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Validation of the Benefits of Ambulation Within 8 Hours of Elective Cervical and Lumbar Surgery: A Michigan Spine Surgery Improvement Collaborative Study

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BACKGROUND: Early ambulation is considered a key element to Enhanced Recovery After Surgery protocol after spine surgery.

OBJECTIVE: To investigate whether ambulation less than 8 hours after elective spine surgery is associated with improved outcome.

METHODS: The Michigan Spine Surgery Improvement Collaborative database was queried to track all elective cervical and lumbar spine surgery between July 2018 and April 2021. In total, 7647 cervical and 17 616 lumbar cases were divided into 3 cohorts based on time to ambulate after surgery: (1) <8 hours, (2) 8 to 24 hours, and (3) >24 hours.

RESULTS: For cervical cases, patients who ambulated 8 to 24 hours (adjusted odds ratio [aOR] 1.38; 95% CI 1.11-1.70; $P = .003$) and >24 hours (aOR 2.20; 95% CI 1.20-4.03; $P = .011$) after surgery had higher complication rate than those who ambulated within 8 hours of surgery. Similar findings were noted for lumbar cases with patients who ambulated 8 to 24 hours (aOR 1.31; 95% CI 1.12-1.54; $P < .001$) and >24 hours (aOR 1.96; 95% CI 1.50-2.56; $P < .001$) after surgery having significantly higher complication rate than those ambulated <8 hours after surgery. Analysis of secondary outcomes for cervical cases demonstrated that <8-hour ambulation was associated with home discharge, shorter hospital stay, lower 90-day readmission, and lower urinary retention rate. For lumbar cases, <8-hour ambulation was associated with shorter hospital stay, satisfaction with surgery, lower 30-day readmission, home discharge, and lower urinary retention rate.

CONCLUSION: Ambulation within 8 hours after surgery is associated with significant improved outcome after elective cervical and lumbar spine surgery.

KEY WORDS: Ambulation, Cervical, Elective spine surgery, Lumbar, Spine, Surgery

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The traditional practice of bed rest during the postoperative period has largely been replaced with early mobilization. Its benefit has been observed as early as 1949, and early ambulation is considered a key element to the enhanced recovery after surgery (ERAS) protocol after various surgical procedures.[1-4] ERAS incorporates an evidence-based, multidisciplinary approach and interventions through patient assessment, education, and high-quality perioperative management to expedite postoperative recovery. Application of ERAS in spine surgery has been increasingly advocated to enhance postoperative recovery and reduce complications; early mobilization is one of the key elements in ERAS protocol.[5-12] Early mobilization after spinal surgery is generally encouraged, and its role has been highlighted by multiple studies that demonstrate reduced perioperative complications (ie, urinary tract infection, venous thromboembolism, and respiratory decompensation), readmission, and length of hospital stay.[13-18] However, patients undergoing spine surgery are reported to experience fear of reinjury through exercise and movements

ABBREVIATIONS: BCBSM, Blue Cross Blue Shield of Michigan; **CAD,** coronary artery disease; **ERAS,** Enhanced Recovery After Surgery; **MCID,** minimum clinically important difference; **MSSIC,** Michigan Spine Surgery Improvement Collaborative; **PROMIS-PF,** Patient-Reported Outcomes Measurement Information System Physical Function 4-item Short Form; **SSI,** surgical site infection.

(kinesiophobia), which is linked to fear-avoidance behavior and diminished postoperative activity.[19-21] These patients would benefit significantly from a safe, early mobilization protocol to accelerate functional rehabilitation after surgery.

Zakaria et al[22] recently published a study that demonstrated that same-day ambulation, defined as less than 24 hours after surgery, is associated with improved outcomes after elective lumbar spine surgery. However, many institutions have adopted ERAS paradigms that encourage ambulation at 6 or 8 hours for elective spinal operations, and whether there is an additional benefit to ambulating patients within a shorter time frame after surgery has yet to be evaluated in a multicenter setting after elective spine surgery.[12,23-26] To date, there has been little evidence to support this as a universal practice after elective spine surgery.

The goal of our study was to evaluate whether there were additional benefits to ambulating patients within 8 hours of surgery as opposed to within 24 hours of surgery. We hypothesized that ambulation less than 8 hours after surgery would be associated with better outcome after surgery.

