fortune Journals

Research Article

JOURNAL OF SPINE RESEARCH AND SURGERY

ISSN: 2687-8046

Can Anterior Discectomy and Fusion (ACDF) Surgery be Safely Performed in an Outpatient Setting? A Systematic Review on the Post-operative Complication and Readmission Rates

Salman Ghani, BEng, MSc, MBBS[1], Ahmed Ali Kayyale, MBBS[1]

Abstract

Background: Anterior Cervical Discectomy and Fusion (ACDF) is a common surgical procedure used to treat cervical spine disorders. The safety and efficacy of outpatient versus inpatient ACDF settings have been debated, with varying findings reported in the literature. This study aims to evaluate and compare post-operative complication reporting frequency, numerical rate and readmission rates and readmission rates between outpatient and inpatient ACDF surgeries.

Methods: A systematic review was performed between 1996 and 2024 using PubMed, Medline and Embase. Thirty one studies were included, 22 compared inpatient and outpatient settings directly and nine that focused solely on outpatient settings. Data were analysed on the overall rates of major and minor post-operative complications, frequency of specific complications, and readmission rates. Statistical significance was assessed using p-value of <0.05.

Results: Results showed that inpatient ACDF surgeries had a higher interquartile range of overall complication rates compared to outpatient surgeries. Specifically, inpatients reported complication rates ranging from 0% to 31.36%, while outpatients ranged from 0.001% to 34.59%. Sixteen out of twenty two studies demonstrated higher complication rates for inpatients, with statistically significant differences observed in mortality, haematoma, dysphagia, respiratory and dural complications. Conversely, dysphagia was reported at higher rates in outpatients in one statistically significant study. Readmission rates were also higher for inpatients, ranging from 0% to 44.2%, compared to 0% to 24.69% for outpatients. The findings suggest that outpatient ACDF surgeries are associated with lower overall complication rates and readmission rates compared to inpatient procedures. The variability in complication rates and readmission may be influenced by differences in patient selection, procedural complexity, and post-operative monitoring.

Conclusion: Outpatient ACDF surgery appears to be as safe and effective as inpatient surgery, with advantages including lower readmission rates and fewer major complications. Despite some discrepancies, particularly concerning dysphagia, the overall evidence supports the efficacy of outpatient ACDF. Further research with standardised definitions and methodologies is needed to confirm these findings and better understand the implications for clinical practice.

Keywords: Spine; ACDF; Surgery; Day-case; Post-operative complication rate; Readmission rates

Affiliation:

[1]Princess Alexandra Hospital NHS Foundation Trust, Harlow UK

***Corresponding author:**
Dr Salman Ghani, Princess Alexandra Hospital, Harlow, CM20 1QX, UK.

Citation: Dr Salman Ghani, Dr Ahmed Ali Kayyale. Can Anterior Discectomy and Fusion (ACDF) Surgery be Safely Performed in an Outpatient Setting? A Systematic Review on the Post-operative Complication and Readmission Rates, Journal of Spine Research and Surgery. 6 (2024): 61-73.

Received: July 23, 2024
Accepted: July 31, 2024
Published: August 12, 2024

Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

Introduction

Global & National Burden of Neck Pain

Back pain is an endemic health problem which has become a major contributor to the global burden of disease affecting both adults and adolescents worldwide. Epidemiological studies have estimated that approximately 50—80% of adults experience at least one episode of back pain during their lifetime [41]. One of the first systematic reviews on the epidemiology of cervical spine radiculopathy reported a prevalence of 1.14% (95% CI 0-45-1.82) and 1.31% (95% CI 0.66-1.96) for males and females respectively and an incidence rate ranging between 0.832 -1.79 per 1000 persons [33]. In 2016, neck pain was a top 5 cause of years lived with disability amongst middle to high income countries [50]. In addition, reports of neck pain are also found to be present in young adults. Jahre et al. 2021 performed an 11- year follow up of 1433 adolescents into young adulthood in which 18.4% reported prevalence of neck/shoulder pain at follow up [24].

The Global Health Data Exchange (GHDE) provides statistical data on various health metrics for worldwide countries [23]. GHDE data shown in table 1 were analysed from 2015 to 2019 for the global and UK population, illustrating a rising trend in the annual incidence, prevalence and years lost lived with disability due to cervical neck pain. A full summary of GHDE data is provided in tables 2 and 3 within the appendix.

Table 1: A summary of Global and UK GHDx Data for cervical neck pain

	Global prevalence, million (2015 to 2019)	Annual incidence, million (2015 to 2019)	Years lived with disability
Global	202.27 million to 222.72 million (+10.1%)	43.91 million to 47.53 million (+8.24%)	20.11 million to 22.08 million (+9.8%)
UK only	3.22 million to 3.77 million (+17%)	580,053 to 662,700 (+14.25%)	315,178 to 370,075 (+17.4%)

Anterior Cervical Discectomy and Fusion & Day Case Surgery

Anterior cervical discectomy and fusion (ACDF) is a surgical technique which can be used to treat a broad range of pathologies causing neck pain including cervical radiculopathy, cervical spondylotic myelopathy. One of the first attempts at performing lumbar discectomy on an outpatient basis was carried out by Silvers et al 1996. A cohort of 50 patients were successfully treated as day-cases with acceptable safety and post operative outcomes [44]. Over the last two decades, refinements in surgical techniques have made it more feasible to perform ACDF surgery as an outpatient procedure. The use of allograft bone instead of iliac crest grafts and cervical plating has markedly improved postoperative pain [43]. Furthermore, the advances in minimally invasive surgery have been shown to be a feasible option for ACDF due to the lowered risk of inadvertent iatrogenic injury to vital structures by minimising tissue disruption and blood loss, reducing postoperative pain and length of stay and better cosmetic results [49] [45]. Engquist et al. 2017 demonstrated the efficacy of ACDF for treatment of cervical radiculopathy in which ACDF alongside physiotherapy compared to physiotherapy alone showed significant greater reductions in neck pain (39mm vs 19mm; p=0.01), neck disability (21% v 11%; P=0.03) and arm pain (3 mm vs 19 mm; p = 0.1) at 5 to 8 year follow up [12]. A more recent study assessing the efficacy of ACDF for the treatment of cervical radiculopathy and myelopathy in 235 patients found a significant reduction in VAS neck pain, disability and physical function following ACDF surgery [46]. There has been a movement in the United States to establish ACDF as an outpatient procedure, largely driven by the American College of Surgeons National Surgical Quality Improvement database (ACS NSQIP®). The surgical community in the United Kingdom has been less eager to follow suit due to the lack of local data concerning outpatient ACDF procedures and protocols relating to the UK population.

