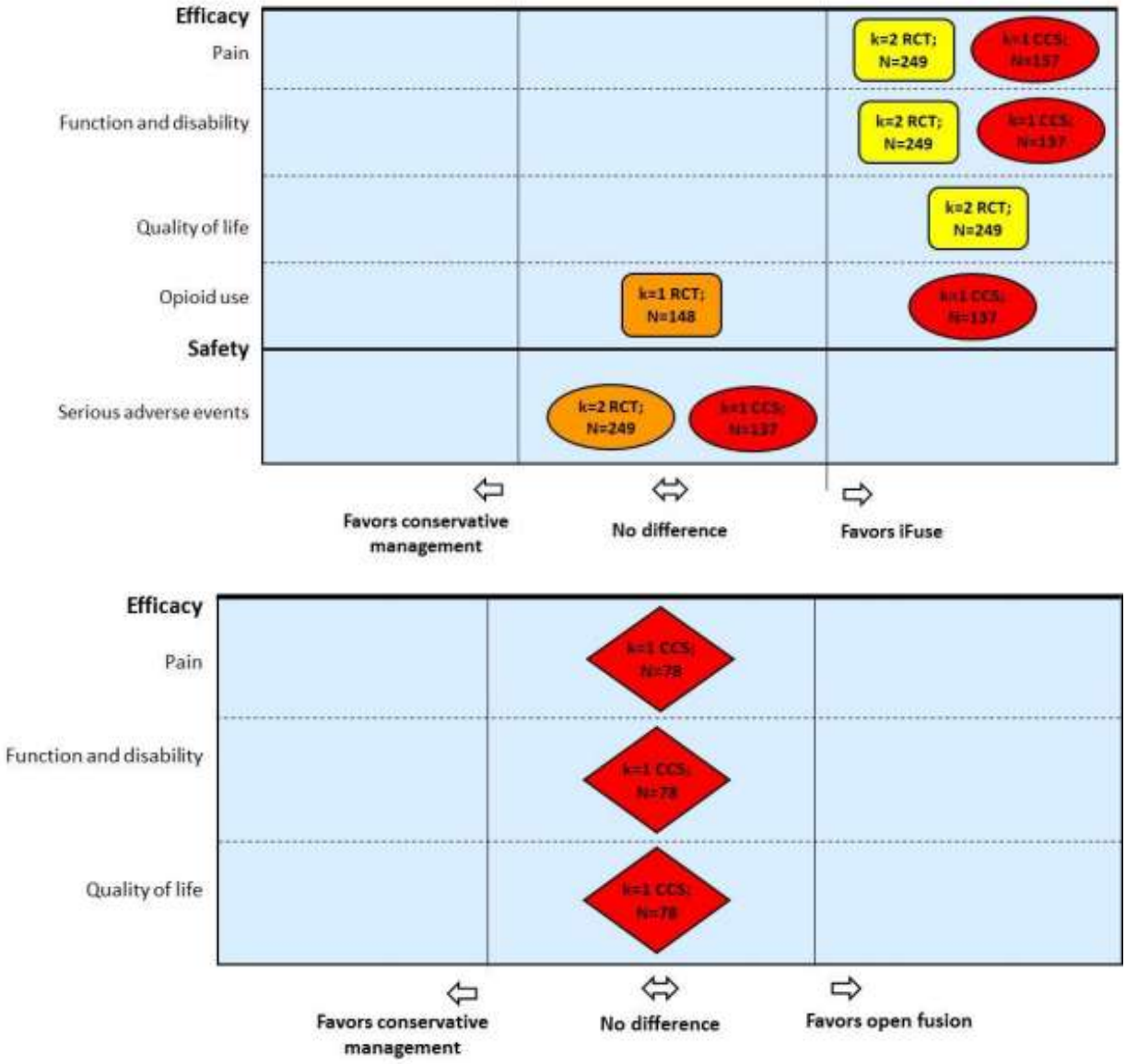
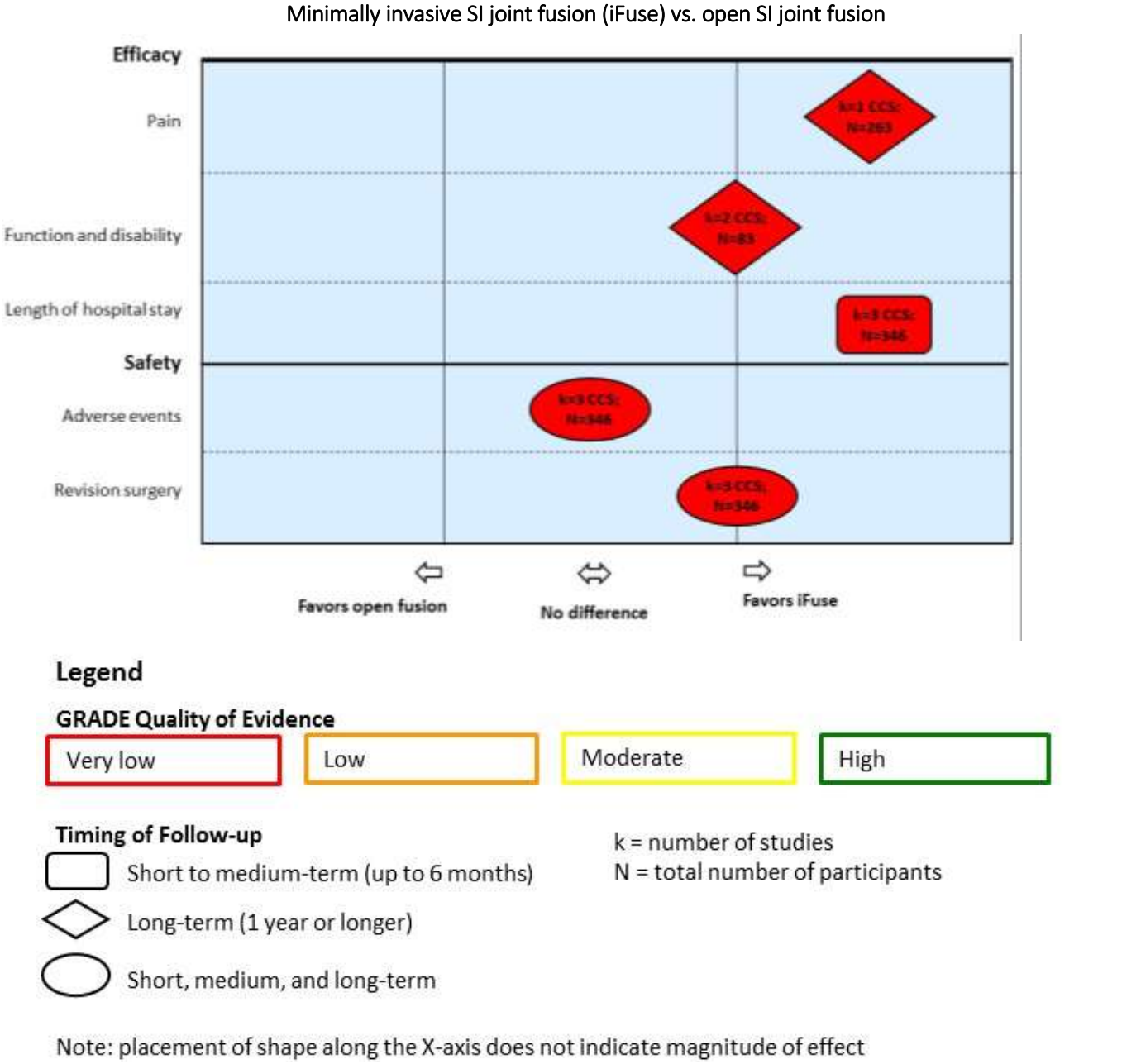


Figure 2 (continued). Evidence maps from 2018 HTA on SI joint



Abbreviations: CCS = controlled cohort study; CQ = cost question; EQ = efficacy question; HTA = health technology assessment; RCT = randomized controlled trial; SI = sacroiliac; SQ = safety question.

