

Enhanced Recovery After Lumbar Fusion Surgery: An International Survey on Current Practice

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Abstract

Study Design: Cross-sectional, web-based international survey study.

Objectives: To assess spine surgeons' perspectives on the importance of Enhanced Recovery After Surgery (ERAS) components and barriers to implementing ERAS programs in degenerative lumbar fusion.

Methods: In May 2024, a web-based survey was distributed to AOSpine members. The survey covered eight ERAS components derived from the 2021 consensus statement for perioperative care in lumbar fusion. Respondents selected up to three components with the biggest perceived impact on recovery and up to three with the greatest room for improvement. Responses were summarized in a priority matrix. Demographics, perceived barriers, and implementation support needs were analyzed using descriptive statistics.

Results: The survey was accessed by 400 individuals, yielding 322 responses (80.5%) and a 76.7% completion rate. Respondents represented academic (50.6%), private (28.9%), and local/community hospitals (20.5%) worldwide. ERAS components perceived to have the biggest impact on recovery were multimodal opioid-sparing analgesia (73.3%), early mobilization (63.8%), and preoperative education & counselling (58.6%), which were also identified as having the greatest room for improvement (39.4%, 41.4%, and 62.6%, respectively). Key barriers were the absence of clear protocols and guidelines (56.2%), staff shortages (53.8%), and difficulties coordinating implementation and adherence (43.0%).

Conclusion: Multimodal opioid-sparing analgesia, early mobilization, and preoperative education & counselling were identified as ERAS components with the biggest perceived impact on patient recovery and the greatest room for improvement. Targeted efforts in these domains may represent an important opportunity to enhance perioperative care and support the implementation of ERAS programs in lumbar spinal fusion.

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Keywords

lumbar fusion, degenerative, early recovery, ERAS, survey, questionnaire, AOSpine, ERAS-DLF

Introduction

Since the turn of the century, the number of spinal fusion procedures has risen precipitously.^{1,2} Rather than slowing down, this trend is expected to continue at an accelerated pace, mostly due to an ageing population and the associated rise in degenerative spinal conditions.^{3,4} Overall, spinal fusion surgery ranks amongst the most cost-intensive procedures and is expected to place an increasing burden on healthcare systems.^{5,6} Moreover, despite their frequent success in restoring spinal stability and function, these procedures are also associated with substantial postoperative pain.⁷ Opioids are routinely used to manage acute postsurgical pain, but their effectiveness is limited by dose-restricting side-effects such as respiratory depression, nausea, obstipation, and urinary retention, often resulting in suboptimal pain control in the first few days.⁸ Besides causing direct discomfort to patients, insufficient pain control results in delayed mobilization, extended postoperative lengths of stay (LOS), and increased direct hospital costs.^{9,10} Furthermore, poor pain control in the first 24 hours postoperatively has been associated with worse surgical outcomes up to two years after elective spine surgery.¹¹ Accordingly, there are clear clinical and economic incentives to optimize and standardize perioperative care pathways in degenerative lumbar fusion surgery, aiming to improve patient outcomes and reduce unwanted practice variation.^{12,13}

In recent decades, sustained efforts to standardize surgical care have led to the development of structured perioperative protocols, collectively termed Enhanced Recovery After Surgery (ERAS) programs or 'fast-track surgery'. These programs encompass a set of evidence-based clinical care interventions in the pre-, intra-, and postoperative phase intended to improve and accelerate recovery.¹⁴ The approach was first introduced in general surgery, where ERAS pathways improved clinical outcomes, prevented complications, reduced hospital stays, and saved costs without increasing readmission rates.^{15,16} In orthopedics, the concept of ERAS has been applied more recently, predominantly in total joint arthroplasties, where it has reduced LOS from 4-12 days to 1-3 days, depending on age and comorbidities, also without significantly increasing readmission rates.^{17,18} Similarly, in spinal fusion surgery, where the concept of ERAS is relatively new, early evidence suggests that targeted perioperative interventions may improve outcomes, prevent complications and readmissions, and reduce LOS.^{19,20} Based on these findings, it is plausible that the implementation and refinement of ERAS protocols could add real value to lumbar fusion surgery.