A key aspect leading up to day-case ACDF surgery is the pre-operative care for patients. Based on the GIRFT (Getting it Right First Time) pathway for 1-2 level ACDF procedures [17], pre-operative care begins once surgical opinion is agreed following General Practitioner (GP) referral. Upon referral the GP begins the optimisation of patient comorbidities which will then be continued by the spinal team during their pre-operative assessment. As detailed in the GIFRT pathway the initial assessment following outpatient referral involves assessing the severity and impact of the cervical spinal disease on patient daily function by means of full history, physical/neurological examination and imaging. The GIRFT pathway is largely influenced by the Enhanced Recovery after Surgery (ERAS) pathway introduced in 1997 which has been used to reduce the patient's surgical stress response, optimise their physiologic function, and facilitate recovery [26]. The pathway takes a patient centred approach with a focus on pre-operative nutrition, analgesia regimens and providing pre-operative education and counselling. Linca et al. 2021 performed a systematic review for individual ERAS pathway components and found that patient education had a positive impact on behavioural outcomes in so much that it improved patient reported outcomes such as readiness for surgery, early mobilisation, self-care ability and perceived quality of life [29]. Prospective cohort studies have further demonstrated decreased postoperative opioid use and greater mobility on post-operative day 0 and day 1 in patients within the ERAS pathway compared to patients receiving traditional peri-operative care [2]. The feasibility of implementing

Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

the ERAS pathway for facilitating a day-case pathway without compromising the safety of patients and has been successfully applied to patients undergoing both single and multilevel ACDF [35]. The pathway has also been shown to significantly reduce patient length of stay without causing increases in post-operative complications or a decrease in patient satisfaction [11]. A more recent study by Leung et al. 2022 showed reduced postoperative complications, shorter length of stay cost in addition to increase post-operative satisfaction in patients within an ERAS pathway, with no significant differences in increasing 90-day readmission and reoperation [28].

Lastly, as proposed in the GIFRT ACDF pathway, a full pre-operative assessment should be carried out 6 weeks prior surgery in order to optimise medical comorbidities. A standardised pre-operative assessment protocol to optimise medical comorbidities was proposed in recent study by Wang et al. 2021 for patients undergoing elective spine surgery. Identification of key risk factors associated with various medical conditions including diabetes, cardiac, renal and psychosocial comorbidities were noted as well as optimisation of nutrition, BMI, bone density and smoking status [51]. Current literature is focussed on the optimisation of single comorbidities and there is a paucity in the literature regarding the optimisation of those patients with multiple comorbidities. Risk calculators such as the American Society of Anaesthesiologists (ASA) Physical Status Classification System (ASA grade), Charlson Comorbidity Index (CCI) and Elixhauser Comorbidity Index have therefore been used to help quantify risks in these patients but require room for improvement [48] [16].

Methods (literature search)

PICO

The PICO framework (population, intervention, comparator, outcome) was used to produce the following question: Do patients undergoing day-case (i.e., total length of stay <24h) anterior cervical discectomy and fusion surgery have the same post-operative complications and readmissions in comparison to patients who were admitted as inpatients after surgery (i.e., total length of stay >24h)?

Population: Patients undergoing elective anterior cervical discectomy and fusion surgery

Intervention: Same day discharge

Comparator: Overnight stay

Outcome: Any complication (intra or post-operative)

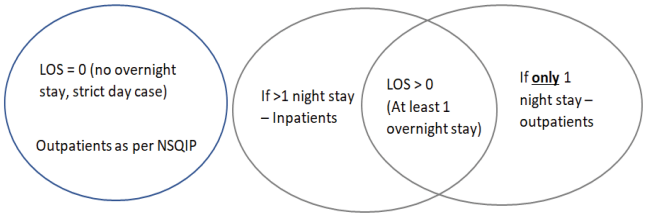
Current Definitions of Outpatient Anterior Cervical Discectomy and Fusion Surgery

Within the literature there has not been a consistent definition to describe patients undergoing 'day-case' or 'outpatient' ACDF surgery. Some of various definitions are as follows:

- Patients with an actual length of stay (LOS) less than 24 hours
- As per 'two-midnight rule' from the 'Center for Medicare and Medicaid Service', patients discharged within a 47-hour period are considered outpatients
- Patients who are not observed overnight in hospital
- Patients with the same surgical and discharge date
- Patients who were not admitted to the hospital inpatient list

These definitions makes it challenging to discern the difference between outpatient and inpatient surgeries based on patient's length of stay. This disparity may impact on the way in which healthcare professionals interpret data relating to patient safety and outcomes in ACDF surgery.

Several of the retrospective reviews captured within this literature search collected data from the NSQIP database containing figures from hundreds of hospitals in the United States. Within this database the 'inpatient' or 'outpatient' variable did not always correlate with LOS > 0 day or LOS = 0 day [1]. This may be explained by the fact that US regulations allow patients who have undergone 'outpatient' ACDF to stay in hospital overnight under 'observation' and thus be categorised as 'outpatients' in the NSQIP database [6]. In the NSQIP database, a LOS>0 group included both 'inpatients' and 'outpatients', whereby patients who stayed only one night at the hospital were classified as outpatients and those that stayed more than one night were classified as inpatients. As such in studies which used the NSQIP database, for patients with LOS >0 there was uncertainty as to whether they were classed as inpatients (>1 overnight stay) or outpatient (only stayed 1 night). On the other hand patients with a LOS = 0 were strict day cases and did not stay overnight and thus were also classified as 'outpatients'. For this systematic review, any patient who had a total length of stay less than 24 hours was considered an 'outpatient', even if they stayed overnight.



Venn diagram illustrating the classification of inpatients and outpatients in the NSQIP database based on length of stay.

Search strategy

A comprehensive literature search was conducted on PubMed and EMBASE for articles published between 1st January 1996 to 1st June 2024. A search strategy was constructed using combinations of the synonyms in the following table.

Population	Intervention	Comparison	Outcome
All adults undergoing elective anterior cervical discectomy and fusion	Same day discharge following surgery	Overnight stay following surgery	Complication
Search Terms: **Term/ indicates subject heading** **Term* indicates truncated keywords**			
	Same day discharge Or Discharge Or SDD Or Outpatient Or Short stay Or Ambulatory Or Day case **AND** Anterior cervical discectomy and fusion Or ACDF	Admission Or Prolonged stay Or Prolonged LOS Or Overnight stay Or Inpatient Or Long stay Or Extended stay **AND** Anterior cervical discectomy and fusion Or ACDF	Complications Or Intervention Or Interventions **AND** Anterior cervical discectomy and fusion Or ACDF
	Similar search terms combined with Boolean Operator "**OR**" were then combined with "**AND**"		

PUBMED & Embase/Medline search strategy:

Search done on 01.06.24

('same day discharge' OR 'sdd' OR 'discharge' OR 'outpatient' OR 'short stay' OR 'ambulatory' OR 'day case') AND ('admission' OR 'prolonged stay' OR 'prolonged LOS' OR 'overnight stay' OR 'inpatient' OR 'long stay' OR 'extended stay') AND ('adcf' OR 'anterior cervical discectomy and fusion') AND ('complication' OR 'complications' OR 'intervention' OR 'interventions')

Inclusion and Exclusion Criteria

The results found in both databases were filtered using an inclusion and exclusion criteria, listed below.

Inclusion criteria

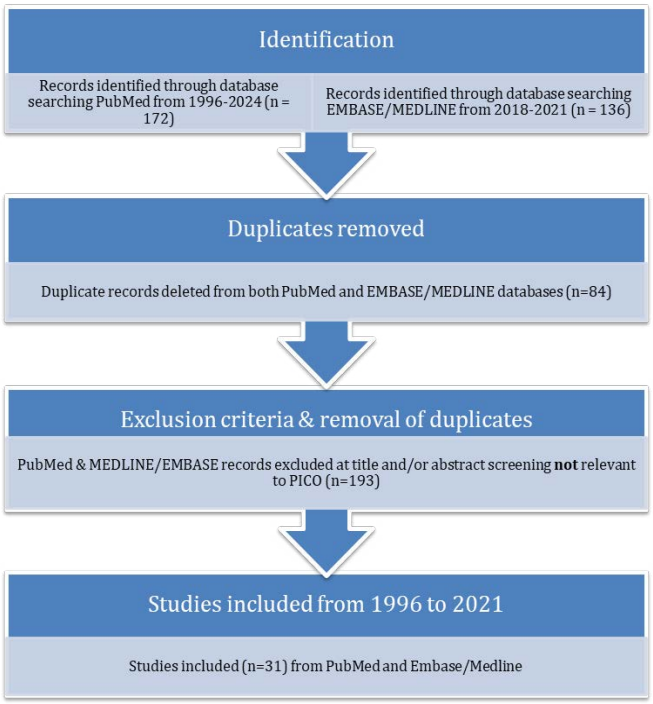
- Comparative studies that evaluate the safety of inpatient vs outpatient ACDF, along with those that only described outpatient ACDF
- Must be written in English
- Must include all PICO components and compares the intervention with the comparison
- Human studies