In addition to the 2 RCTs and 6 CCSs evaluating both efficacy and safety of SI joint fusion, we identified 32 uncontrolled studies that reported safety outcomes from various SI joint fusion procedures. Eight studies evaluated open fusion procedures, and the rest evaluated various minimally invasive fusion procedures. We rated half of these uncontrolled studies as high risk of bias. The ways in which study authors defined and monitored adverse events, including the time frame over which participants were followed, varied greatly. Prospective uncontrolled trials were more likely to actively monitor participants and report all adverse events participants experienced during the study time frame, regardless of whether the event was device or procedure related. Some studies reported only whether major complications of surgery occurred.

Among the 13 uncontrolled studies evaluating the iFuse Implant System, the frequency of adverse events that were definitely or probably related to the device or procedure ranged from 0% to 30%. One study retrospectively evaluated the frequency of adverse events after minimally invasive SI joint fusion using a large insurance claims database from 2007 through 2014. Study authors could not report the specific procedures or systems used based on available data. The overall incidence of complications was 13.2% at 90 days and 16.4% at 6 months among 469 claimants that had received surgery. In these 13 studies, the frequency of revision surgery ranged from 0% to 8%. The largest of these studies reported the incidence of revision based on the manufacturer's postmarket surveillance database over the years 2009 through 2014. Of 11,388 participants who underwent an initial procedure with iFuse, 320 (2.8%) underwent a revision, and 63% of the revisions occurred within the first year postoperatively.

2. Methods

To determine the need for an HTA update, we used several modifications to the method initially described by Shojania et al. at the University of Ottawa based on qualitative and quantitative signals that a conclusion from an evidence review is out-of-date.[3-5] Our modification to this method included 1) conducting a comprehensive update search using the original search from the prior HTA and 2) evaluating every study identified for whether it included a signal suggesting the need for an update (see Section 2.3).

2.1 Literature Search

We searched MEDLINE® (via PubMed) for relevant English-language studies between January 1, 2018, and September 1, 2020, allowing an overlap of 6 months with the previous search. The search strategy is described in detail in ***Appendix A***. In addition, we reviewed suggested references submitted by stakeholders to the State's HTA Program. In brief, we used medical subject headings (MeSH terms) and text words associated with "sacroiliac joint" and "fusion." We limited the search by eliminating studies indexed using terms for infants, children, adolescents, and animals. We used MeSH terms to remove editorials, letters, and publication types that do not represent primary research studies from the search yield.

2.2 Study Selection

We sought to identify new primary research studies that addressed the research questions and study selection criteria used in the original HTA. In addition, we sought systematic reviews to hand search for potentially missed primary research studies. The study selection criteria are briefly described below:

- Population: adults with chronic SI joint pain and positive diagnostic tests
- Intervention(s): open SI joint fusion, minimally invasive SI joint fusion
- Comparator(s): fusion surgery (head-to-head comparison), active conservative treatment, no treatment
- Outcomes: pain, physical function, quality of life, patient satisfaction, opioid use, return to work, infection, surgical morbidity, adverse events, revision surgery, costs, and cost-effectiveness We also considered the following outcomes from head-to-head studies—length of stay, non-union, discharge to rehabilitation facility, intraoperative blood loss, and duration of surgery.
- Study design(s): RCTs, controlled trials, CCSs, and systematic reviews of similar scope; we also considered uncontrolled studies for the safety question, and cost analyses for the cost question
- Setting: inpatient or outpatient settings from countries as assessed as *very high* on the United Nations Human Development Index[6]
- Other: English-language, no restrictions on time period included

2.3 Data Abstraction and Signal Assessment

Two reviewers evaluated titles/abstracts retrieved through our search; we reviewed the full text of those deemed relevant based on a review of the title/abstract. If a study met the study selection criteria, we abstracted brief information about the population, intervention, and comparator (if applicable) into a structured form. We then captured brief information about whether the outcomes reported by the study were new, consistent with previous findings, or inconsistent with previous findings and any notable details related to the results presented that might affect a decision on whether to update the previous HTA. Lastly, we assigned a code when studies we reviewed suggested a signal for potentially invalidating changes in evidence or for signals of major changes in evidence. ***Table 1*** describes the signals we applied, if applicable. If we did not identify any signals for an update, then no signal code was assigned.

Table 1. Summary of signal codes used to describe studies identified in a signal search based on Ottawa Method

Signal Code	Description
Criteria for Signals of Potentially Invalidating Changes in Evidence	
A1	Opposing findings: A pivotal trial or systematic review (or guidelines) including at least 1 new trial that characterized the treatment in terms opposite to those used earlier
A2	Substantial harm: A pivotal trial or systematic review (or guidelines) whose results called into question the use of the treatment based on evidence of harm or that did not proscribe use entirely but did potentially affect clinical decision making
A3	A superior new treatment: A pivotal trial or systematic review (or guidelines) whose results identified another treatment as significantly superior to the one evaluated in the original review, based on efficacy or harm
Criteria for Signals of Major Changes in Evidence	
A4	Important changes in effectiveness short of "opposing findings"
A5	Clinically important expansion of treatment
A6	Clinically important caveat
A7	Opposing findings from discordant meta-analysis or nonpivotal trial
Quantitative Criteria for Signals of Potentially Invalidating Changes in Evidence	
B1	A change in statistical significance (from nonsignificant to significant)
B2	A change in relative effect size of at least 50%

3. Results

3.1 Search Yield and Overview of Studies

We identified 118 unique, new citations from the PubMed search and 3 additional citations identified from hand searching or from stakeholder correspondence. We reviewed 29 citations at full-text and included 11 articles representing 11 unique studies that met the study selection criteria used in the prior HTA report. The list of articles we screened at the full-text stage, but which we excluded, is provided in ***Appendix B***. Note that articles may have been excluded for more than 1 reason, but we report only 1 reason. ***Table 2*** provides a summary of the included studies; detailed information about these studies is provided in ***Tables C-1*** and ***C-2*** in ***Appendix C***.