In 2021, a consensus statement was published on the use of ERAS programs in lumbar spinal fusion.²¹ By synthesizing the best available evidence into a set of pre-, intra- and postoperative clinical practice recommendations, it

established a framework for optimizing surgical care towards early recovery and discharge. However, the extent to which these principles have been adopted in clinical practice, and how they are perceived by spine surgeons, remains limited. To address this gap, we developed the ERAS in Degenerative Lumbar Fusion (ERAS-DLF) survey in collaboration with authors of the original consensus statement. The aim was to evaluate current perceptions, the degree of adoption, and perceived barriers to implementing ERAS programs in lumbar fusion surgery for degenerative indications, to help improve clinical practice and guide further research on this topic. The primary aim of this study was to examine which ERAS components are considered to have the biggest impact on early recovery and which ones should be further improved. In addition, it explored existing barriers to adoption and the type of support needed for effective implementation.

Methods

In 2024, a cross-sectional, web-based international survey study was conducted among spine surgeons connected to AOSpine, an international academic network of spine professionals. The survey was developed by a multidisciplinary group with expertise in spine surgery and perioperative care and was designed and reported in accordance with the Checklist for Reporting of Survey Studies (CROSS) guidelines.²² Survey questions were developed based on the consensus statement for perioperative care in lumbar spinal fusion.²¹ Draft questions were iteratively refined to ensure clarity, relevance, and clinical applicability. The survey was pre-tested in 15 participants representative of the target population, and minor revisions were made based on feedback to improve question clarity and usability. Formal psychometric validation was not performed, as the survey was intended for exploratory purposes.

Recommendations from this statement were divided into eight thematic sections, preceded by respondents' background information (Section A) and followed by a set of overarching questions relating to various ERAS components (Section B) (Figure 1). Overall, the survey contained a total of 38 multiple-choice questions. The background information section solicited respondents' clinical specialty, hospital setting, years of experience, fellowship completion status, and country. The thematic sections were: (1) Preoperative education & counseling, (2) Anesthesia & perioperative care, (3) Surgical techniques, (4) Minimizing surgical wound drains, (5) Multimodal opioid-sparing analgesia, (6) PONV prevention & early nutrition, (7) Early mobilization, and (8) Monitoring compliance & outcomes. As such, the survey addressed specific ERAS components relevant to lumbar fusion surgery.

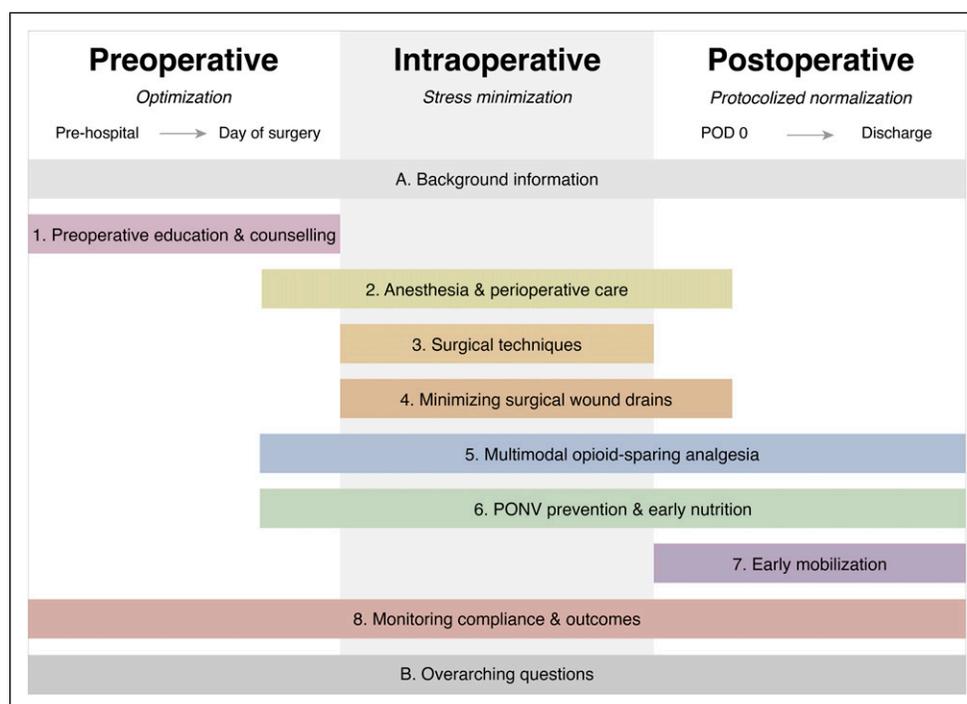


Figure 1. Sections covered by the ERAS-DLF survey study, based on the consensus statement for perioperative care in lumbar fusion²¹

