



## Variation in selection criteria and approaches to surgery for Lumbar Spinal Stenosis among patients treated in Boston and Norway



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### ABSTRACT

**Objectives:** There are no uniform guidelines regarding when to operate or the ideal surgical intervention in Lumbar Spinal Stenosis (LSS). Understanding the presence of practice-based variation between different localities is critical. We sought to compare patient-reported pre-operative pain, disability, and health-related quality of life as indications for surgery between Boston and Norway, and the use of decompression alone vs. decompression and arthrodesis.

**Patients and methods:** This study included 3826 patients; 1886 from Boston and 1940 from Norway. Eligible patients were 50 years or older who received surgery for the diagnosis of LSS. Data were retrieved from a centralized clinical database in Boston and a national spine registry in Norway based on reported diagnosis and procedure. We evaluated patient-reported pre-operative pain, disability, and health-related quality of life as indications for surgery. A propensity score match was performed for the generation of comparable cohorts.

**Results:** There were no significant differences in demographics between the unadjusted cohorts. The rates of obesity (39.4% vs. 25.4%;  $p < 0.001$ ) and patients with ASA  $\geq 3$  (34.8% vs. 22.1%;  $p < 0.001$ ) were higher in the Boston cohort, while smokers were less frequent (9.6% vs. 19.3%;  $p < 0.001$ ). These differences were accounted for in the propensity score matching. Pre-operative ODI was slightly higher among patients in Boston (43.3 [95% CI 41.5, 45.1] vs. 40.7 [95% CI 40.0, 41.4];  $p = 0.005$ ), but did not reach the minimal clinically important difference. No statistical difference was encountered between pre-operative EQ-5D (0.339 [95% CI 0.304, 0.374] vs. 0.366 [95% CI 0.351, 0.381];  $p = 0.16$ ). Fifty-one percent of patients treated in Boston received a decompression and arthrodesis, as compared to only 13.9% of those in Norway ( $p < 0.001$ ). In the matched cohort, counting 294 in each group, the overall conclusions were the same.

**Conclusions:** The results demonstrate that indications for intervention were very similar in comparable patient populations with LSS in Boston and Norway. The use of supplemental arthrodesis was significantly greater in Boston. The etiology behind this finding is likely multifactorial but may represent medico-legal concerns in the US, or the phenomenon of provider inducement.

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## 1. Introduction

Lumbar Spinal Stenosis (LSS) is the most common indication for spine surgery in the elderly [1,2]. A number of studies have shown that surgery is more effective than conservative treatment in terms of restoring function and quality of life [3–6]. However, the indication for surgery is relative and there are no uniform guidelines regarding when to operate or the ideal surgical intervention

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**Table 1**  
Important aspects of the general populations of Boston and Norway.

	Boston <sup>a</sup>	Norway <sup>b</sup>
Demographics <sup>c</sup>		
Inhabitants (n)	4.7 mill	5.2 mill
>65 y of age (%)	15.1	16.2
Life expectancy (years)	80.5	81.6
Education		
Completed bachelor or higher (%)	43.0	31.4
Healthcare		
Physicians per 1000	3.1	3.7
Hospital beds per 1000 <sup>d</sup>	2.9	3.9
Spend on healthcare (US\$/person)	9278 <sup>e</sup>	5669 <sup>f</sup>

<sup>a</sup> Boston-Cambridge-Newton, MA-NH Metropolitan Statistical Area, census.gov, 2014.

<sup>b</sup> Statistics Norway, ssb.no, 2014.

<sup>c</sup> Boston: <https://local.niche.com/m/boston-metro-area/#demographics-section>.  
Norway: <https://www.ssb.no/en/utdanning/statistikker/utniv/aar/2015-06-18>.

<sup>d</sup> OECD. *Health at a Glance 2015*. ([http://www.keepeek.com/Digital-Asset-Management/oecd/social-issues-migration-health/health-at-a-glance-2015-health\\_glance-2015-en](http://www.keepeek.com/Digital-Asset-Management/oecd/social-issues-migration-health/health-at-a-glance-2015-health_glance-2015-en)).

<sup>e</sup> Health Care Expenditures per Capita by State of Residence (<http://kff.org/other/state-indicator/health-spending-per-capita/>).

<sup>f</sup> Department for Professional Employees, AFL-CIO (<http://dpeaflcio.org/programs-publications/issue-fact-sheets/the-u-s-health-care-system-an-international-perspective/>).

[7–9]. While a simple laminectomy procedure is the accepted intervention for lumbar stenosis in the absence of instability, a lack of consensus with respect to the optimal surgical approach means that a wide variety of procedures may be performed for patients with radiographically similar stenosis, ranging from simple decompression, to decompression and arthrodesis-based procedures [10–13]. These differences may be further magnified across national boundaries.

