Institution: University of Oxford		
Unit of Assessment: 1 - Clinical Medicine		
Title of case study: Preventing unnecessary shoulder surgeries to reduce patient risk and save healthcare resources		
Period when the underpinning research was undertaken: 2012 – 2019		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
David Beard	Professor of Musculoskeletal & Surgical Science	2000 - present
Andrew Carr	Nuffield Professor of Orthopaedic Surgery	2001 - present
Andrew Judge	Senior Statistician and Departmental Lecturer in Musculoskeletal Epidemiology	2008 - 2017
Karolina Wartolowska	Clinical Research Fellow	2009 - present
Period when the claimed impact occurred: August 2013 – December 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

Without robust clinical evidence, the use of subacromial decompression in England increased by 91% from 15,112 procedures in 2007/08 to 28,802 procedures in 2016/17. The results of the University of Oxford's multicentre, pragmatic, parallel group, placebo-controlled, three-group, randomised surgical trial (CSAW) showed no difference in outcome between the two surgical groups undergoing decompression or arthroscopy only (placebo surgery) at any time point. The CSAW trial results were published in November 2017, leading to a change in NHS England guidelines in 2018 placing subacromial decompression on a list of 'procedures of limited value' meaning surgery is perform only when specific criteria are met. Annual rates of surgery in England have since fallen progressively from 28,000 operations in 2016/17 to 5,720 operations in 2019/20. This constitutes a reduction in unnecessary surgery, patient risk, burden of surgery and recovery, with a cost saving to the NHS of approximately GBP103,000,000 per annum.

2. Underpinning research

Painful shoulders pose a substantial socioeconomic burden accounting for 2.4% of all primary care consultations in the UK and 4,500,000 visits to physicians annually in the USA. Sub-acromial pain accounts for up to 70% of all shoulder pain problems and can impair ability to work or perform household tasks. For sub-acromial pain an anatomical aetiology has been proposed, whereby mechanical contact occurs between the rotator cuff tendons and the overlying acromion and/or bone "spur" which often forms at the antero-inferior margin of the acromion narrowing the sub-acromial space. The narrowing makes physical contact more likely, particularly in certain positions of the arm (known as a "painful arc"). The condition is sometimes referred to as "impingement".

Whilst many patients with sub-acromial pain are treated with, and will respond to, non-operative treatment alone, surgical intervention has been used as both an early treatment choice or in recalcitrant cases. This involves decompressing the sub-acromial space by removing the bone spur arthroscopically, a procedure known as Arthroscopic Sub-Acromial Decompression (ASAD). Surgery has been indicated for persistent and severe sub-acromial shoulder pain combined with functional restrictions that are resistant to conservative measures. However, there has been uncertainty around the effectiveness of this procedure. Some reports suggest that surgery can be no more effective than exercise therapy whilst others report good outcome from surgery.

In 2014, a University of Oxford study into the temporal trends and geographical variation in the use of ASAD and rotator cuff repair of the shoulder highlighted a substantial increase in the use of ASAD in England over the previous decade. The study demonstrated intervention rates

increasing by 750% from 5.2 per 100,000 people in 2000/2001 to 40.2 per 100,000 in 2009/2010 without any evidence of efficacy or benefit [1]. Furthermore, the team conducted a systematic review of the use of placebo controls in the evaluation of surgery [2], which demonstrated that a placebo controlled trial is a safe, powerful, and feasible way of showing the efficacy of surgical procedures. Despite the complexity and scarcity of such trials they concluded that without well-designed, placebo-controlled trials of surgery, ineffective treatment may continue unchallenged.