The sections ‘Anesthesia & perioperative care’ and ‘Surgical techniques’ were selectively displayed depending on whether the respondent was an anesthesiologist or spine surgeon based on their answers in the ‘Background information’ section. In ‘Overarching questions’, respondents were asked to prioritize different ERAS components and address broader implementation challenges. The survey was designed to be completed in approximately 10 to 15 minutes to minimize respondent burden.

Given the breadth of the survey, the current article reports the results from the ‘Overarching questions’ section, addressing the core research questions of this study, rather than presenting the entire survey in detail. Accordingly, it presents the relative impact of ERAS components, highlights those with the greatest potential for improvement, and outlines key barriers to implementation in lumbar fusion for degenerative spinal disease. To assess perceived impact, respondents were asked to select a maximum of three ERAS components they believed had the biggest influence on patient recovery. Subsequently, they chose a maximum of three components that could be improved the most in clinical practice, which was intentionally left undefined to solicit responses based on individual clinical judgement and experience. Responses to these two questions were integrated into a priority matrix to visualize the relationship between the biggest perceived impact on patient recovery and the greatest room for improvement. Then, to identify implementation hurdles, respondents selected all applicable barriers from a list of ten predefined options which were drawn from the literature and refined

through expert consultation. Finally, the survey concluded by asking what kind of support they would find most helpful in facilitating the local adoption of ERAS principles, allowing multiple responses from a list of five options which was also based on previous research and reviewed by experts.

The online survey was created with SurveyMonkey (San Mateo, CA, USA). It was distributed to the AOSpine network via a dedicated e-mail to its international membership containing a link to the survey. It was accessible from May 10 to May 31st, 2024, with one e-mail reminder sent on May 24th. No personal identifiers or IP addresses were collected, and all responses were stored on secure, password-protected servers, with access restricted to the study investigators. According to Dutch regulations, this study did not fall under the scope of the Medical Research Involving Human Subjects Act (WMO) and therefore did not require formal review by a medical ethics committee. Participation was voluntary, completion of the anonymous survey implied informed consent, and the study was conducted in accordance with applicable data protection regulations. Descriptive statistics were used to summarize the data. Continuous measures were reported as means with standard deviations or as medians with interquartile ranges, depending on the distribution. Normality was assessed visually using Q-Q plots. Categorical variables were summarized using frequencies and percentages. Response rates were reported overall and for each question individually. Analyses were performed on available data without imputation using R (v4.4.1, R Foundation for Statistical Computing, Vienna, Austria) or Microsoft Excel.

Table 1. Respondents' Professional & Geographic Background

Demographics	
Clinical background	Respondents (%)
Orthopedic surgeon	212 (65.8%)
Neurosurgeon	67 (20.8%)
Spine surgeon/other healthcare professional	11 (3.4%)
No response	32 (9.9%)
Total	322 (100%)
Place of work	Respondents (%)
Academic hospital	162 (50.3%)
Private care facility	93 (28.9%)
Local hospital or community medical center	66 (20.5%)
No response	1 (0.3%)
Total	322 (100%)
Experience as a spine surgeon	Respondents (%)
0 – 5 years	95 (29.5%)
6 – 15 years	83 (25.8%)
16 – 25 years	52 (16.1%)
25+ years	46 (14.3%)
No response	46 (14.3%)
Total	322 (100%)
Fellowship completed in spine surgery	Respondents (%)
Yes	179 (55.6%)
No	74 (23.0%)
In progress	23 (7.1%)
No response	46 (14.3%)
Total	322 (100%)
Continent	Respondents (%)
Asia	105 (32.6%)
Europe	93 (28.9%)
South America	37 (11.5%)
North America	33 (10.2%)
Africa	22 (6.8%)
Australia	2 (0.6%)
No response	30 (9.3%)
Total	322 (100%)

Results

During the three-week survey period, 400 unique users accessed the link, and 322 submitted their responses (80.5%). Of these respondents, 247 completed the entire survey, resulting in a completion rate of 76.7%.