Table 2. Summary of eligible studies identified in signal search for SI joint fusion

Study	Study Status	Design	Eligible Research Questions	Interventions (Sample Size)	Signal Code Assigned*
Dengler et al., 2019[12] iMIA	Previously included study[13-15]	RCT	Efficacy, safety	• iFuse MI-SIJF (54 originally randomized; 47 with 2-year follow-up) • Conservative management (51 randomized, 46 with 2-year follow-up)	**No code**; findings consistent with prior HTA
Buysman et al., 2018[19]	New study	Single-group cohort (R)	Safety, cost	• Unknown MI-SIJF (302; based on administrative claims data)	**No code**; findings consistent with prior HTA
Cher et al., 2018[20]	New study	Single-group cohort (R)	Safety	• iFuse MI-SIJF (standard iFuse, 11,070; iFuse-3D 3,140)	**No code**; findings consistent with prior HTA
Claus et al., 2020[7]	New study	Controlled cohort	Efficacy, safety	• Rialto MI-SIJF (74) • iFuse MI-SIJF (82)	**No code**; no comparison in prior HTA
Cleveland et al., 2019[16]	New study	Single-group cohort (R)	Safety	Modified MI-SIJF with iFuse and limited open computer navigation for direct decortication and graft placement (50)	**No code**; findings consistent with prior HTA
Mao et al., 2018[22]	New study	Single-group cohort (R)	Safety	iFuse MI-SIJF (24)	**No code**; findings consistent with prior HTA
Murakami et al., 2018[21]	New study	Single-group cohort (P)	Safety	Open SIJF (27)	**No code**; findings consistent with prior HTA
Patel et al., 2019[11] SALLY	New study	Uncontrolled trial	Safety	iFuse 3D MI-SIJF (28 interim enrollment, study is targeting 50 total)	**No code**; findings consistent with prior HTA
Rainov et al., 2019[17]	New study	Single-group cohort (R)	Safety	iFuse MI-SIJF (160)	**No code**; findings consistent with prior HTA
Rajpal et al., 2018[18]	New study	Single-group cohort (R)	Safety	Rialto MI-SIJF (24)	**No code**; findings consistent with prior HTA
Whang et al., 2019[8] LOIS	Previously included study[8-10]	Single-group cohort (P)	Safety	iFuse MI-SIJF (103 of 127 participants from INSITE/SIFI trials began LOIS; 93 with 5-year data available)	**No code**; findings consistent with prior HTA

Notes: *See Table 1 for list of signal codes, if no signal identified then no code was assigned.
Abbreviations: HTA = health technology assessment; iMIA = iFuse Implant System Minimally Invasive Arthrodesis; INSITE = Investigation of Sacroiliac Fusion Treatment ; LOIS = Long Term Outcomes from INSITE and SIFI; MI-SIJF = minimally-invasive sacroiliac joint fusion; P = prospective; R = retrospective; RCT= randomized controlled trial; SALLY = Study of Bone Growth in the Sacroiliac Joint after Minimally Invasive Surgery with Titanium Implants; SI = sacroiliac; SIFI = Sacroiliac Joint Fusion with iFuse Implant System; SIJF = sacroiliac joint fusion.

3.2 Study Characteristics

Of the 11 studies we identified, 2 publications[8,12] were articles providing outcomes at additional time points in follow-up for studies that were included in the prior report.[8,12] The study authored by Dengler et al.[12] provided outcome data at 2 years of follow-up for the iFuse Implant System Minimally Invasive Arthrodesis (iMIA) study, an RCT that compared minimally invasive SI joint fusion with the iFuse Implant System to conservative management, consisting of 1) optimization of medical therapy, 2) individualized physical therapy that focused on mobilization and stabilization exercises for control and stability, and 3) adequate information and reassurance

of the patient as part of a multifactorial treatment. The new article provided longer term data for pain, function/disability, quality of life, change in opioid use, and adverse events. The study authored by Whang et al.[8] provided outcome data at 5 years of follow-up for the Long Term Outcomes from INSITE and SIFI (LOIS) study,[9,10] a prospective longitudinal cohort of participants that received iFuse as part of the Investigation of Sacroiliac Fusion Treatment (INSITE) RCT[23-25] or as part of the uncontrolled, multicenter Sacroiliac Joint Fusion with iFuse Implant System (SIFI) trial.[26-28] The results for revision surgery and adverse events presented in LOIS would be eligible for the safety research question in an update, but the efficacy results presented in LOIS would not be eligible because the study was uncontrolled.

The remaining 9 studies we identified are new, unique studies published after the date of the search used in the previous HTA.[7,11,16-22] Only 1 of these 9 studies included a comparison group and, thus, would be eligible to be included in updates of both the efficacy and safety research questions. Claus et al. [7] compared minimally invasive SI joint fusion with cylindrical implants using the Rialto system to minimally invasive SI joint fusion with iFuse. Of the other 8 studies, 6 studies[16-20,22] were retrospective uncontrolled cohort studies, 1 study[21] was a prospective uncontrolled cohort study, and 1 study[11] was an uncontrolled trial. These studies would be eligible for the safety research questions in an update, but they would not be eligible for the efficacy research question because the studies were not controlled. Five of the 8 new uncontrolled studies evaluated the iFuse minimally invasive SI joint fusion system,[11,16,17,20,22] but 1 of these studies[16] evaluated a modification that involved a limited open approach for direct decortication and graft placement. Of the remaining 3 studies, 1 study evaluated minimally invasive SI joint fusion with cylindrical implants (Rialto),[18] 1 study evaluated open SI joint fusion,[21] and 1 study evaluated administrative claims for minimally invasive SI joint fusion from a larger insurer, and the specific device or approach was not known.[19] Further, this study only reported cost outcomes and was the only article we identified that reported cost outcomes.

The populations enrolled in the studies identified during this signal search assessment were similar to the populations enrolled in studies identified in the previous HTA. Nine of the studies enrolled participants with chronic (at least 3 to 6 months) back pain consistent with SI joint origin based on history, 3 or more provocative physical examination maneuvers, and relief of pain after diagnostic SI joint injection performed under imaging guidance. The other 2 studies were based on administrative claims[19] and a manufacturer registry of complaints[20]; thus, clinical details about the participants who received SI joint fusion procedures were not available.

3.3 Signals Identified and Concordance With Previous HTA Findings

Across the body of new evidence identified, we did not identify any signals for an update; thus, no signal codes were assigned. We briefly describe our assessment of the findings for the articles eligible for the efficacy research question (k = 2), articles eligible for the safety question (k = 2 controlled studies, and 8 uncontrolled studies), and articles eligible for the cost question (k = 1) We also comment on the evidence presented for efficacy in the uncontrolled studies identified, though these studies would not be eligible for a future update but may provide additional context for decision making.