The CSAW study was designed and led by Beard and Carr to investigate the effectiveness of ASAD surgery by comparing it with arthroscopy only (placebo surgery) and a non-surgical treatment with results published in 2017 [3,4]. CSAW was a multicentre, randomised, pragmatic, parallel group, placebo-controlled, three-group trial at 32 hospitals in the UK with 51 surgeons, which recruited 313 patients in total. The patients were randomly allocated to one of the three possible treatments, ASAD surgery, a placebo procedure or active monitoring, with follow up at six months and one year. The results showed no difference in outcome between the two surgical groups undergoing ASAD or placebo surgery at any time point. This suggests that the treatment effect is not due to the principal clinical justification for the surgery, which is the removal of bone, bursa and soft tissue to relieve impingement on the underlying tendons during movement of the arm. The CSAW study also shows that both types of surgery are slightly more effective than having no treatment at all (monitoring) at both six months and one year. However, the magnitude of difference was not large, and while it may be clinically important for individual patients, could still be explained (at least in part) by other factors including a surgical placebo effect, or to other unidentified effects of arthroscopic evaluation of the joint and bursa, or to rest and post-operative physiotherapy.

Findings from the CSAW trial are supported by the Finnish Subacromial Impingement Arthroscopy Controlled Trial (FIMPACT) of 210 patients published six months after CSAW also reporting no statistically significant difference in clinical outcomes between patients undergoing ASAD and arthroscopy only. With Carr and Beard as co-Chief Investigators, the University of Oxford team have since published the first cost-effectiveness analysis of ASAD compared to placebo surgery only and to no treatment. They found that decompression is significantly more costly than no treatment over 12 months, with no clear evidence that it is cost-effective [5].

3. References to the research (University of Oxford researchers highlighted in bold)

1. **Judge A**, Murphy RJ, Maxwell R, **Arden NK**, **Carr AJ** (2014). Temporal trends and geographical variation in the use of subacromial decompression and rotator cuff repair of the shoulder in England, *The Bone & Joint Journal*, 96b(1), 70-74. DOI: 10.1302/0301-620X.96B1.32556 Citations 77 (WoS to 31/12/2020)
2. **Wartolowska K**, **Judge A**, Hopewell S, Collins GS, Dean BJF, Rombach I, Brindley D, Savulescu J, **Beard DJ, Carr AJ** (2014) Use of placebo controls in the evaluation of surgery: systematic review, *BMJ* , 348, g3253. DOI: 10.1136/bmj.g3253 Citations 119 (WoS to 31/12/2020)
3. **Beard D**, Rees J, Rombach I, Cooper C, Cook J, Merritt N, Gray A, Gwilym S, **Judge A**, Savulescu J, Moser J, Donovan J, Jepson M, Wilson C, Tracey I, **Wartolowska K**, Dean B**, Carr A**; CSAW Study Group (2015). The CSAW Study (Can Shoulder Arthroscopy Work?) - a placebo-controlled surgical intervention trial assessing the clinical and cost effectiveness of arthroscopic subacromial decompression for shoulder pain: study protocol for a randomised controlled trial. *Trials* 16:210. DOI: 10.1186/s13063-015-0725-y
4. **Beard DJ**, Rees JL, Cook JA, Rombach I, Cooper C, Merritt N, Shirkey BA, Donovan JL, Gwilym S, Savulescu J, Moser J, Gray A, Jepson M, Tracey I, **Judge A**, **Wartolowska K**, **Carr AJ** (2018). Arthroscopic subacromial decompression for subacromial shoulder pain (CSAW): a multicentre, pragmatic, parallel group, placebo-controlled, three-group, randomised surgical trial, *The Lancet*, 391 (10118), 329-338. DOI 10.1016/S0140-6736(17)32457-1 Citations 110 (WoS to 31/12/2020)
5. Rombach I, Merritt N, Shirkey BA, Rees JL, Cook JA, Cooper C, **Carr AJ**, **Beard DJ**, Gray AM (2019). Cost-effectiveness analysis of a placebo-controlled randomized trial evaluating the effectiveness of arthroscopic subacromial decompression in patients with subacromial

shoulder pain, *The Bone & Joint Journal* 101-B(1):55-62.
DOI: 10.1302/0301-620X.101B1.BJJ-2018-0555.R1

Funding for the CSAW trial included a Clinical Studies Grant from Arthritis Research UK to Beard, GBP332,390 to the University of Oxford (reference 19707, 2011-2017).