Exclusion criteria:

- Published after 1st January 1996 or after 1st June 2024
- Studies not detailing the length of stay in their definition of inpatients and outpatients
- Studies relating to other types of spine surgery which may include ACDF however do not differentiate between patient data between different types of spine surgery
- Studies which did not differentiate between the post-operative complication rates between inpatients and outpatients
- Studies which not explicitly state the type of major post-operative complications. These studies were however included during the review of during readmission rates.
- Written in languages other than English
- Animal studies

PRISMA Flow Diagram

A PRISMA flow diagram showing the number of records found through both databases, including those that were included and excluded.



Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

The search strategy yielded thirty one articles which were published between 1996 and 2024. For studies comparing outpatient and inpatient results, propensity-matched and/or data from post-matched cohorts was used when provided. For studies which assessed complications of patients undergoing multi-level ACDF, the comparison of complication rate was included for all levels individually when provided.

Results

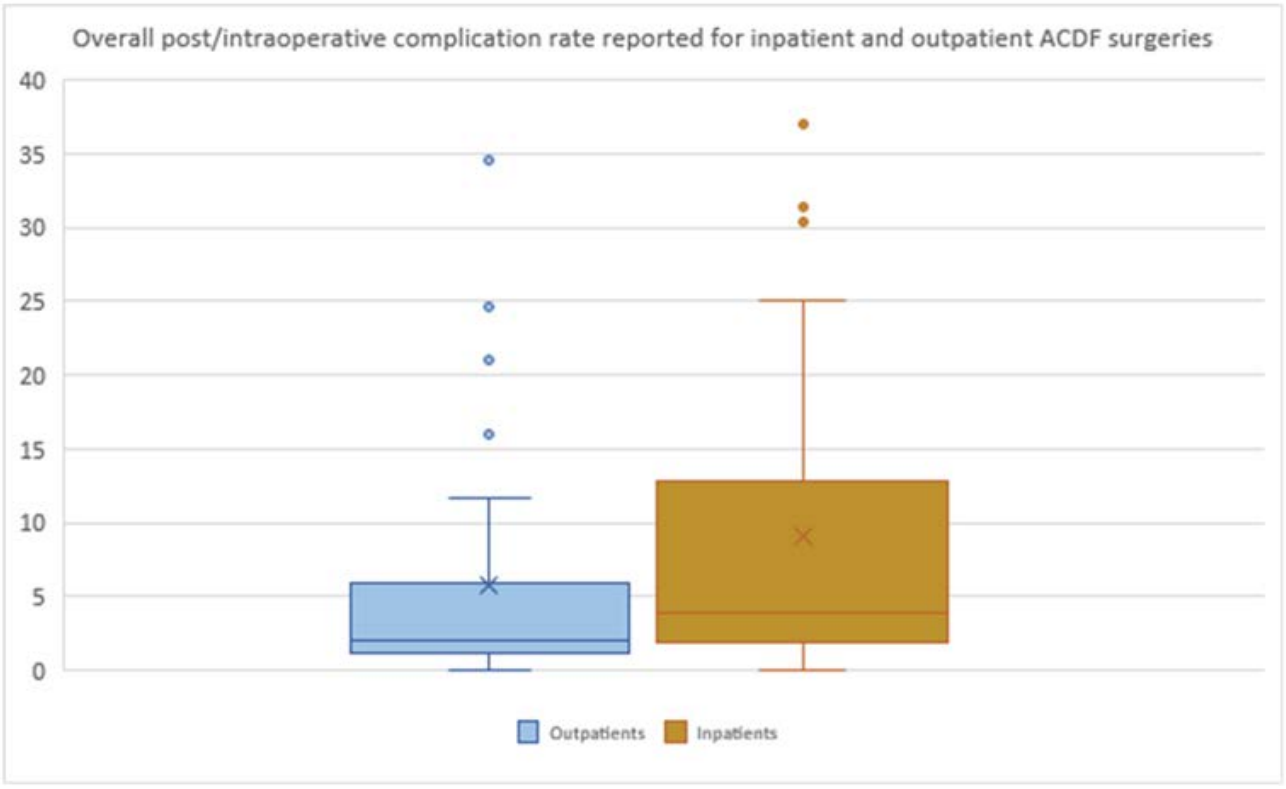


Figure 1: Range of overall major and minor post-operative complications reported in the literature for inpatients and outpatients.

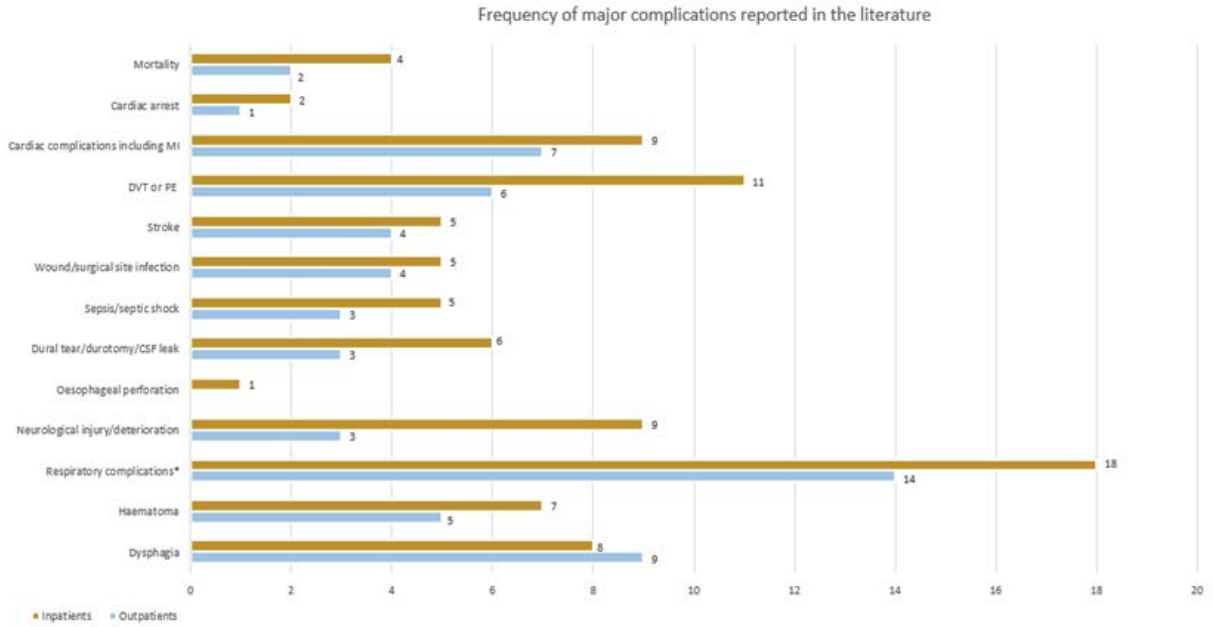


Figure 2: Number of articles which reported major post-operative complications for outpatients and inpatients in literature search. *Respiratory complications included respiration insufficiency/failure/airway compromise/unplanned intubation/neck/airway swelling.