3.3.1 Efficacy of SI Joint Fusion (2 Controlled Studies)

Dengler et al.[12] reported outcome data at 2 years for the iMIA trial; we included the previously reported 6-month follow-up data in the prior HTA. Twenty-one participants in the conservative management arm had crossed over to receive surgery after the 6-month follow-up point, and the last observation carried forward method was used to impute pre-crossover data for all efficacy outcomes for these participants. The larger improvements in pain, function, and quality of life that were observed at 6 months persisted at 2 years. New data related to opioid use were reported in this article; a lower proportion of persons allocated to surgery were still using opioids at 2 years relative to the conservative management group.[13-15]

Claus et al.[7] reported on a head-to-head comparison of 2 minimally invasive SI joint fusion systems (Rialto vs. iFuse) in a controlled cohort study; no head-to-head comparisons were included in the prior HTA. For both study arms, there was a significant improvement in all efficacy outcomes (pain, function/disability, quality of life) at 6 months when compared to their preoperative values. The authors reported no significant difference between study arms at the 6-month follow-up or 1-year follow-up in efficacy outcomes.

Uncontrolled studies were not eligible for inclusion in the prior HTA. Seven of the 9 uncontrolled studies we identified as part of this signal search assessment reported pre/post efficacy outcomes; all reported pain outcomes and all but 1 reported function/disability measures. In these studies, pain and function/disability improved post-operatively compared to baseline. Further, the magnitudes of improvements reported by authors are consistent with the magnitudes of improvements seen in controlled studies of minimally invasive SI joint fusion.

3.3.2 Safety of SI Joint Fusion (2 Controlled Studies and 8 Uncontrolled Studies)

Dengler et al.[12] reported outcomes at 2 years for the iMIA trial, which we included in the prior HTA for outcomes reported up to 6 months. At follow-up after 6 months, 3 additional adverse events probably or definitely related to the study device or procedure occurred in the conservative management group compared to 0 in the SI joint fusion group. The authors reported 27 additional adverse events in the conservative management group and 34 in the SI joint fusion group that were not related to the study device or procedure. At 2 years, 2 cases of revision surgery were reported: 1 was in a patient who crossed over from conservative management, and the other was in a participant originally allocated to iFuse.

Claus et al.[7] reported safety outcomes for the comparison of the Rialto and iFuse minimally invasive SI joint fusion procedures; this comparison was not reported in the previous HTA. No significant differences between study arms were observed. The incidence of revision surgery in the iFuse study arm was similar to the incidence reported in studies that evaluated iFuse included in the prior HTA.

Five of the 8 new uncontrolled studies evaluated minimally invasive SI joint fusion procedures (iFuse, iFuse 3D, or Rialto), and the incidence of revision surgery was reported by 4 of them. The incidence was 0% in 2 of them and was rare in the other 2 studies, similar to what was reported in the prior HTA. Similarly, the rates of adverse events in these studies were consistent with what was reported in the prior HTA.

One of the 8 uncontrolled studies, Murakami et al.,[21] was a prospective, uncontrolled cohort study that evaluated 2 approaches (anterior or pararectal) to open SI joint fusion. In the prior HTA, a limited number of studies evaluated open fusion; no intraoperative complications were reported, and post-operative complications ranged from 2.3% to 35% across the studies that were included. In the Murakami et al. study, the reporting of events did not allow a direct comparison of incidence of adverse events with previous studies because data were reported for individual events. In this study, 1 of 27 participants experienced a hematoma, 7 of 27 participants had lateral femoral cutaneous neuralgia, 14 of 27 participants had pain develop on the unaffected side that required SI joint injections, and 2 of these persons also required pelvic ring fusion. Symptoms worsened in 3 of 27 patients after surgery. These findings are consistent with the incidences reported in the prior HTA from the controlled studies and among the 8 uncontrolled studies that reported on open procedures.

One of the 8 uncontrolled studies was an analysis of data from a registry of participants who had received iFuse maintained by the manufacturer.[20] This analysis included 14,210 participants, of whom 3,140 had received the 3D-printed version of iFuse, which became available in 2017 and was reported to have been used in 80% of such surgeries since 2018. The rest received the original, machined version of the device. The findings reported in this article are consistent with previously reported post-marketing surveillance results of iFuse. Among the 14,210 cases, 435 revisions occurred (409 in iFuse cases and 26 in iFuse-3D cases) for an overall incidence of 3.06%; the incidence for the machined-version of iFuse was 3.7% compared to 0.83% for the 3D-printed version. The 2-year revision rate for 2012–2014 reported in the prior post-marketing surveillance study (2.2%) was the same as that observed in the current study (2.3%). Notably, no instances of device breakage or migration occurred with the 3D implant, and no new types of complaints related to the device were identified.

Lastly, 1 of the 8 uncontrolled studies reported on a modified minimally invasive placement of the iFuse Implant System that involved a limited direct approach using computer navigation and direct decortication and graft placement. This study reported no revision surgeries after 22 months of follow-up, and the number of adverse events reported was consistent with the previous HTA.

3.3.3 Cost of SI Joint Fusion (1 Uncontrolled Study)

One uncontrolled study using claims from a larger insurer compared costs associated with low back pain for the period of time before SI joint fusion to costs associated with low back pain for the period after surgery.[19] No comparable cost results were reported in the prior HTA. From this study, median costs were statistically significantly lower between the pre- and post-surgery periods; mean costs were lower but not statistically significantly different.

4. Discussion and Conclusions

We identified 11 new articles evaluating SI joint fusion, of which 9 represented new, unique studies. The preponderance of new evidence reports on minimally invasive procedures, with the most evidence for the iFuse system. We did not identify any signals indicating a need to update

the prior HTA report, such as evidence of opposing findings, substantial harms, superior new treatments, or other major changes in the evidence.

Additional long-term data from 1 RCT continue to indicate there is a benefit in terms of pain, function/disability, and quality of life for iFuse compared to conservative management. A new head-to-head controlled cohort study comparing iFuse with the Rialto minimally invasive surgery reported no significant differences in efficacy or safety outcomes. Data from controlled and uncontrolled studies suggest that the need for revision surgery is infrequent; adverse events vary across studies and are difficult to interpret because of differences in ascertainment methods and study reporting. The evidence continues to suggest that open fusion approaches for SI joint dysfunction are likely to be associated with high rates of revision surgery and adverse events. However, open approaches may be appropriate for clinical indications other than chronic SI joint pain and dysfunction (e.g., infection, tumor, trauma). Cost data were only reported in 1 newly identified study and were not directly comparable to previously reported findings because of differences in methods used.

4.1 Limitations

This signal search assessment has several limitations. First, we searched only 1 electronic database (PubMed); therefore, we may have missed relevant studies published in journals not indexed in PubMed. Second, we conducted a limited data abstraction and assessment of the evidence; we did not conduct risk-of-bias assessments of studies that we identified, and we did not perform certainty of evidence assessments.

4.2 Conclusion

Newly identified evidence from 11 studies is consistent with findings from the previous HTA. We did not identify any signals suggesting major changes in the evidence or changes that would invalidate the prior HTA findings.