4. Details of the impact

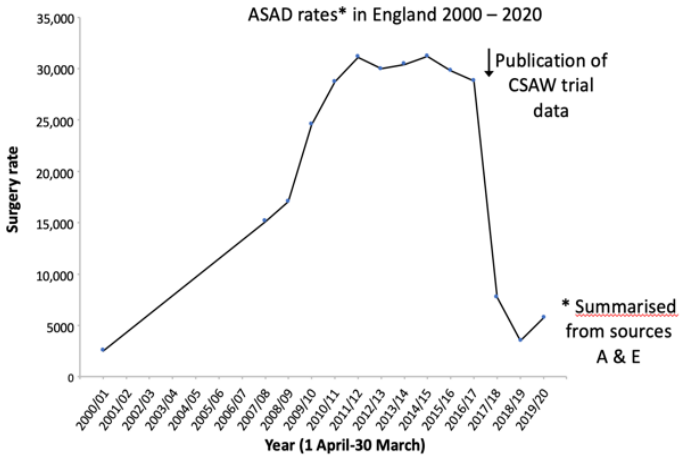
Shoulder pain is a common musculoskeletal condition associated with a high socioeconomic burden. Subacromial shoulder pain, which accounts for up to 70% of shoulder pain, has increasingly been treated with surgery over the past two decades, despite a lack of compelling evidence for clinical effectiveness or cost effectiveness. The University of Oxford team collaborated with the University of Bristol on a subsequent longitudinal study of use and cost of subacromial decompression surgery [A]; this investigated the use and cost of subacromial decompression in England over the last decade compared with other countries and explored how this related to the conduct and outcomes of randomised, placebo-controlled clinical trials e.g. [4]. They found that in England, the use of arthroscopic subacromial decompression (ASAD) increased by 91% from just over 15,000 procedures in 2007/8 to nearly 29,000 procedures in 2016/17 at a cost of approximately GBP125,000,000 per annum [A]. Despite this increase, publication of the CSAW trial results in November 2017 showed no difference in outcome between two surgical groups undergoing ASAD or placebo surgery for subacromial shoulder pain at any time point [3].

Impact on clinical guidelines

NHS England responded rapidly to the publication of the CSAW trial results. In 2018, the NHS England Evidence Based Intervention programme, which aims to reduce the number of inappropriate interventions on the NHS, placed ASAD for subacromial shoulder pain on a 'procedures of limited value' list for national Clinical Commissioning Groups, meaning ASAD would be performed only when specific criteria are met. The guidance for CCGs states *"Recent research has indicated that in patients with pure subacromial impingement (with no other associated diagnoses such as rotator cuff tears, calcific tendinopathy and acromio-clavicular joint pain), non-operative management with a combination of exercise and physiotherapy is effective in the majority of cases."* [B p.35]. The CSAW trial [3] is cited as the primary source in the rationale for this recommendation. An updated patient information leaflet was produced (C).

Reduction of surgery rates and cost saving

Most of the increase in ASAD in England over the past two decades took place before 2011/12 [A]. The subsequent plateau in rates between 2011/12 to 2016/17, illustrated in the graph, could be attributed to raised awareness of the issue of treatment uncertainty and correlates with the CSAW trial registration in 2012, publication of the trial protocol in 2015 [3], presentation of the trial by Beard and Carr with the clinical community, and media attention [D].



Following publication of the CSAW trial results in 2017 and subsequent changes to NHS guidelines in 2018, annual rates of surgery in England have fallen 80% from 28,000 in 2016/17 to 5,720 in 2019/20 [A, E]. In 2016/2017, the median cost of an elective admission for ASAD alone was GBP4,476 [4]. This places ASAD costs at an estimated GBP129,000,000 in 2016/17 compared with GBP26,000,000 in 2019/20. The fall in ASAD rates following publication of the CSAW trial therefore represents a cost saving to the NHS of GBP103,000,000 per annum. A study published in 2020 found that surgery rates also fell by 29% in Scotland between 2014 and 2018 [F], and the authors identified this decline as "*corresponding to the publication of epidemiological studies demonstrating a rise in [ASAD], and awareness of studies which questioned the benefit of*

[ASAD]", citing [1] and [4]. Meanwhile, the FIMPACT trial also found no clear evidence that ASAD is cost-effective [5].