Information on demographic and professional characteristics was provided by 290 participants (90.1%). Overall, 65.8% of respondents were orthopedic surgeons, 20.8% neurosurgeons, and 3.4% other healthcare personnel (Table 1). Approximately half was employed in academic hospitals, whereas 28.9% worked in private practice and 20.5% in a local hospital or community medical center. Twenty-nine percent

had 0-5 years of experience in spine surgery, whereas 14.3% had more than 25 years of experience. Respondents were geographically distributed across six continents, with the largest proportions from Asia (32.6%) and Europe (28.9%). South America (11.5%) and North America (10.2%) showed similar representation, while Africa (6.8%) and Australia (0.6%) contributed the fewest responses.

Biggest Impact & Room for Improvement

Figure 2 presents a priority matrix positioning ERAS components according to their biggest perceived impact on patient recovery and greatest room for improvement. These results were derived from two survey questions in the 'Overarching questions' section, in which spine surgeons were asked to select up to three ERAS components for each domain. Both questions were completed by 251 respondents (77.9%).

Multimodal opioid-sparing analgesia was selected by 73.3% of respondents as having the biggest perceived impact on patient recovery. Early mobilization (63.8%) and preoperative education & counselling (58.6%) were also selected by more than half of respondents. Surgical techniques (32.3%) and anesthesia & perioperative care (24.7%) were reported less frequently, while PONV prevention & early nutrition (15.5%), monitoring compliance & outcomes (8.8%), and minimizing surgical wound drains (7.2%) were selected by smaller proportions of spine surgeons.

The ERAS components identified as having the greatest room for improvement were preoperative education & counselling (62.6%), followed by early mobilization (41.4%) and multimodal opioid-sparing analgesia (39.4%). Monitoring compliance & outcomes ranked fourth (37.1%), followed by anesthesia & perioperative care (22.7%), PONV prevention & early nutrition (17.9%), and surgical techniques (15.1%). Minimizing surgical wound drains was selected least frequently (10%).

Key Barriers to Implementation

Out of 322 respondents, 251 spine surgeons (77.9%) completed the question regarding perceived barriers to implementing ERAS principles in their hospital (Figure 3). The two most frequently selected barriers were the lack of clear protocols and guidelines (56.2%), and staff shortages (53.8%). These were followed by difficulties in coordinating implementation and adherence (43%), the cost of implementation (35.1%), the absence of a functional compliance or auditing system (35.1%), the lack of awareness among colleagues (32.7%), and patient variability (22.3%). There were also spine surgeons who felt that the implementation of ERAS principles was not in their control (17.5%) or not a current priority in their clinical practice (14.7%). A lack of appropriate medical or surgical