Citation: Dr Salman Ghani, Dr Ahmed Ali Kayyale. Can Anterior Discectomy and Fusion (ACDF) Surgery be Safely Performed in an Outpatient Setting? A Systematic Review on the Post-operative Complication and Readmission Rates, Journal of Spine Research and Surgery. 6 (2024): 61-73.

Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

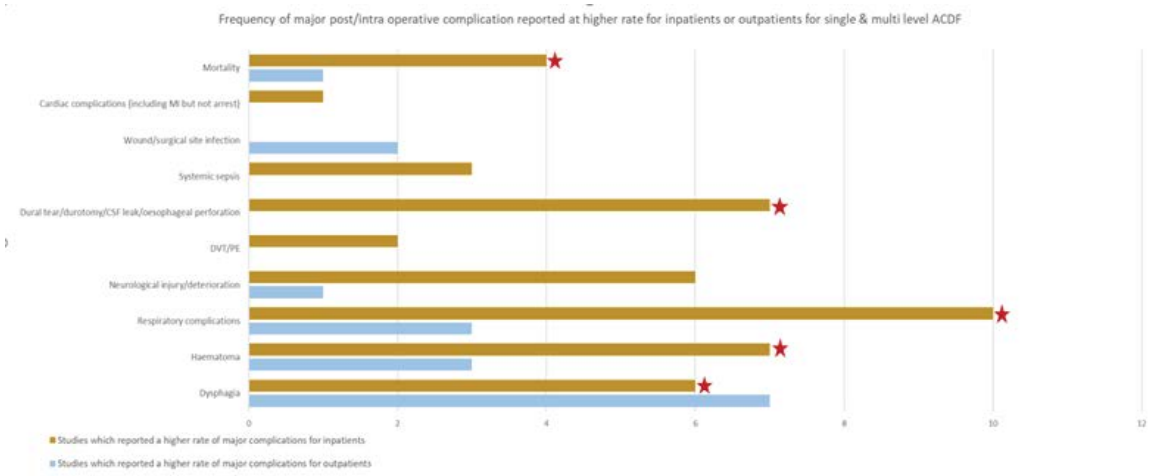


Figure 3: Number of studies which reported higher rates of major post-operative complications in outpatient and inpatient ACDF surgery for single and multi-level ACDF surgeries. Star indicating at least 1 study showing statistical significance ($p<0.05$).

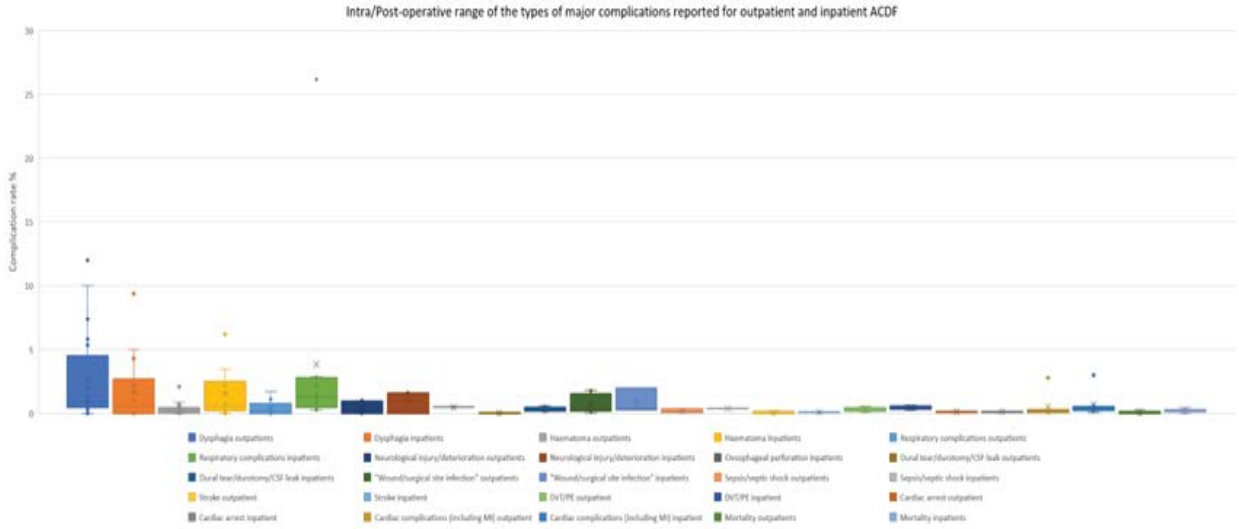


Figure 4: Range of rate of major intra/postoperative complications reported for patients undergoing ACDF in outpatient vs inpatient settings.

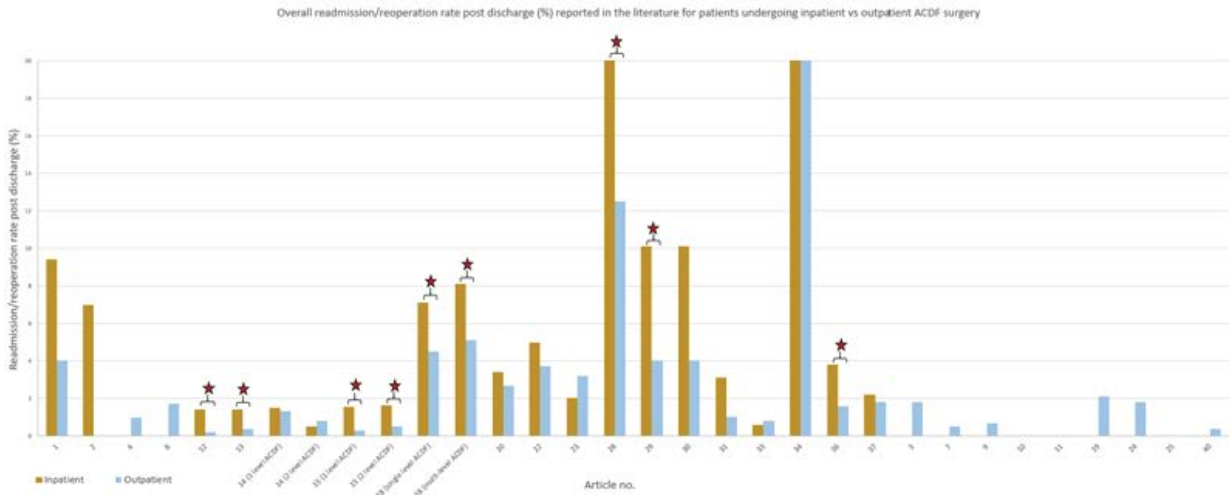


Figure 5: Readmission rate range reported in studies which assessed outpatient vs inpatient ACDF. Star indicates statistical significance ($p<0.05$) between reported rate between outpatients and inpatients.

Citation: Dr Salman Ghani, Dr Ahmed Ali Kayyale. Can Anterior Discectomy and Fusion (ACDF) Surgery be Safely Performed in an Outpatient Setting? A Systematic Review on the Post-operative Complication and Readmission Rates, Journal of Spine Research and Surgery. 6 (2024): 61-73.

Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

Discussion

Safety of day-case ACDF

A higher reporting frequency and numerical rate of post/intra operative complications was demonstrated for patients undergoing ACDF in inpatient compared to outpatient settings

The frequency of postoperative complications in patients undergoing Anterior Cervical Discectomy and Fusion (ACDF) significantly differs between inpatient and outpatient settings. An analysis of thirty one studies, of which twenty two directly compared inpatient and outpatient settings and nine focused solely on outpatients, revealed notable trends. Overall postoperative complication rates for inpatients ranged from 0% to 31.36%, while for outpatients, they ranged from 0.001% to 34.59% as indicated in table 4. The interquartile range (IQR) for complication rates was higher for inpatients at 3.87% compared to 2% for outpatients, suggesting more variability and a higher frequency of complications among inpatients. Sixteen out of the twenty two studies showed higher overall complication rates for inpatients, with seven studies reaching statistical significance.

On analysis of the types of major complications, figure 2 shows the number of times a major complication was mentioned in the literature for patients undergoing ACDF in inpatient settings. All major complications except dysphagia were mentioned more frequently for patients undergoing ACDF in inpatient compared to outpatient settings. The detailed analysis in figure 3 shows the frequency of major post/intraoperative complications reported at higher rates for inpatients compared to outpatients. For single-level ACDF, more studies indicated higher rates of major complications for inpatients, except for dysphagia, where two studies reported higher rates for outpatients and inpatients respectively. Statistically significant differences were found in respiratory and dural complications whereby four studies reported higher respiratory complication rates for inpatients (two statistically significant), and six studies reported higher dural complication rates for inpatients (two statistically significant).

A similar trend was observed in the combined analysis of major complications for both single and multi-level ACDF. More studies reported higher rates of all major complications for inpatients, except for dysphagia, where one additional study reported higher rates for outpatients. This however was not statistically significant. Mortality was higher in inpatients in four studies (one statistically significant), dural complications were higher in six studies (two statistically significant), respiratory complications were higher in six studies (three statistically significant), haematoma was higher in five studies (two statistically significant), and dysphagia was higher in five studies (one statistically significant).

Figure 4. illustrates the range of the rate of major complications reported for patients undergoing ACDF in outpatient and inpatient settings. Analysis of inter-quartile ranges demonstrate higher reported rates for 3 major complications including dysphagia, stroke and DVT/PE. Current literature has highlighted most frequent major complications associated with ACDF including dysphagia, haematoma, infection, vertebral artery injury, oesophageal perforation and respiratory insufficiency [52] [13].

Dysphagia

Dysphagia was an exception as it was the only major complication reported at a higher rate in a statistically significant study for patients undergoing ACDF in outpatient compared to inpatient settings. Dysphagia showed the biggest difference in interquartile ranges for outpatients (3.19) compared to inpatients (0.355). Dysphagia has been reported as a common issue associated with anterior cervical surgery since the early 2000s [20] [15]. The most common complication associated with dysphagia is aspiration, dehydration and malnutrition [38]. Jeffery et al. 2011 performed one of the first prospective studies which assessed the incidence of post-operative dysphagia following ACDF. They reported up to 71% of patients with some degree of dysphagia at 2-week follow up, according to the Bazaz dysphagia scoring system. This rate decreased to 8% with conservative measures at the 12-week follow up period [39]. However, another systematic review has reported up to 12% to 14% of patients with persistent dysphagia one year after the procedure [9]. Meanwhile a prospective study including 348 patients by Lee et al. 2007 found an incidence rate of 54.2% at one month which decreased to 33.6%, 18.6%, 15.2% and 13.6% at two months, six months and 1 year post-operatively [36]. Additional studies reporting on dysphagia included Yernini et al. 2020 whom found an 113% increase in the risk of developing dysphagia in patients who underwent outpatient ACDF compared to their inpatient counterparts, however this result was not statistically significant [53]. The use of post operative surgical drainage has been shown to be beneficial in certain patient cohorts which will have a higher drain output including smokers, more than 2 level ACDF procedures, patients older than 50 years old and others [4] [37]. In these patients drainage use decreases the risk of seroma accumulation and decrease the risk of dysphagia.

Respiratory complications

The most frequently reported complication for patients undergoing ACDF in both inpatient and outpatient settings was respiratory complications. Respiratory complications are often the end result of neck swelling or wound haematoma causing airway compromise. Boddapati et al. 2021 reviewed 52,270 patients who developed respiratory compromise after anterior cervical spinal surgery and found an incidence rate of 0.57% [5]. Although rare, these complications can be life-threatening and often occur shortly after surgery. The patient

Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

specific risk factors identified in the study included patient age, male gender, chronic cardiac and respiratory disease, pre-operative myelopathy, prolonged surgery duration and 2-level ACDF [5]. These predictors can facilitate preoperative stratification of patients prior to outpatient surgery.

Venous thromboembolism

In our analysis the second most reported complication for inpatients and fourth most frequent for outpatients was venous thromboembolism. A recent study reported on the incidence of this complication in 21,000 patients undergoing ACDF and found the highest incidence of VTE occurring within the first post-operative week at an incidence of 0.65%, which then decreased to 0.61% at 1 month, 0.53% at 3 months [7]. The high frequency of reported incidences of VTE may be explained by the nature of ACDF surgery which often necessitates the manipulation of structures inside and around the carotid sheath. As such, this increases the risk of vascular injury potentially giving rise to other intracranial emboli leading to events such as ischaemic stroke (18) [8].

Dural complications

Dural complications most often occur intra-operatively due to issues such as oesophageal or dural tears, CSF leak and neurological injury. No studies reported a higher rate of dural complications for inpatients compared to outpatients for both single and multi-level ACDF surgery. The interquartile range of the rate of dural complications was twice as much for patients undergoing ACDF in inpatient settings compared to outpatient (0.41 vs 0.1). Due to the nature of this complication it would require further monitoring after the procedure and therefore it would be unlikely the patient would be discharged on the same day or within 24 hours. As such these patients would be allocated to the inpatient cohort despite initially being treated in an outpatient setting resulting in potential skewing of the data toward higher complication rates for inpatients. Moreover, the timing of post-operative complication identification and allocation of patients to inpatient/outpatient cohorts is not consistent within the literature and may also explain the rate of infection for outpatients being reported at a higher rate in the outpatients inpatient setting in two studies.

Revision

Arshi et al. 2018 found patients undergoing ACDF in outpatient settings had a significant greater likelihood of anterior revision or extension of fusion (OR 1.46 at 1 year), conversion to posterior fusion (OR 1.58 at 6 months, OR 1.79 at 1 year) and acute renal failure within fourteen days (OR 1.25) [3] at the same or adjacent level. This was one of the first studies which found higher post-operative complications associated with outpatient ACDF compared to inpatient settings. These higher rates of postoperative pseudoarthrosis were potentially be attributable to lower efficacy in outpatient/ambulatory settings which were pressured by time constraints and high surgical volume, as well as newer ACDF systems used in such centres which are biomechanically inferior to the traditional plate and screw systems [3]. Another potential explanation proposed by Arshi et al. 2018 for the higher rates of revision surgery surgeon preference of doing only do 1 or 2 level ACDF procedures in outpatient settings despite disease in adjacent segments, whereas a surgeon may consider 3 level ACDF within an inpatient setting where there is post operative monitoring and follow up. Recent critical analyses of this literature by Rossi et al. 2020 highlighted several inconsistencies within the methodology of Arshi et al. 2018 associated with the CPT codes used to search the database referred only to hospital inpatient and hospital outpatient procedures which could not be generalised to true ambulatory surgery centres [40]. In addition, the increased revision rate attributed to outpatient surgery is strongly inherent patient-level factors and patient selection rather than facility-related variables. Lastly it was deemed difficult to determine how representative the study sample was to the larger population due to the multiple biases associated with an insurance database [40].