Understanding the presence of such practice-based variation, as well as underlying etiologies for its presence, are critical as surgical research from institutions in the United States and other countries (e.g. Norway, Sweden, Japan, China, etc.) are frequently used to inform the care of patients around the world [11,14,15]. While differences in surgical practice between these localities have been reported in the past [16], the source of these disparities is unclear. Different approaches to care may exist as a result of philosophic divergence in practice between surgeons operating in different national health systems. Differentiation in the socio-demographic and medical characteristics of the population (e.g. obesity, average patient education and patient expectations) may also be a cause, as well as concerns regarding the medical-legal environment, particularly in the United States. At the present time, no studies exist that empirically evaluate differences between surgeons in the U.S. and any other country in terms of approaches to surgical management for LSS in a similar group of patients.

In this context, we sought to perform a cohort study using patients with LSS from Boston and Norway to evaluate differences in surgical approaches between these countries. The use of patients from Boston (as a proxy for the US) and Norway (as a proxy for Scandinavia) is particularly attractive, as there are numerous demographic similarities between the source populations in both localities (Table 1). The primary aim of this investigation was to compare patient-reported pre-operative pain, disability, and health related quality of life as indications for surgical intervention between cohorts receiving surgical care in Boston and Norway. A secondary aim was to compare treatment strategy, specifically the use of decompression as opposed to decompression and arthrodesis.

## 2. Materials and methods

This was a retrospective cohort study evaluating data from two academic hospitals in Boston and five university hospitals in Norway. Eligible patients were those 50 years or older who received surgery for the diagnosis of LSS between January 1, 2011 and May 31, 2015 with decompression, with or without arthrodesis. Patients with a primary diagnosis of isthmic spondylolisthesis or disc herniation, prior lumbar spine surgery, and those treated with anterior arthrodesis alone or arthrodesis without decompression were excluded. Similarly, patients with stenosis secondary to tumor, fracture or infection were also removed from consideration.

Boston was selected as a proxy for the US given the demographic similarities between the general population of this American city and that of the country of Norway, particularly with respect to the percentage of patients aged 65 and older, life expectancy and number of physicians per capita (Table 1). Patients treated at hospitals in the Boston and Norwegian cohorts received care from fellowship trained spine surgeons at academic centers. The manner of training is not substantially different between the US and Norway in terms of length of training and the techniques employed. The healthcare system of Norway is publically funded with physician reimbursement consisting of a fixed payment based on working hours. Reimbursement in the United States occurs in a fee-for-service system with private insurance covering approximately 56% of the population. The Boston cohort was assembled from the cases of patients treated at Massachusetts General Hospital (MGH) and Brigham and Women's Hospital (BWH). These two medical centers serve the greater Boston area and parts of eastern Massachusetts. Data were retrieved through the Research Patient Data Registry (RPDR), a centralized clinical database that has previously been used in several clinical studies [17,18]. Eligible patients were identified through the use of International Classification of Diseases, ninth and tenth revision (ICD-9/10) codes indicating a diagnosis of LSS (724.02, 724.03, M48.02, M48.03), and from Current Procedural Terminology (CPT) and Norwegian procedural codes identifying the performance of surgical decompression with or without arthrodesis (codes available by request). Where ICD and CPT codes were ambiguous regarding the diagnosis or surgical procedure, a direct search was performed of the operative report to assess eligibility for inclusion. The Norwegian cohort consisted of data from the Norwegian Registry for Spine Surgery (NORspine). The registry contains data from 36 of 40 centers performing lumbar spine surgery in Norway, and is estimated to capture 65% of all patients who have had lumbar spine surgery in Norway [13]. We accessed data from patients operated at university hospitals in Oslo, Stavanger, Bergen, Trondheim and Tromsø. All data was abstracted from the Boston and Norwegian registries by a single author (GL).

Eligible patients from Boston and Norway had their medical records abstracted and demographic details, smoking status, body mass index (BMI) and medical co-morbidities (categorized using the American Society of Anesthesiologists [ASA] classification) were recorded. These factors were selected because they are known to affect clinical outcomes [19–22]. Consequently, they are considered to play important roles in determining patient candidacy for surgery. The type of surgery was stratified as decompression alone or decompression and arthrodesis, including posterior interbody arthrodesis techniques. Pre-operative patient-reported data, including Oswestry Disability Index (ODI) and European Quality of Life 5-Dimension three levels (EQ-5D) scores, were also captured for patients in both cohorts. The ODI and EQ-5D are validated measures of pain, disability and quality of life and are extensively used in other research regarding patients with LSS [23,24]. The ODI is available in English and Norwegian and has been tested for psychometric properties in both languages [25,26]. The US English and Norwegian versions of the ODI are slightly different with two

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