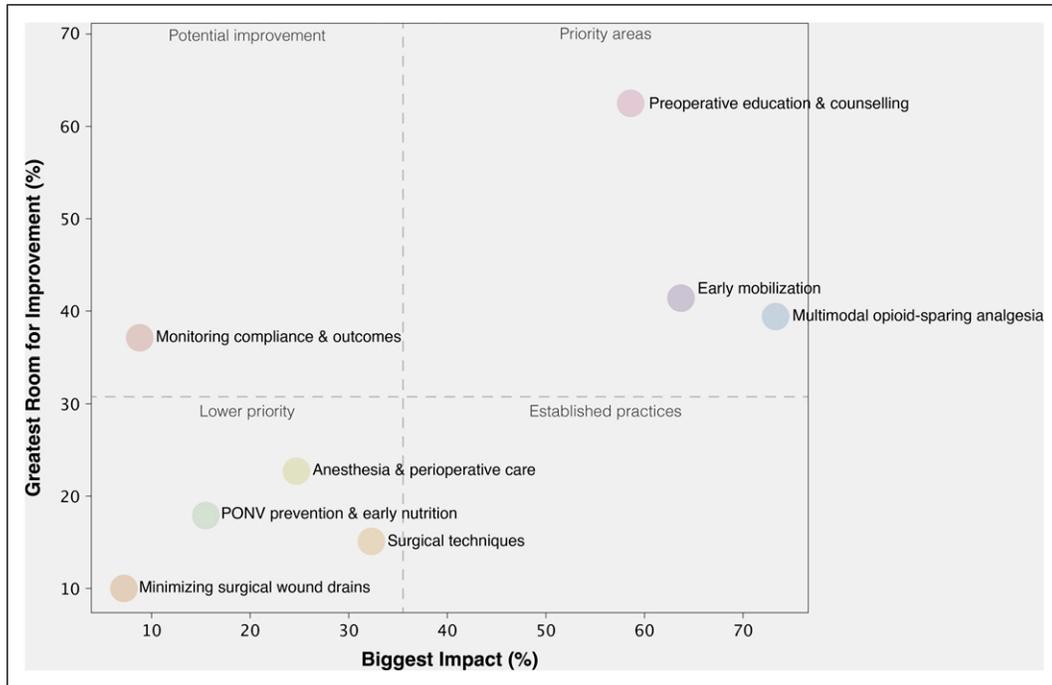


Figure 2. Priority matrix positioning ERAS components according to biggest perceived impact and greatest room for improvement (percentage of respondents). Quadrants were defined using mean values to aid interpretation. Dot colours correspond to the ERAS components shown in Figure 1

tools was cited by 9.2% of respondents. When asked to specify which tools, 70% chose ‘safe and effective pain treatments’ and 60% ‘appropriate surgical techniques’. Lastly, ‘Other’ reasons were selected by eight spine

surgeons (3.2%), four of whom stated that ERAS was already implemented in their hospital, whereas the remaining four identified the local institutional culture or a lack of support from payors or the clinical leadership.

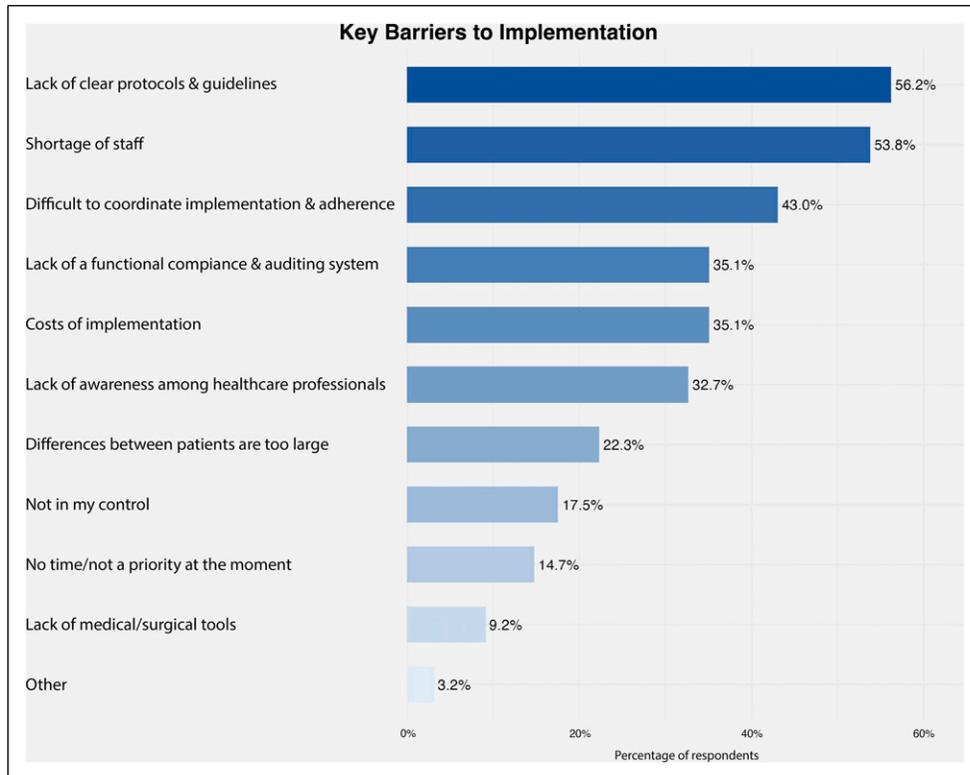


Figure 3. Key barriers to the implementation of ERAS protocols in respondents’ place of work (n = 251 (77.9%))