Influencing change in practice internationally

The use of surgery has also been in decline in other countries, and this has been linked to CSAW trial data. For example, in Sweden rates of ASAD increased from approximately 80 per 100,000 in 2008/09 to approximately 150 per 100,000 in 2014/15 and subsequently decreased to 120 per 100,000 in 2018/19. According to the Professor of Orthopaedic Surgery at Lund University, Sweden: *"This decrease was without doubt influenced by the awareness raised in the orthopaedic community of the limited evidence to support for efficacy of the procedure by first the publication of your trial protocol, and then the outcomes of the trial in The Lancet."* He continues: "*The Publication of the CSAW trial, and associated papers, has initiated a review within the Swedish Governmental Institutes of 'National Board of Health and Welfare', and the 'Swedish Agency for Health Technology Assessment'…The result will be an update of the Swedish national clinical guidelines for patients with shoulder pain"* [Gi]. The Director of the Whitlam Orthopaedic Research Centre reports changes in practice in response to the CSAW trial:

> "*I have been pleased to see the practice change that has occurred in sub-acromial decompression surgery worldwide. In my own country, rates of sub-acromial decompression have significantly declined and this has been seen in many countries worldwide, including the UK"* [Gii].

Benefits to patients

Arthroscopic surgery is low risk, but some patients can experience infection, stiff shoulder, damage to blood vessels or nerves and ongoing pain [G]. Furthermore, analysis of mixed shoulder arthroscopic procedures suggests around 5 in 1,000 patients will suffer a significant or life threatening complication such as deep infection, pulmonary embolus or death. This small incidence of serious harms has been reduced as a result in the fall in surgery fates following publication of the CSAW trial. Indeed, a BMJ Rapid Response Review on Subacromial Decompression for Shoulder Pain published in 2019 in response to the CSAW and FIMPACT trials concluded, "*almost all informed patients would choose to avoid surgery because there is no benefit but there are harms and it is burdensome. Subacromial decompression surgery should not be routinely offered to patients with sub acromial shoulder pain*" [H]. The review also highlights the burden of surgery on patients including a 2–10 hour outpatient stay following surgery, approximately two weeks off work during recovery and avoidance of activities such as overhead carrying for three months.

As noted by the Director of the Whitlam Orthopaedic Research Centre: *"The impact on health that has largely stemmed from the C-SAW paper is not only felt in cost savings by avoiding unnecessary care, but it has also decreased the risks associated with unnecessary care"* [Gii]. Similarly the President of the Canadian Orthopaedic Association and Research Chair in Evidence-Based Orthopaedics noted, "*I firmly believe that the CSAW trial has decreased the risks associated with sub-acromial decompression, allowing patients to return to their usual activities with greater confidence and ease.*" [Giii]

Wider impact on perception and design of surgical trials

In addition to the direct effect on shoulder pain care, the philosophy and approach to CSAW has resulted in many wider impacts on the scientific and public perception of surgical evaluation which remain ongoing. The CSAW trial led to significant media coverage, sparking public debate on the role of placebo surgery [I]. Together with epidemiological studies [1] it has also contributed to a step change in the orthopaedic community's acceptance of evidence-based decisions for costly based interventions thereby maximising the effectiveness of hospital care budgets, for example in one account from Australia:

> "*I have found the C-SAW publication to be a recent example of one that has had a major impact not only in changing clinical practice, but in changing it for the better in that clinical practice is now much more reliant on the evidence available*"
>
> Director, Whitlam Orthopaedic Research Centre, Australia [Gii].