Reported readmission rates were higher in patients undergoing ACDF in inpatient compared to outpatient settings

As well as short term post-operative complications, it is also important to consider any complications which required re-admission to hospital following discharge. The readmission rates for patients undergoing ACDF ranged from 0%-24.69% and 0%-44.2% in outpatient and inpatient settings respectively. Figure 5. shows seventeen studies which demonstrated a higher readmission rate for patients undergoing ACDF in inpatient compared to outpatient settings, of which nine were statistically significant. Of these, seven followed up patients up to thirty days and two followed up patients up to ninety days. The lower rates of readmission within the outpatient setting may be attributable to several factors including patients within the outpatient cohort having ACDF across fewer spinal levels, lower comorbidities and therefore better outcomes. McClelland et al. 2017 found similar results based on a cohort of 2016 patients analysed over 10-year period. Readmission rates of 5.2% were reported to occur 7 days postoperatively, for patients undergoing 1-2 level ACDF with a length of stay less than 1 day [34]. A more recent study by Lee et al. 2020 analysed the outcomes patients from the NSQIP database undergoing ACDF for myelopathy from 2010-2021. Patients undergoing ACDF in outpatient settings demonstrated a statistically significant difference in the lower minor and major outcomes as well as reoperation and mortality rates in the 30-day period when compared to matched inpatient cohorts [27]. Further studies are needed involving outpatient data from other countries with significant power and detailed information regarding the

Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

date and reasons for readmission to determine whether this study's results are applicable to the UK.

Efficacy of day-case ACDF

Safaee et al. 2021 compared the efficacy of ACDF cases performed within various care pathways including same-day discharge, overnight observation and standard inpatient admissions [42]. A total of four hundred and seventy patients were separated into these care pathways with no statistically significant difference in age, gender, ASA classification, levels fused or preoperative diagnosis between patients. Same-day and overnight cohorts had shorter procedure durations and lower estimated blood loss. Despite a higher proportion of patients with CCI scores >6 was observed in the overnight observation group, results showed no difference was noted between patients within each pathway with respect to perioperative complications, 30-day readmission rate, improvements in pre-operative weakness and fusion defined by cervical radiographs rates at twelve months (42). Further evidence to demonstrating radiographic evidence of good postoperative outcomes for outpatient ACDF was reported by Shephard et al. 2012 performed a retrospective review of one hundred and fifty two patients undergoing outpatient ACDF. A radiographic analysis of post operative x-rays confirmed cervical fusion at six and twelve months in 95.1% of patients to have solid arthrodesis [43]. These results demonstrate no increased risk of postoperative complications, readmissions or patient functional outcomes or radiographic evidence in patients undergoing ACDF in outpatient settings with a shorter stay compared to those undergoing the procedure within inpatient settings.

Subjective measurements, such as post-operative functional outcomes and experiences reported from patients, may not always be at the forefront of studies assessing the efficacy of ACDF surgery. Although the PICO question in this literature search was not specifically designed to assess the post operative functional outcomes of patients, thirty one studies included in the search provided information on patient follow up and evidence of the efficacy of performing ACDF in an outpatient versus inpatient setting. One of these studies followed-up both inpatients and outpatients over 1.27 years and found no significant difference between the patient settings when assessing relief of arm pain, neck pain, muscle weakness and return to normal activities, work and overall satisfaction [44]. Similarly, another study by Liu et al. 2009 assessed one hundred and nine patients at follow up (mean 62.4 days) and found no significant statistical difference between outpatient and inpatients in outcomes including complete/partial/exacerbation/no improvement of symptoms or complications [32]. A retrospective review of one hundred and six patients in a single surgeon database by Vishnav et al. 2019 demonstrated statistical significance in several patient reported outcome measures. These included the Neck Disability Index score (outpatient 27.97 vs inpatient 37.5) and Visual Analogue Scale of neck pain (outpatient 2.92 vs inpatient 4.02) at six weeks post-surgery. Furthermore, statistical difference was found for SF-12 Short Form Physical Health Score prior to the surgery (outpatient 34.4 vs inpatient 30.11) and 6 weeks post-surgery (outpatient 35.66 vs inpatient 30.79) [47].

There were four studies which commented on the post operative patient reported outcome (PROM) and experiences (PREM) in outpatient settings only. One study by Erickson et al. 2007 found 57.8% patients who had ACDF surgery were very satisfied with outcome. 40% of patients returned to work by six weeks and 42.2% return to normal activities by six weeks. In addition, 53.3% patients reported their post operative pain was well controlled. From the 46.6% of patients' experiencing post operative pain, 17% of patients reported it to be mild-moderate and 3% of patients reported severe pain [14]. Higher levels of patient satisfaction were reported from a cohort of three hundred and ninety outpatients, on their first post-operative visit by Joseffer et al. 2010 who reported 92% of patients who believed their symptoms had improved [25]. Shephard et al. 2012 performed a retrospective review of one hundred and fifty two patients undergoing outpatient ACDF and in the 30-day outcomes, half of patients responded to a survey, in which 98% reported good pain control post op and 100% would have surgery again [43]. Lied et al. 2013 reported on pain scores in outpatients undergoing ACDF and found significant differences in pre and 6-month post-surgery reporting on improvement of radicular pain (78.5% of patients reported improvement) and neck pain (85.4% of patients reported improvement) VAS scale. In the same study patient satisfaction using NASSQ (Negative Affect Self-Statement Questionnaire) showed that 91% reported overall good result of treatment for their neck and arm pain [30].

Conclusion

The definition of an 'outpatient' and 'inpatient' within the literature has not been consistent. This disparity often makes it difficult to compare the postoperative outcomes of patients' treated within these settings and affects the conclusions relating to patient safety and outcome efficacy for ACDF surgery. These studies provide supportive evidence to demonstrate that ACDF done in outpatient settings can be as safe and efficacious if not better than in an inpatient setting. Results for outpatients undergoing ACDF indicate lower readmission rates, less major post-operative complications, and improved patient outcomes/experience measures.

Conf ict of interest: None to declare

Contributions: Both authors are joint first authors and have contributed equally to the manuscript

References

1. ACS, 2018. User Guide for the 2017 ACS NSQIP Participant Use Data File (PUF). [Online] Available at: https://www.facs.org/~/media/files/quality%20programs/nsqip/nsqip_puf_userguide_2017.ashx [Accessed 21 December 2021].

2. Ali, Z. S. Enhanced recovery after elective spinal and peripheral nerve surgery: pilot study from a single institution. Journal of Neurosurgery 30 (2019): p.532–540.

3. Arshi, A. Ambulatory anterior cervical discectomy and fusion is associated with a higher risk of revision surgery and perioperative complications: an analysis of a large nationwide database. The Spine Journal, 18 (2018): pp.1180-1187.

4. Basques, B. A. Factors predictive of increased surgical drain output after anterior cervical discectomy and fusion (ACDF). Spine (Phila Pa 1976) 39 (2014): pp.728-735.

5. Boddapati, V. Respiratory Compromise After Anterior Cervical Spine Surgery: Incidence, Subsequent Complications, and Independent Predictors. Global Spine Journal (2021).

6. Bovonratwet, P. Definitional Differences of 'Outpatient' Versus 'Inpatient' THA and TKA Can Affect Study Outcomes. Clinical Orthopaedics and Related Research 475 (2017): p.2917-2925.

7. Bui, A. Incidence and Risk Factors for Postoperative Venous Thromboembolic Events in Patients Undergoing Cervical Spine Surgery. Clinical Spine Surgery 34 (2021): pp.458-465.