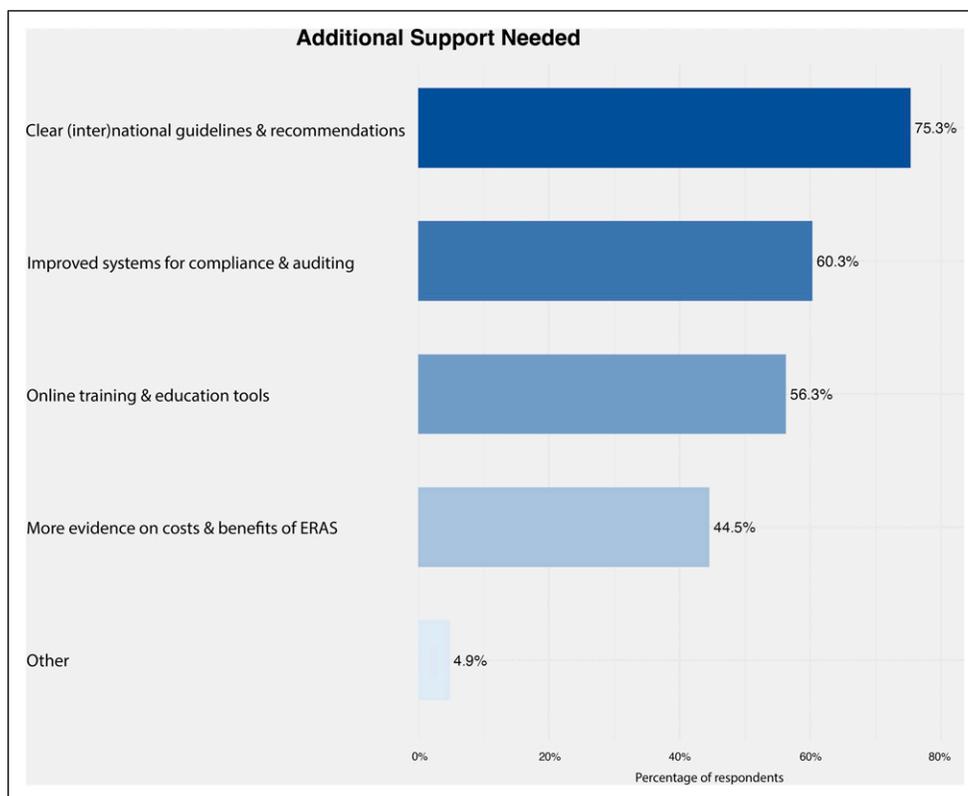


Figure 4. Additional support needed to implement ERAS protocols (n = 247 (76.7%))

Additional Support Needed

A total of 247 spine surgeons (76.7%) responded to the question regarding the type of support needed to facilitate the implementation of ERAS principles in their hospital (Figure 4). Clear international guidelines and recommendations were most frequently selected (75.3%), followed by improved systems for compliance monitoring (60.3%) and online training and educational tools (56.3%). Additionally, 44.5% reported that more evidence on the costs and benefits of ERAS in spine surgery would be helpful. A small proportion selected 'Other' (4.9%), with free-text responses including requests for additional (in-person) training, institutional or staff support, and opportunities for research collaboration with leading clinicians in the field.

Discussion

The ERAS-DLF study is an international survey study that explores the clinical importance and implementation of Enhanced Recovery After Surgery (ERAS) principles in lumbar fusion surgery for degenerative spinal disease. A total of 322 spine surgeons from academic, local, and private care facilities worldwide participated in the survey. Overall, the results underscore several areas for improving perioperative care in lumbar fusion surgery. Mapping ERAS components according to perceived impact and room for improvement

highlighted multimodal opioid-sparing analgesia, early mobilization, and preoperative education & counselling as areas that may warrant particular attention in future implementation efforts. Although perception-based, these findings provide insight into where clinicians believe implementation efforts could yield meaningful gains. Perceived barriers to implementation included the absence of clear protocols, staff shortages, and difficulties in coordinating implementation and adherence. In terms of support needed, respondents most often selected clear (inter)national guidelines and recommendations, improved compliance monitoring tools, online training and education programs, and more context-specific evidence on the cost-effectiveness of ERAS programs.