From being a rare and pharmacologically influenced design, the 3-way placebo surgical control trial pioneered in CSAW is now championed as a rigorous and appropriate method for fundamental

assessment of surgical efficacy and treatment mechanisms in all surgical subspecialities. In 2018, the MRC and NIHR Methodology Research Programme jointly commissioned a workshop to set guidelines for use of placebo controls in surgical trials, led by Beard, leading to the ASPIRE guidelines to assist commissioners and researchers at a global level to design and conduct high quality placebo surgical trials [J]. Several surgical placebo control trials are now underway both in the UK and abroad, including the ACCURATE trial recruiting from Finland, Sweden and Norway. The Director of the Whitlam Centre wrote that *"…the impact of the C-SAW study has been felt worldwide … in the change it has made to orthopaedic thinking by pushing it towards a greater understanding of and respect for the evidence"* [Gii]. The President of the Canadian Orthopaedic Association summarised the impact of the University of Oxford research:

> *"Without doubt, the CSAW trial has had a global impact on research and clinical practice. This trial has empowered health care professionals and clinician scientists to pursue similar trials and sparked many discussions on the topic of placebo surgery within the orthopaedic field"* [Giii].

5. Sources to corroborate the impact

A. Journal article: Jones T et al (2019). A longitudinal study of use and cost of subacromial decompression surgery: the need for effective evaluation of surgical procedures to prevent overtreatment and wasted resources. *BMJ Open* 9:e030229. DOI : 10.1136/bmjopen-2019-030229

B. NHS England Evidence-Based Interventions: Guidance for CCRGs November 2018 https://www.england.nhs.uk/wp-content/uploads/2018/11/ebi-statutory-guidance-v2.pdf (especially page 35-36)

C. NHS Evidence Based Interventions: Patient information leaflet

D. Pre-publication publicity of the CSAW trial, including: The Times, November 2017 https://www.thetimes.co.uk/article/shoulder-pain-surgery-is-no-better-than-a-placebo-2zt3v8hvm; the Guardian, June 2017 https://www.theguardian.com/science/2017/jun/11/operations-placebo-andy-carr; and Observer August 2017 https://www.theguardian.com/science/2017/aug/20/when-surgery-is-just-a-stitch-up-placebo-effect

E. Data on rates of arthroscopic sub-acromial decompression (ASAD) in England, 1 April 2017 – 30 March 2019 from NHS Improvement data and the Clinical Practice Research Database (CPRD) GOLD data

F. Journal article: Jenkins et al (2020) The changing incidence of arthroscopic subacromial decompression in Scotland *Bone and Joint Journal* 102-B(3):360-364 DOI: 10.1302/0301-620X.102B3.BJJ-2019-0752.R2

G. Testimonial letters outlining value of CSAW trial from: i) Senior Professor of Orthopaedic Surgery, Lund University Sweden; ii) Professor of Orthopaedic Surgery, University of New South Wales and Director, Whitlam Orthopaedic Research Centre; iii) President of the Canadian Orthopaedic Association and Research Chair in Evidence-Based Orthopaedics

H. Journal article: Vandvik et al (2019). Subacromial decompression surgery for adults with shoulder pain: a clinical practice guideline *BMJ* 364:l294. DOI: 10.1136/bmj.l294

I. Media coverage of the CSAW study and placebos in surgery: i) BBC Horizon Production with interview of one of the chief investigators. https://www.youtube.com/watch?v=c8T4-K2ZiWA ii) New Statesman February 2019 https://www.newstatesman.com/politics/health/2019/02/surgical-stitch-meet-placebo-surgeon iii) BBC Jeremy Vine Show in June 2019. https://www.bbc.co.uk/programmes/p07c934t iv) Der Spiegel (circulation 850,000) November 2018 https://dgou.de/news/news/detailansicht/artikel/zum-artikel-leben-ohne-schmerz-im-spiegel-magazin/ v) The Independent Nov 2017 https://www.independent.co.uk/news/health/decompression-surgery-nhs-procedure-joint-trial-placebo-common-study-pointless-a8067866.html

J. Journal article: Beard DJ, Campbell MK, Blazeby JM, et al (2020). Considerations and methods for placebo controls in surgical trials (ASPIRE guidelines). *Lancet.* 395:828-838. DOI: 10.1016/s0140-6736(19)33137-x