8. Cheung, J. Complications of anterior and posterior cervical spine surgery. Asian Spine Journal 10 (2016): pp.385-400.

9. Cho, S. K. Dysphagia following anterior cervical spinal surgery. The Bone & Joint Journal, 95-B (2013): pp. 868-873.

10. Cohen, S. P. Epidemiology, Diagnosis, and Treatment of Neck Pain. Symposium of Pain Medicine 90 (2015), pp. 284-299.

11. Debono, B. Implementation of enhanced recovery after surgery (ERAS) protocol for anterior cervical discectomy and fusion: a propensity score-matched analysis. European Spine Journal 30 (2021): pp.560-567.

12. Engquist, M. A 5- to 8-year randomized study on the treatment of cervical radiculopathy: anterior cervical decompression and fusion plus physiotherapy versus physiotherapy alone. Journal of Neurosurgery 26 (2017): pp.19-27.

13. Epstein, N. E. A Review of Complication Rates for Anterior Cervical. Surgical Neurology International, 10 (2019).

14. Erickson, M. Outpatient Anterior Cervical Discectomy and Fusion. The American Journal of Orthopaedics, 36 (2007): pp.429-432.

15. Frempong-Boadu, A. Swallowing and speech dysfunction in patients undergoing anterior cervical discectomy and fusion: a prospective, objective preoperative and postoperative assessment. Journal of Spinal Disorders & Techniques, 15 (2002): pp.362-368.

16. G.Whitmore, R. ASA grade and Charlson Comorbidity Index of spinal surgery patients: correlation with complications and societal costs. The Spine Journal, 14 (2014): pp.31-38.

17. GIRFT, 2022. www.gettingitrightfirsttime.co.uk. [Online] Available at: https://www.gettingitrightfirsttime.co.uk/bpl/pathways/ [Accessed 14 April 2022].

18. Graffeo, C., 201. Delayed cerebral infarct following anterior cervical diskectomy and fusion. Surgical Neurology International 7 (86).

19. Hartvigsen, J. What low back pain is and why we need to pay attention.. Lancet, (2018): pp. 2356-2367.

20. H,T. Dysphonia and dysphagia after anterior cervical decompression. Journal of Neurosugery 7(2007): pp.124-130.

21. Hutton, M., 2019. Spinal Services - GIRFT Programme National Speciality Report. [Online]

22.Available at: https://gettingitrightfirsttime.co.uk/wp-content/uploads/2019/01/Spinal-Services-Report-Mar19-L1.pdf [Accessed 10 March 2022].

23. IMHE, 2022. Global Burden of Disease Results Tool. [Online] Available at: http://ghdx.healthdata.org/gbd-results-tool [Accessed 10 March 2022].

24. Jahre, H. Risk factors and risk profiles for neck pain in young adults: Prospective analyses from adolescence to young adulthood - The North Trøndelag Health Study. PLOS ONE, 16 (2021): p.e0256006.

25. Joseffer, S. Outpatient Anterior Cervical Discectomy and Fusion: Indications and Clinical Experience in a Consecutive Series of 390 Patients. Neurosurgery Quarterly 20 (2010): pp.107-110.

26. Kehlet, H. Multimodal approach to control postoperative pathophysiology and rehabilitation. British Journal of Anasthesia 78 (1997): pp.606-617.

27. Lee, R. Outcomes following outpatient anterior cervical

discectomy and fusion for the treatment of myelopathy. Journal of Clinical Orthopaedics and Trauma 9 (2020): pp.161-167.

28. Leng, X. An enhanced recovery after surgery pathway: LOS reduction, rapid discharge and minimal complications after anterior cervical spine surgery. BMC Musculoskeletal Disorders 23 (2022).

29. Licina, A. Pathway for enhanced recovery after spinal surgery-a systematic review of evidence for use of individual components. BMC Anaesthesiology 21 (2021).

30. Lied, B. Outpatient anterior cervical discectomy and fusion for cervical disk disease: a prospective consecutive series of 96 patients. Acta Neurologica Scandinavica, 127 (2013): pp.31-37.

31. Lin, W. Diagnosing Pseudoarthrosis After Anterior Cervical Discectomy and Fusion. Neurospine 15 (2018), pp. 194-205.

32. Liu, J. T. Comparison of inpatient vs. outpatient anterior cervical discectomy and fusion: a retrospective case series. BMC Surgery 9 (2009): pp.1471-2482.

33. Mansfield, M. Cervical spine radiculopathy epidemiology: A systematic review. Musculoskeletal Care, 18 (2020): pp. 555-567.

34. McClelland, S. Outpatient Anterior Cervical Discectomy and Fusion: An Analysis of Readmissions from New Jersey State Ambulatory Services Database. International Journal of Spine Surgery, 11 (2017): p.3.

35. Mesfin, F. B. Retrospective Data Analysis and Literature Review for a Development of Enhanced Recovery after Surgery Pathway for Anterior Cervical Discectomy and Fusion. Cureus, 12 (2020): p.e6930.

36. MJ, L. Risk factors for dysphagia after anterior cervical spine surgery: a two-year prospective cohort study. The Spine Journal 7 (2007): pp.141-147.

37. O'Neill, K. R. Risk factors for postoperative retropharyngeal hematoma after anterior cervical spine surger. Spine (Phila Pa 1976), 39 (2014): pp.246-252.

38. Philipsen, B. B. Dysphagia - Pathophysiology of Swallowing Dysfunction, Symptoms, Diagnosis and Treatment. Journal of 5 (2019).

39. Rihn, J. A. What Is the Incidence and Severity of Dysphagia After Anterior Cervical Surgery?. Clinical Orthopaedics and Related Research 469 (2011): pp.658-665.

40. Rossi, V. Outpatient anterior cervical discectomy and fusion in the ambulatory surgery center setting: safety assessment for. Journal of Neurosugery Spine, 32 (2020): p.360-365.

41. Rubin, D. I. Epidemiology and risk factors for spine pain. Neurologic Clinics (2007): pp.353-371.

42. Safaee, M. M. Cost Analysis of Outpatient Anterior Cervical Discectomy and Fusion at an Academic Medical Center without Dedicated Ambulatory Surgery Centers. World Neurosurgery, Volume 146 (2021): pp.940-946.

43. Sheperd, C. S. Instrumented Outpatient Anterior Cervical Discectomy and Fusion: Is it Safe?. International surgery, 97 (2012): pp.86-89.

44. Silvers, H. R., 1996. Day surgery for cervical microdiscectomy: is it safe and effective? Journal of Spinal Disorders 9 (4): pp.287-293.

45. Soliman, H. M. Cervical microendoscopic discectomy and fusion: does it affect the postoperative course and the complication rate? A blinded randomized controlled trial.. Spine 38 (2013): pp.2064-2070.

46. Stull, J. D. The Outcomes of Patients With Neck Pain Following ACDF. Cervical Spine 45 (2020): pp. 1485-1490.

47. Vaishnav, A. Comparison of Multilevel Anterior Cervical Discectomy and Fusion Performed in an Inpatient Versus Outpatient Setting. Global Spine Journal, 9 (2019): pp.834-842.

48. Veeravagu, A. Predicting complication risk in spine surgery: a prospective analysis of a novel risk assessment tool. Journal of Neurosurgery 27 (2017): pp.81-91.

49. Vergara, P. Minimally invasive anterior cervical discectomy and fusion: a valid alternative to open techniques. Acta Neurochirurgica 160 (2018): p.2467-2471.

50. Vos T, A. A. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet, 390 (2017), pp. 1211-1259.

51. Y.Wang, T. Preoperative optimization for patients undergoing elective spine surgery. Clinical Neurology and Neurosurgery, Volume 202 (2021).