Although comparable studies are scarce, the results of this survey appear to be in line with the growing body of evidence on the application of ERAS principles in spine surgery. The response to the survey seems to reflect a growing support for ERAS programs among spine surgeons, as has been reported previously.^{21,23-26} Furthermore, the three ERAS components with the biggest perceived impact are increasingly supported by recent scientific evidence. First, multimodal opioid-sparing analgesia is strongly recommended based on high-quality evidence demonstrating more effective pain control, fewer opioid-related side-effects, improved patient satisfaction, shorter hospital lengths of stay, and lower costs.^{27,28} Likewise, early mobilization and preoperative education & counselling are both regarded as integral components of ERAS programs

in spine surgery given their potential to improve outcomes, although these effects are partly based on low to moderate quality evidence.^{21,29,30} As such, both the survey responses and recent studies suggest that these three ERAS components are emerging as important focus areas for research and clinical practice. Further research is required to clarify the impact of each individual component on patient outcomes after lumbar fusion surgery.

Implications for Clinical Practice

More than half the respondents expressed a need for spine-specific ERAS guidelines and protocols (56.2%). This concern is mirrored by the literature, wherein various studies have stressed the need for standardized care protocols and outcome variables to facilitate implementation and benchmarking.³¹⁻³³ Although previous studies offer broad recommendations as well as their underlying quality of evidence, an important next step may be the development of specific, operationalized treatment protocols especially for the first days after surgery. The findings of this study point to a need for practical tools and infrastructure to support effective adoption of ERAS programs, as reflected by participants' call for standardized guidance, monitoring systems, and training resources. As these interventions start to take shape, hospitals can already start monitoring patient outcomes and compliance in a consistent manner, preferably using standardized outcome sets that enable benchmarking to the literature and between institutions. Meanwhile, online training and education tools should be made accessible to healthcare professionals who are looking to improve perioperative care in their hospital, providing clear instructions on how to implement ERAS programs and protocols and where to start. Notably, many respondents identified institutional and cultural barriers, such as staff shortages, implementation costs, coordination challenges, a lack of urgency, or limited influence on changing perioperative care pathways. These findings highlight that, beyond clinical and economic guidance, successful implementation of ERAS programs depends on local support and engagement from the hospital leadership and other stakeholders. Multidisciplinary collaboration across surgical, anesthesiological, nursing, and rehabilitation teams is essential for ERAS principles to be ingrained into clinical practice, to reach patient-centered goals and consolidate their benefits over time.¹²

Strengths and Limitations

One of the main strengths of the ERAS-DLF study is its international focus, with 322 respondents representing a mix of nationalities and healthcare settings. Furthermore, its structure and topics are well-grounded in clinical research. The survey design was based on the 2021 consensus statement, which synthesized the best available evidence into a set of practice recommendations, and refined through expert consultation with leading experts in the field. By consolidating these recommendations into a thematic focus, the survey was able to include the

relevant pre-, intra-, and postoperative care interventions whilst remaining manageable in terms of time, resulting in a rich dataset with a high response and completion rate. Consequently, the findings likely provide a representative reflection of spine surgeons' attitudes towards ERAS programs, and can help better understand the key drivers and barriers for implementation.

There were also several limitations. First, the survey covers the full spectrum of perioperative care across different countries and healthcare settings, thereby taking a high-level approach which may not fully appreciate the specifics of different healthcare contexts or geographies. Although exploratory subgroup analyses by hospital type demonstrated broadly comparable response patterns (data not shown), contextual variations may still exist. Second, although the survey was originally intended for a multidisciplinary audience, including anesthesiologists and other healthcare professionals, it was sent out via AOSpine and thus responded to by (spine) surgeons. Its results should therefore be viewed as a surgeon-centric perspective on ERAS programs in lumbar fusion procedures, with the risk of a response bias due to the voluntary nature of participation. Accordingly, the priority matrix should be understood as an interpretive visualization of current clinician perspectives rather than as evidence of causal relationships or objective measures of effectiveness. Third, because of the thematic survey structure, some degree of overlap may exist between the different ERAS components, which are not always as distinct as they may seem. For example, in the 'Early mobilization' section, when asked to identify the main barriers for early mobilization, by far the most frequently selected response was 'postsurgical pain' (76.7%), illustrating the interconnectedness of early mobilization and multimodal opioid-sparing analgesia (Section 5). Although these two sections are particularly closely linked, the same applies to other sections in different degrees. From previous studies, it is known that isolating the effects of specific healthcare interventions on patient recovery can be challenging in a complex and dynamic healthcare environment. Thus, when interpreting the results of this survey, each ERAS component should be regarded as a link in the chain towards enhanced patient recovery rather than viewed in isolation.