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Appendix A. Search Strategy

PubMed searched from 1/1/208 to 9/1/2020

#1 ((Sacroiliac Joint/surgery[MeSH Terms] OR Sacroiliac Joint/therapy[MeSH Terms] OR (sacroiliac joint[Title/Abstract] AND fusion[Title/Abstract]) OR (sacroiliac joint[Title/Abstract] AND arthrodesis[Title/Abstract]) OR iFuse[Title/Abstract] OR SImmetry[Title/Abstract] OR SI-LOK[Title/Abstract] OR Siconus[Title/Abstract] OR Prolix[Title/Abstract] OR Silex[Title/Abstract] OR TriCor[Title/Abstract] OR M.U.S.T.[Title/Abstract] OR SIFix[Title/Abstract] OR SI-Fix[Title/Abstract] OR INTER FIX[Title/Abstract] OR Rialto[Title/Abstract] OR PathLoc [Title/Abstract] OR SIJFuse[Title/Abstract] OR Entasis[Title/Abstract] OR SiCure[Title/Abstract] OR Re-Live[Title/Abstract] OR SacroFuse[Title/Abstract] OR SImpact[Title/Abstract] OR Tri-Fin[Title/Abstract] OR SambaScrew[Title/Abstract] OR TransFasten[Title/Abstract] OR SiJoin[Title/Abstract] OR PSIF[Title/Abstract] OR (DIANA[Title/Abstract] AND Sacroiliac Joint[Title/Abstract]) OR SI-DESIS[Title/Abstract] OR SICAGE[Title/Abstract]) NOT (Infant[MeSH Terms] OR Child[MeSH Terms] OR Pediatric[Title/Abstract] OR Children[Title/Abstract] OR Case Reports[Publication Type] OR Editorial[Publication Type] OR Letter[Publication Type] OR Patient Education Handout[Publication Type] OR News[Publication Type])) AND Humans[mh:noexp]

#2 ((Sacroiliac Joint/surgery[MeSH Terms] OR Sacroiliac Joint/therapy[MeSH Terms] OR (sacroiliac joint[Title/Abstract] AND fusion[Title/Abstract]) OR (sacroiliac joint[Title/Abstract] AND arthrodesis[Title/Abstract]) OR iFuse[Title/Abstract] OR SImmetry[Title/Abstract] OR SI-LOK[Title/Abstract] OR Siconus[Title/Abstract] OR Prolix[Title/Abstract] OR Silex[Title/Abstract] OR TriCor[Title/Abstract] OR M.U.S.T.[Title/Abstract] OR SIFix[Title/Abstract] OR SI-Fix[Title/Abstract] OR INTER FIX[Title/Abstract] OR Rialto[Title/Abstract] OR PathLoc [Title/Abstract] OR SIJFuse[Title/Abstract] OR Entasis[Title/Abstract] OR SiCure[Title/Abstract] OR Re-Live[Title/Abstract] OR SacroFuse[Title/Abstract] OR SImpact[Title/Abstract] OR Tri-Fin[Title/Abstract] OR SambaScrew[Title/Abstract] OR TransFasten[Title/Abstract] OR SiJoin[Title/Abstract] OR PSIF[Title/Abstract] OR (DIANA[Title/Abstract] AND Sacroiliac Joint[Title/Abstract]) OR SI-DESIS[Title/Abstract] OR SICAGE[Title/Abstract]) NOT (Infant[MeSH Terms] OR Child[MeSH Terms] OR Pediatric[Title/Abstract] OR Children[Title/Abstract] OR Case Reports[Publication Type] OR Editorial[Publication Type] OR Letter[Publication Type] OR Patient Education Handout[Publication Type] OR News[Publication Type])) NOT Animals[mh:noexp]

#3 (#1 OR #2)

#4 (#1 OR #2) Filters: English

Appendix B. List of Excluded Studies

X1: Ineligible study design
X2: Ineligible population
X3: Ineligible intervention
X4: Ineligible comparator
X5: Ineligible outcomes
X6: Ineligible setting
X7: Ineligible country
X8: Systematic review used for handsearch
X9: Ineligible publication type
X10: Duplicate or superseded
X11: Study protocol or study in progress
X12: Abstract only
X13: Non-English full-text
X14. Data missing or uninterpretable

- Bayerl SH, Finger T, Heiden P, et al. Radiofrequency denervation for treatment of sacroiliac joint pain-comparison of two different ablation techniques. *Neurosurg Rev.* 2020;43(1):101-107. PMID: 30066034. doi: 10.1007/s10143-018-1016-3. Exclude: X3
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- Vanaclocha V, Herrera JM, Sáiz-Sapena N, Rivera-Paz M, Verdú-López F. Minimally invasive sacroiliac joint fusion, radiofrequency denervation, and conservative management for sacroiliac joint pain: 6-year comparative case series. *Neurosurgery.* 2018;82(1):48-55. PMID: 28431026. doi: 10.1093/neuros/nyx185. Exclude: X10
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Appendix C. Detailed Study Tables

Table C-1. Study and population characteristics for studies evaluating SI joint fusion

Study Identifiers	Study Design	Country	Study Sponsor	Population Enrolled
Claus et al., 2020[7] Minimally Invasive Sacroiliac Joint Fusion Using Triangular Titanium versus Cylindrical Threaded Implants: A Comparison of Patient-Reported Outcomes	Controlled cohort study (two or more groups)	U.S.	Not specified	156 consecutive patients who had SI joint dysfunction and who were considered surgical candidates after failing at least 3 months of conservative treatment; all with confirmed SI joint dysfunction based on physical exam, provocative tests, imaging studies ruling out other pathology, and 2 consecutive SI joint injections under fluoroscopic guidance with at least 60% improvement in pain scores.
Whang et al., 2019[8]; Darr et al., 2018[9]; Darr et al., 2018[10] NCT02270203 LOIS – Long Term Outcomes from INSITE and SIFI Long-Term Prospective Clinical And Radiographic Outcomes After Minimally Invasive Lateral Transiliac Sacroiliac Joint Fusion Using Triangular Titanium Implants	Prospective, single-group cohort (or registry)	U.S.	Industry/manufacturer	Subjects included in the current study were enrolled at 12 centers that participated in either INSITE (RCT of minimally invasive SIJ with iFuse vs. conservative management) or SIFI (single-arm trial evaluating same procedure). Patients enrolling in INSITE and SIFI were diagnosed with SIJ dysfunction due to degenerative sacroiliitis or SI joint disruption based on medical history, a positive Fortin Finger test, at least 3 positive physical examination signs suggestive of SIJ dysfunction, and a positive diagnostic SIJ block performed under fluoroscopic or CT guidance.
Patel et al., 2019[11] NCT03122899 Study of Bone Growth in the Sacroiliac Joint after Minimally Invasive Surgery with Titanium Implants (SALLY) Minimally invasive lateral transiliac sacroiliac joint fusion using 3D-printed triangular titanium implants	Uncontrolled (single-arm) trial	U.S.	Industry/manufacturer	Aged 21–70 years, SIJ pain for at least 6 months inadequately responsive to conservative care, an Oswestry Disability Index (ODI) score of at least 30%, an average visual analogue scale (VAS) pain score of at least 50 points; diagnosis based on standardized algorithm consisting of history, 3 or more provocative physical exam maneuvers, and diagnostic pain injection under imaging guidance with at least a 50% or more decrease in pain at 30 to 60 minutes.
Dengler et al., 2019[12]; Dengler et al., 2017[13]; Dengler et al., 2016[14]; Sturesson et al., 2016[15] NCT01741025 iMIA Randomized Trial of Sacroiliac Joint Arthrodesis Compared with Conservative Management for Chronic Low Back Pain Attributed to the Sacroiliac Joint	RCT	Belgium, Germany, Italy, Sweden	Industry/manufacturer	Adults aged 21–70 years old diagnosed with SI joint pain for >6 months (or >18 months if related to pregnancy), an ODI at baseline of ≥30%, and a low back pain VAS score at baseline of at least 50 points; diagnosis based on history, at least 3 positive provocative physical exam maneuvers, and at least 50% pain reduction in response to image-guided diagnostic joint injection.
Cleveland et al., 2019[16] Mini-open Sacroiliac Joint Fusion with Direct Bone Grafting and Minimally	Retrospective, single-group	U.S.	Not specified	Patients who were 18 years or older at time of surgery, underwent primary SI fusion, and had at least 1 postop follow-up visit at 6 weeks; diagnostic criteria for eligibility for surgery not described.