52. Yee, T. J. Complications of anterior cervical spine surgery: a systematic review of the literature. Journal of Spine Surgery, 6 (2020): pp.302-322.

53. Yerneni, K. Safety of Outpatient Anterior Cervical Discectomy and Fusion: A Systematic Review and Meta-Analysis. Neurosurgery 86 (2020): pp.30-45.

Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

Appendix

Year	Prevalence rate			Incidence			Years Lived with Disability		
	Number (95% uncertainty interval, UI)	Age Standardised Rates (ASR) per 100,000 population (95% UI)	Age Standardised Percentage Rate per 100,000 population (95% UI)	Number (95% uncertainty interval, UI)	Age Standardised Rates (ASR) per 100,000 population (95% UI)	Age Standardised Percentage Rate per 100,000 population (95% UI)	Number (95% uncertainty interval, UI)	Age Standardised Rates (ASR) per 100,000 population (95% UI)	Age Standardised Percentage Rate per 100,000 population (95% UI)
2015	202.27 million (255.30 – 163.39 million)	2632.52 (3298.23 – 2131.85)	2.75 (3.44 – 2.23)	43.91 million (55.49 – 34.77 million)	570.87 (719.73 – 453.95)	0.11 (0.14 – 0.09)	20.11 million (28.87 – 13.20 million)	261.40 (373.95 – 171.84)	2.43 (3.14 – 1.90)
2016	206.87 million (261.38 – 166.85 million)	2642.81 (3312.58 – 2137.86)	2.76 (3.45 – 2.23)	44.75 million (56.49 – 35.38 million)	572.19 (721.68 – 454.95)	0.11 (0.14 – 0.09)	20.56 million (29.53 – 13.49 million)	262.34 (375.45-172.32)	2.44 (3.15 – 1.90)
2017	211.86 million (267.90 – 170.64 million)	2657.48 (3332.41 – 2147.82)	2.77 (3.47 – 2.25)	45.65 million (57.51 – 36.07 million)	574.14 (724.45 – 456.18)	0.11 (0.14 – 0.09)	21.04 million (30.22 – 13.81 million)	263.69 (377.66 – 173.21)	2.45 (3.16-1.91)
2018	217.09 million (273.94 – 174.96 million)	2674.66 (3351.24 – 2162.81)	2.79 (3.50 – 2.26)	46.57 million (58.68 – 36.79 million)	576.33 (726.87 – 456.92)	0.11 (0.14 – 0.09)	21.54 million (30.94 – 14.16 million)	265.3 (380.31 – 174.33)	2.46 (3.18 – 1.91)
2019	222.72 million (281.07 – 179.24 million)	2696.52 (3375.19 – 2177.01)	2.81 (3.53 – 2.28)	47.53 million (59.94 – 37.45 million)	579.09 (729.64 – 457.90)	0.11 (0.14 – 0.09)	22.08 million (31.73 – 14.51 million)	267.35 (383.54 – 175.53)	2.48 (3.21 – 1.93)

Table 1: Global GHDx Data

Year	Prevalence rate			Incidence			Years Lived with Disability		
	Number (95% uncertainty interval, UI)	Age Standardised Rates (ASR) per 100,000 population (95% UI)	Age Standardised Percentage Rate per 100,000 population (95% UI)	Number (95% uncertainty interval, UI)	Age Standardised Rates (ASR) per 100,000 population (95% UI)	Age Standardised Percentage Rate per 100,000 population (95% UI)	Number (95% uncertainty interval, UI)	Age Standardised Rates (ASR) per 100,000 population (95% UI)	Age Standardised Percentage Rate per 100,000 population (95% UI)
2015	3.22 million (3.98 – 2.59 million)	3827.54 (4765.30 – 3078.26)	4.2 (5.22 – 3.39)	580053.88 (712303.19 – 455956.87)	741.41 (914.47 – 590.73)	0.14 (0.18 – 0.11)	315,178.75 (449,674.35 - 209,516.71)	379.07 (544.89 – 251.44)	3.29 (4.20 – 2.60)
2016	3.47 million (4.23 – 2.79 million)	4164.52 (5223.39 – 3343.50)	4.58 (5.74 – 3.67)	616,922.74 (754,212.01 - 489,803.90)	796.23 (995.60 – 632.68)	0.15 (0.19 – 0.12)	340,472.73 (484,700.44 - 227,076.61)	413.16 (591.93 -276.91)	3.59 (4.59 – 2.85)
2017	3.72 million (4.63 – 2.98 million)	4501.85 (5676.20 – 3592.40)	4.95 (6.24 – 3.95)	653,876.09 (801,589.90 - 520,571.69)	851.10 (1,073.43 - 675.85)	0.16 (0.21 – 0.13)	365,699.74 (522,040.69 - 245,476.52)	447.24 (637.33 – 302.42)	3.88 (4.98 – 3.07)
2018	3.75 million (4.66 – 3.01 million)	4501.58 (5675.71 – 3592.01)	4.95 (6.24 – 3.95)	658,337.95 (805,877.02 - 523,867.47)	851.14 (1,073.46 - 675.88)	0.16 (0.20 – 0.13)	367,990.93 (525,335.26 - 246,410.83)	447.09 (637.11 – 302.21)	3.87 (4.96 – 3.06)
2019	3.77 million (4.70 – 3.03 million)	4501.34 (5675.23 – 3591.70)	4.94 (6.24 – 3.94)	662,700.79 (810,120.42 - 527,440.56)	851.18 (1073.50 – 675.90)	0.16 (0.20 – 0.13)	370,075.82 (528,171.87 - 247,710.52)	446.79 (636.94 – 301.97)	3.85 (4.94 – 3.04)

Table 2: UK GHDx Data

Citation: Dr Salman Ghani, Dr Ahmed Ali Kayyale. Can Anterior Discectomy and Fusion (ACDF) Surgery be Safely Performed in an Outpatient Setting? A Systematic Review on the Post-operative Complication and Readmission Rates, Journal of Spine Research and Surgery. 6 (2024): 61-73.

Ghani S, et al., J Spine Res Surg 2024
DOI:10.26502/fjsrs0076

Table 3: Major postoperative complication (separated by type) rate range reported in studies which assessed patients undergoing ACDF in outpatient versus inpatient settings. Unable to calculate IQR as total number reported complications less than 4 was denoted by '-'

Major postoperative complication	Patients undergoing ACDF in both outpatient and inpatient settings / IQR	
	Outpatient complication (%) / IQR (including studies assessing only outpatient ACDF)	Inpatient complication (%) / IQR
Dysphagia	0-12% /3.19	0-9.4% / 0.355
Haematoma	0-2.1% / 0.3	0-6.2% / 1.6
Respiratory complications	0-1.69% / 1.1	0.25-26.17% / 2.32
Neurological injury/deterioration	0-1% / 1	0-1.62% / -
Dural tear/durotomy/CSF leak	0-0.17% / 0.1	0.16-0.61% / 0.41
Wound/surgical site infection	0.3-1.79% / 1.075	0.26-2% / -
Sepsis/septic shock	0.1-0.38% / -	0.38-0.4%
Stroke	0-0.22% / 0.11	0.07-0.14% / 0.045
DVT/PE	0.19-0.57% / 0.305	0.28-0.63% / 0.23
Cardiac complications (including MI)	0.1-2.8% / 0.2	0.1-3% / 0.35
Cardiac arrest	0-0.1% / -	0.1-0.18% / -
Mortality	0-0.3% / 0.155	0-0.44% / 0.16