Future Research Directions

Future research on ERAS programs in lumbar fusion surgery should be centered around three main goals. First, to develop clear, specific, and actionable recommendations for specific ERAS components. Second, to establish the cost-effectiveness of ERAS programs or their constituent parts. Third, to formulate best practices for local implementation into various healthcare contexts. Based on the results of this survey, future research may initially focus on multimodal opioid-sparing analgesia, early mobilization, and preoperative education & counselling. The overarching objective should be to improve and standardize perioperative care in a way that is consistent, comparable, evidence-based, and adaptable to different environments.

In terms of practice recommendations, researchers should develop and test specific treatment protocols and measure their

performance in a consistent and interoperable manner. For instance, for multimodal opioid-sparing analgesia, standardized combinations of baseline and rescue therapies could be proposed, which clinicians can select according to local practice or patient characteristics. Likewise, for early mobilization, specific physical therapy protocols could be given per postoperative day, indicating when to start, which exercises to do, and which functional milestones to meet. For preoperative education and counselling, process-oriented outcomes can be considered, such as checklists for discussing specific topics. In any case, ERAS interventions should be monitored in a consistent manner using reliable indicators of patient recovery. In the current literature, for instance, pain, opioid use, and mobilization are often underreported in the first days after surgery, providing a spotty image at best of patient recovery. Thus, the use of clear and standardized outcome sets could greatly improve the interpretability and added value of future studies.

Nearly half the respondents desired more robust evidence on the cost-effectiveness of ERAS in lumbar fusion surgery (44.5%), suggesting that further economic validation may be critical to convincing all relevant stakeholders. Because successful ERAS programs require multidisciplinary collaboration and institutional support, they tend to require upfront investments of time and resources. Therefore, spine-specific studies are required with clear interventions and outcome sets, to help demonstrate the added value of ERAS programs to spine surgeons, hospital administrators, and healthcare payors. Thus, over time, producing robust evidence on the cost-effectiveness of ERAS interventions could facilitate their inclusion in clinical practice guidelines, thereby significantly enhancing their widespread adoption.

To establish best practices for local implementation, future research must extend beyond clinical and economic outcomes to address the context-specific barriers and facilitators influencing adoption. Although this survey was not designed to populate a formal implementation framework, tools from implementation science, such as the Consolidated Framework for Implementation research (CFIR) or the Theoretical Domains Framework (TDF), may help elucidate barriers at the patient, professional, and hospital levels.^{34,35} Applying these frameworks could support hospitals in recognizing the influence of multidisciplinary practices, communication strategies, and individual ‘champions’ in fostering a resource-supported environment conducive to change.^{36,37}

Conclusions

In an international survey study of over 250 spine surgeons, multimodal opioid-sparing analgesia, early mobilization, and preoperative education & counselling were identified as the ERAS components with the greatest impact on patient recovery and with the most room for improvement. Targeted interventions in these domains, supported by spine-specific guidelines, outcome-monitoring tools, and education and training resources, may represent an important opportunity to enhance perioperative care and support the implementation of ERAS programs in lumbar spinal fusion.

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Ethical Considerations

According to Dutch regulations, this study did not fall under the scope of the Medical Research Involving Human Subjects Act (WMO) and therefore did not require formal review by a medical ethics committee. Participation was voluntary, completion of the anonymous survey implied informed consent, no identifiable personal data were collected, and the study was conducted in accordance with applicable data protection regulations.

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Declaration of conflicting interests

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Authors HJ, FT, and JJV are paid employees and stock owners in SentryX, a clinical-stage start-up company developing non-opioid local pain treatments for major surgery.

Author TG is a paid employee and stock owner of Medip Analytics, and a former employee of the Radboud University Medical Center. The activities of Medip Analytics are unrelated to the present study.

Data Availability Statement

The data is available to the authors of the present manuscript and to the AO Spine Knowledge Forum Degenerative. The data is available from the corresponding author upon reasonable request.

Supplemental Material

Supplemental material for this article is available online.

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