Study Identifiers	Study Design	Country	Study Sponsor	Population Enrolled
Invasive Fixation Using Intraoperative Navigation	cohort (or registry)			
Rainov et al., 2019[17] Triangular Titanium Implants for Sacroiliac Joint Fusion	Retrospective, single-group cohort (or registry)	Germany	Not specified	Patients with chronic low back pain and leg pain. All patients had a prior conservative treatment for their pain, and SIJ or lumbar facet joint injections with local anesthetic or steroids drugs that failed to produce long-term pain relief. Diagnosis based on history, at least 3 positive provocative physical exam maneuvers, and 1 or more confirmatory diagnostic SIJ injections under imaging guidance with at least 50% or more pain relief.
Rajpal et al., 2018[18] Minimally Invasive Sacroiliac Joint Fusion with Cylindrical Threaded Implants Using Intraoperative Stereotactic Navigation	Retrospective, single-group cohort (or registry)	U.S.	Not specified	Patients with SIJ disruption or sacroiliitis who underwent at least 6 months of conservative treatment; diagnosis based on physical examination, provocative SIJ pain tests, imaging studies, and diagnostic SIJ injections under guidance, but further details not specified.
Buysman et al., 2018[19] Sacroiliac Joint Fusion Health Care Cost Comparison Prior to and Following Surgery: An Administrative Claims Analysis	Retrospective, single-group cohort (or registry)	U.S.	Industry/Manufacturer	Adult commercial health plan members 18–64 years old with a medical claim with a CPT code for SIJ fusion (CPT codes 27279, 27280, 0334T) between January 1, 2011, and February 29, 2016; patients were included if they had continuous enrollment in the health plan with medical and pharmacy benefits for 12 months before the index date and for 12 months beginning on the index date.
Cher et al., 2018[20] Postmarket Surveillance of 3D-Printed Implants for Sacroiliac Joint Fusion	Retrospective, single-group cohort (or registry)	U.S.	Industry/Manufacturer	Complaints reported to manufacturer about iFuse device from persons who received them as part of SIJ fusion procedure. Additional details not provided.
Mao et al., 2018[22] A Consideration for the Utility of the Post-operative Oswestry Disability Index for Measuring Outcomes after Sacroiliac Joint Fusion	Retrospective, single-group cohort (or registry)	U.S.	Not specified	Patients with localized SIJ pain and a strong clinical diagnosis of sacroiliitis. Patients included in the study had failed at least 6–8 weeks of conservative management and at least 12 months of follow-up data; diagnosis based on 5 provocative maneuvers (number required to be positive not reported) and at least 50% pain relieve after image-guided diagnostic SIJ injections.
Murakami et al., 2018[21] Sacroiliac Joint Arthrodesis for Chronic Sacroiliac Joint Pain: An Anterior Approach and Clinical Outcomes with a Minimum 5-Year Follow-up	Prospective, single-group cohort (or registry)	Japan	Not specified	Patients with low-back pain or leg symptoms; inadequate responsiveness to conservative treatments including stabilization by pelvic belt, manipulation, or SIJ injections for more than 6 months; and marked restrictions in daily living; diagnosis pain over the SIJ, at least 3 positive provocative physical exam manuevers, and reproduction of pain when an injection needle inserted into the SIJ and improvement of at least 70% after local anesthetic block placed under imaging guidance.

Abbreviations: CPT = current procedural terminology; CT = computerized tomography; INSITE = Investigation of Sacroiliac Fusion Treatment; ODI = Oswestry Disability Index; RCT= randomized controlled trial; SI = sacroiliac; SIFI = Sacroiliac Joint Fusion with iFuse Implant System; SIJ = sacroiliac joint; U.S. = United States; VAS = visual analogue scale.

Table C-2. Intervention and outcomes reported for studies evaluating SI joint fusion

Study Identifier	Intervention (Sample Size) Comparator (Sample Size)	Efficacy Outcomes Reported Consistency with Prior HTA	Safety Outcomes Reported	Cost Outcomes Reported
Claus et al., 2020[7]	*Intervention:* Minimally invasive SI joint fusion with cylindrical threaded implants (Rialto) (74) *Comparator:* Minimally invasive SI joint fusion with triangular dowel implants (iFuse) (82)	*Pain:* VAS 6 months, 1 year *Function/Disability:* ODI 6 months, 1 year *QOL:* Short Form (SF)-12 PCS 6 months, 1 year *Opioid Use:* No opioid measures reported *Consistency with prior HTA:* No head-to-head MIS studies included in prior report. No significant difference between the cohorts at 6-month follow-up or 1-year follow-up for either VAS-back or VAS-leg (e.g., ODI, or SF-12). For both cohorts, there was a significant improvement in all efficacy outcomes at 6 months when compared to their preoperative values.	*Revision surgery:* Revision Surgery *Adverse Events (AEs):* No AE reported *Deaths:* Death outcomes not reported *Follow-up time for harms:* Up to 3.5 years *Consistency with prior HTA:* No head-to-head MIS studies included in prior report. iFuse revision rate similar to findings from 2019 report. No prior findings for Rialto revision rate. In this study, slightly higher but NS difference in revision rate for Rialto compared to iFuse (*P*=.11).	No cost outcomes reported *Consistency with prior HTA:* NA
Whang et al., 2019[8] Darr et al., 2018[9] Darr et al., 2018[10] Whang et al., 2019[8] NCT02270203 LOIS – Long Term Outcomes from INSITE and SIFI	*Intervention:* SIJ fusion with iFuse; this study reports additional follow-up data at 5 years for an analysis that was included in the prior review (103 enrolled from 127 participants in the original INSITE/SIFI trials) and 93 with 5-year data available) *Comparator:* None	*Pain:* VAS 5 years *Function/Disability:* ODI 5 years *QOL:* EQ-5D 5 years *Opioid Use:* Change in opioid use 5 years *Consistency with prior HTA:* Efficacy results not reported in prior report (uncontrolled studies were not eligible), but pre/post efficacy improvements are sustained (VAS, ODI, EQ-	*Revision surgery:* Revision surgery *Adverse Events:* Total AEs Serious AEs *Deaths:* Deaths *Follow-up time for harms:* 5 years *Consistency with prior HTA:* Revision surgery and AE outcomes similar to what was previously reported. This study reported on 2 subjects who died from conditions unrelated to the SIJ, which were not reported previously.	No cost outcomes reported *Consistency with prior HTA:* NA

Study Identifier	Intervention (Sample Size) Comparator (Sample Size)	Efficacy Outcomes Reported Consistency with Prior HTA	Safety Outcomes Reported	Cost Outcomes Reported
		5D) at 5 years, and opioid use continued to decline over the 5 years.		
Patel et al., 2019[11] NCT03122899 Study of Bone Growth in the Sacroiliac Joint after Minimally Invasive Surgery with Titanium Implants (SALLY)	*Intervention:* Minimally SIJ fusion surgeries were performed with iFuse-3D with optional use of FDA-cleared allograft (including demineralized bone matrix) or autograft (28 [interim enrollment, study is targeting 50 total]) *Comparator:* None	*Pain:* VAS Pain maps and interference with ADLs 3 months, 6 months *Function/Disability:* ODI Fully ambulatory 3 months, 6 months *QOL:* EQ-5D 3 months, 6 months *Opioid Use:* Change in opioid use 3 months, 6 months *Consistency with prior HTA:* Findings are consistent with findings in previous report at 6 months (for controlled studies: efficacy not reported for uncontrolled studies) for pain, function/disabilities, and QOL. For opioid use, changes were NS in previous report at 6 months, but in this study there was a significant decrease in use (but no comparator arm).	*Revision surgery:* No outcomes related to revision surgery reported *Adverse Events:* Total AEs Serious AEs *Deaths:* Death outcomes not reported *Follow-up time for harms:* 3 months, 6 months *Consistency with prior HTA:* Consistent with safety results in previous report for uncontrolled studies, which ranged from 0% to 30% for the frequency of AEs that were definitely or probably related to the device or procedure for iFuse; this study had 4 AEs/28 subjects that were probably or definitely related to the study procedure.	No cost outcomes reported *Consistency with prior HTA:* NA
Dengler et al., 2019[12] Dengler et al., 2017[13] Dengler et al., 2016[14] Sturesson et al., 2016[15] NCT01741025 iMIA	*Intervention:* Minimally invasive SIJ fusion using triangular titanium implants (iFuse). (54 randomized [47 with 2 yr follow-up data available]) *Comparator:* Conservative management consisted of (1) optimization of medical therapy, (2) individualized PT that focused on mobilization and	*Pain:* VAS 6 months, 2 years *Function/Disability:* ODI 6 months, 2 years *QOL:* EQ-5D 6 months, 2 years *Opioid Use:* Change in opioid use 2 years	*Revision surgery:* Revision surgery *Adverse Events:* Total AEs Serious AEs *Deaths:* Death outcomes not reported *Follow-up time for harms:* 6 months, 2 years *Consistency with prior HTA:* Safety outcomes only reported at less than or equal to 6 months or greater	No cost outcomes reported *Consistency with prior HTA:* NA

Study Identifier	Intervention (Sample Size) Comparator (Sample Size)	Efficacy Outcomes Reported Consistency with Prior HTA	Safety Outcomes Reported	Cost Outcomes Reported
	stabilization exercises for control and stability, and (3) adequate information and reassurance of the patient as part of a multifactorial treatment. (51 randomized [46 with 2-year follow-up data])	*Consistency with prior HTA:* 21 studies in the comparator arm crossed over to receive surgery after the 6-month follow-up point, and the last observation carried forward method was imputed for the patients who crossed over. Larger improvements in pain, function, and QOL that were observed at 6 months persisted at 2 years. And a lower proportion of persons allocated to surgery were still using opioids at 2 years relative to the comparator group.	than 6 months (unclear at which point they occurred between 6 months and 2 years). For >6 months, 3 additional AEs in conservative management group occurred and 0 in SIJ fusion group that were probably or definitely related to study device or procedure; 27 additional AE in conservative management group and 34 in SIJ fusion group not related to study device or procedure. Two cases of revision surgery reported; 1 was in a patient who crossed over.	
Rainov et al., 2019[17]	*Intervention:* Unilateral or bilateral SIJ fusion using 2 to 3 triangular titanium implants (iFuse) (160) *Comparator:* None	*Pain:* VAS 3, 6, 9, 12 months *Function/Disability:* ODI 3, 6, 9, 12 months *QOL:* No QOL measures reported *Opioid Use:* No opioid measures reported *Consistency with prior HTA:* Improvements in baseline to follow-up VAS and ODI consistent with improvement reported in within-group differences in intervention arms of controlled studies in prior report.	*Revision surgery:* Revision surgery *Adverse Events:* Total AEs *Deaths:* Death outcomes not reported *Follow-up time for harms:* Up to 12 months *Consistency with prior HTA:* Findings are consistent with previous report: no revision surgeries in this study (iFuse revisions ranged from 0%–8% in previous report), AEs also consistent with previous findings for uncontrolled studies.	No cost outcomes reported *Consistency with prior HTA:* NA
Rajpal et al., 2018[18]	*Intervention:* Minimally invasive SIJ fusion using intraoperative stereotactic navigation and the Rialto SI Fusion System (24) *Comparator:* None	*Pain:* VAS Mean follow-up time was 19 months (range, 12–34 months) *Function/Disability:* No function measures reported *QOL:* No QOL measures reported *Opioid Use:*	*Revision surgery:* Revision surgery *Adverse Events:* Total AEs *Deaths:* Death outcomes not reported *Follow-up time for harms:* Mean follow-up time was 19 months (range, 12–34 months)	No cost outcomes reported *Consistency with prior HTA:* NA

Study Identifier	Intervention (Sample Size) Comparator (Sample Size)	Efficacy Outcomes Reported Consistency with Prior HTA	Safety Outcomes Reported	Cost Outcomes Reported
		No opioid measures reported *Consistency with prior HTA:* Efficacy for uncontrolled studies not in previous report, but improvement in VAS is consistent with pre/post findings from other studies.	*Consistency with prior HTA:* Revision surgeries (none) and occurrence of AEs consistent with findings from prior review.	
Buysman et al., 2018[19]	*Intervention:* Retrospective observational study was conducted using administrative claims data from a large U.S. health insurer affiliated with Optum, Inc. between January 1, 2010 and February 28, 2017 (302) *Comparator:* None	*Pain:* No pain measures reported *Function/Disability:* No function measures reported *QOL:* No QOL measures reported *Opioid Use:* No opioid measures reported *Consistency with prior HTA:* NA	*Revision surgery:* No outcomes related to revision surgery reported *Adverse Events:* No AEs reported *Deaths:* Death outcomes not reported *Follow-up time for harms:* NA *Consistency with prior HTA:* NA	Low back pain-related costs *Consistency with prior HTA:* No comparable cost results in prior report. From this study, median costs were statistically significantly lower between the pre- and post-surgery periods among patients whose index SIJF was performed in inpatient and outpatient hospital settings, but mean costs were lower but not statistically significantly different. Median health care costs in the pre-surgery and post-surgery periods were lower than the corresponding means due to the highly skewed nature of the cost data.

Study Identifier	Intervention (Sample Size) Comparator (Sample Size)	Efficacy Outcomes Reported Consistency with Prior HTA	Safety Outcomes Reported	Cost Outcomes Reported
Cher et al., 2018[20]	*Intervention:* Analysis of complaint data reported to manufacturer for the regular and 3-D printed version of iFuse implant, the latter of which became commercially available in 2017. Compared to the prior version of the implant, the 3D-printed version has an optimized porous surface and fenestrations to promote bone growth onto and through the center of the implant. By Q2 of 2018, iFuse 3D implants were being used in more than 80% of all surgeries. Data captured include procedure date, surgeon name, implant catalog number/lot number, and complaint details. (14,210 total [iFuse implants, 11,070; iFuse-3D implants, 3,140]) *Comparator:* None	*Pain:* No pain measures reported *Function/Disability:* No function measures reported *QOL:* No QOL measures reported *Opioid Use:* No opioid measures reported *Consistency with prior HTA:* NA	*Revision surgery:* Revision surgery *Adverse Events:* Total AEs *Deaths:* Death outcomes not reported *Follow-up time for harms:* Time period covered 2015–2018, unclear duration of follow-up for any1 individual *Consistency with prior HTA:* In concordance with previous postmarketing surveillance results, in this report, there were 435 revisions (409 in iFuse cases and 26 in iFuse-3D cases) of 14,210 procedures = 3.06%. For iFuse, 409/11,070 = 3.69%; for iFuse-3D, 26/3,140 = 0.83%. The 2-year revision rate for 2012–2014 reported in the prior post-marketing surveillance study (2.2%) was the same as that observed in the current study (2.3%), both lower than what was observed after initial product launch in 2009. Notably, no instances of device breakage or migration occurred with the 3D implant, and no new types of related complaints were identified. Pain complaints after surgery were low with the 3D implants (3/3,140).	No cost outcomes reported *Consistency with prior HTA:* NA
Murakami et al., 2018[21]	*Intervention:* Anterior or pararectal approach to open SIJ fusion (27) *Comparator:*	*Pain:* VAS pain relief scale 5 years *Function/Disability:* Roland-Morris Scale	*Revision surgery:* Revision surgery *Adverse Events:* Total AEs *Deaths:* Death outcomes not reported	No cost outcomes reported *Consistency with prior HTA:* NA

Study Identifier	Intervention (Sample Size) Comparator (Sample Size)	Efficacy Outcomes Reported Consistency with Prior HTA	Safety Outcomes Reported	Cost Outcomes Reported
	None	5 years *QOL:* No QOL measures reported *Opioid Use:* No opioid measures reported *Consistency with prior HTA:* Change from pre op to post op in VAS and Roland-Morris disability scale in concordance with within-group differences from intervention arms of controlled studies in previous report.	*Follow-up time for harms:* 5 years *Consistency with prior HTA:* Limited number of studies reporting on open procedure in prior review, and no intraoperative complications reported and post-operative complications ranged from 2.3%–35% across the studies. In this study, reporting of events does not allow a direct comparison of incidence: 1/27 had hematoma, 7/27 had lateral femoral cutaneous neuralgia, 14/27 had pain develop on the unaffected side that required SIJ injections, but 2 also required pelvic ring fusion. Symptoms worsened in 3/27 patients after surgery.	
Mao et al., 2018[22]	*Intervention:* Minimally invasive SIJ fusion (iFuse) (24) *Comparator:* None	*Pain:* NRS for pain 12 months *Function/Disability:* ODI 12 months *QOL:* No QOL measures reported *Opioid Use:* No opioid measures reported *Consistency with prior HTA:* Difficult to determine because results are presented as post op differences between patients with prior lumbar fusion and patients without prior lumbar fusion; but overall pre/post differences appear consistent with findings from intervention arms of controlled studies in prior report.	*Revision surgery:* Revision surgery *Adverse Events:* Total AEs *Deaths:* Death outcomes not reported *Follow-up time for harms:* 12 months *Consistency with prior HTA:* Safety results are in concordance with findings from the prior review; events occurred with more frequency among the persons with a prior history of lumbar fusion.	No cost outcomes reported *Consistency with prior HTA:* NA

Study Identifier	Intervention (Sample Size) Comparator (Sample Size)	Efficacy Outcomes Reported Consistency with Prior HTA	Safety Outcomes Reported	Cost Outcomes Reported
Cleveland et al., 2019[16]	*Intervention:* Modified technique for minimally invasive SIJ fusion using triangular titanium implants and limited open computer-navigated approach for direct decortication and placement of bone graft (50) *Comparator:* None	*Pain:* VAS 12 months, 13–22 months *Function/Disability:* ODI Denver Sacroiliac Joint Questionnaire (DSIJQ) 12 months, 13–22 months *QOL:* No QOL measures reported *Opioid Use:* No opioid measures reported *Consistency with prior HTA:* Efficacy for uncontrolled trials not reported in 2019 HTA report. This study showed statistically significant improvement at all postoperative time periods in VAS and ODI with a similar trend in the DSIJQ. Changes from baseline to follow-up for ODI in this study were similar in magnitude to between-group difference for SIF fusion and conservative management. DSIJQ is a measure developed by study authors and is not reported in prior report.	*Revision surgery:* Revision surgery *Adverse Events:* Total AEs *Deaths:* Death outcomes not reported *Follow-up time for harms:* 12 months, 13–22 months *Consistency with prior HTA:* AEs consistent with previous report. No revision surgeries reported. In previous report, revision surgery frequency for uncontrolled open fusion was 4.1%–64.7%.	No cost outcomes reported *Consistency with prior HTA:* NA

Abbreviations: AE = adverse event; ADL = activities of daily living; CPT = current procedural terminology; CT = computerized tomography; DSIJQ = Denver Sacroiliac Joint Questionnaire; EQ-5D = EuroQOL measure of generic health status; FDA = Food and Drug Administration; HTA = health technology assessment; INSITE = Investigation of Sacroiliac Fusion Treatment; MIS = minimally invasive surgery; NA = not applicable; NS = not statistically significant; ODI = Oswestry Disability Index; PT= physical therapy; RCT= randomized controlled trial; QOL = quality of life; SF-12 PCS = Short-Form 12 physical component score; SI = sacroiliac; SIFI = Sacroiliac Joint Fusion with iFuse Implant System; SIJ = sacroiliac joint; SIJF = sacroiliac joint fusion; U.S. = United States; VAS = visual analogue scale; VAS-back = visual analogue scale for back pain; VAS-leg = visual analogue scale for leg pain.