METHODS

Study Design, Settings, and Participants

The details of Michigan Spine Surgery Improvement Collaborative (MSSIC) have been described.[27] In brief, MSSIC is a statewide quality improvement initiative involving 185 neurosurgeons and orthopedic surgeons in 29 hospitals in various settings (ie, academic and private practice). MSSIC is funded by Blue Cross Blue Shield of Michigan (BCBSM). A minimum of 200 annual spine surgeries with active participation from both neurosurgeons and orthopedic surgeons is required to be a participating hospital. The scope of MSSIC includes the breadth of degenerative pathology for cervical and lumbar spine. Cases outside the scope of MSSIC include surgery for nondegenerative and complex pathology (ie, spinal cord injury, traumatic fracture, pre-existing infection, grade 3 or 4 spondylolisthesis, scoliosis greater than 25°, congenital anomalies, or >4 level fusion).

Beginning in July 2018, the exact timing of ambulation after surgery was recorded to allow measurement within the hour with the goal of introducing a less than 8-hour ambulation threshold as a potential performance measure. Standardized ambulation protocol was developed across the participating hospitals as a collaborative quality improvement initiative to minimize institutional variations.

The MSSIC registry was queried to identify patients who had undergone elective cervical or lumbar spine surgery for degenerative disease between July 2018 and April 2021. Each participating center is capped to contribute 700 cases per year to MSSIC database to avoid overrepresentation by a few higher-volume centers.

For the purpose of our analysis, we excluded cases where early ambulation would be contraindicated such as with intraoperative durotomy or suspected cerebrospinal fluid leak. Cases with missing variables were also excluded. A total of 25 236 patients were included in this study. There were 7647 cervical cases and 17 616 lumbar cases (Figures 1 and 2).

Variables, Data Sources, and Measurements

We tracked the number of hours between the end of surgery and time of initial ambulation for all patients. Cervical and lumbar cases were analyzed separately, and each group was divided into 3 cohorts based on ambulation timing (ie, <8 hours, 8-24 hours, and >24 hours). Ambulation was recorded when the patient was up and walking any distance (either assisted or unassisted). Any transfer to bed, chair, or bedside commode did not count as ambulation. Ambulation protocol was driven by input from both bedside nurses and physical therapists, and the timing was recorded in the patient's medical chart. Patients were also educated on the importance of mobilization after surgery as tolerated and avoiding bed rest before surgery to facilitate early postoperative ambulation.

We analyzed patient demographic profile, medical history, functional status, and intraoperative details. Demographic variables included age, sex, race, and private insurance. We captured patients' medical history including diabetes, deep venous thrombosis, coronary artery disease, depression, anxiety, osteoporosis, American Society of Anesthesia class >2, smoking status, chronic opioid use >6 months (defined by daily use over 6 months), and previous spine surgery. Functional status variables included independent ambulatory status before surgery and baseline Patient-Reported Outcomes Measurement Information System Physical Function 4-item Short Form (PROMIS-PF) score. In addition, we included relevant operative variables such as area of spine operated (lumbar or cervical), fusion status, number of levels operated, operative duration, and surgery invasiveness index.[28]

The primary outcome was any complication after lumbar spine surgery. This included mortality, wound dehiscence, surgical site infection, and readmission within 30 and 90 days of index operation, ileus, urinary retention, stroke, claudication, myelopathy, myocardial infarction, pneumonia, pulmonary embolism, urinary tract infection, deep venous thrombosis, and unplanned reoperation during admission or after discharge. Secondary outcomes included length of stay, achieving a "Minimal Clinically Important Difference" improvement in the PROMIS-PF, patient satisfaction at 90 days after surgery, 30-day readmission, 90-day readmission, home discharge, surgical site infection, and urinary retention.

The North American Spine Society patient satisfaction index was used to assess patient satisfaction at 90 days after surgery.[29] Scores of 1 ("the treatment met my expectations") or 2 ("I did not improve as much as I hoped, but I would undergo the same treatment for the same outcome") were considered as "satisfied." Scores of 3 ("I did not improve as much as I had hoped," and "I would not undergo the same treatment for the same outcome") and 4 ("I am the same or worse than before treatment") were grouped as "unsatisfied." In addition, patients who had an increase of ≥4.5 points in PROMIS-PF were considered to have achieved Minimal Clinically Important Difference.[30]

Statistical Analysis

The Student one-way analysis of variance test or Kruskal–Wallis test for continuous variables and the Pearson χ^2 test or Fisher exact test for categorical variables were used in our univariate analysis. Then, multivariate generalized estimating equation models with a logit link were used to investigate the association between ambulation <8 hours with primary and all secondary outcomes listed in the Methods section while accounting for potential differences. Our regression model adjusted the baseline difference in all variables listed in Tables 1 and 2 including patient demographics, medical history, functional status, and operative details (ie, fusion status, number of levels, and surgery invasiveness index) while accounting for hospital-to-hospital variations.

All analyses were performed using SAS 9.4 (SAS Institute, Inc.).

Ethical Consideration

Approval for this study was obtained from our Institutional Review Board (No. 10581). Patient consent is not required for the MSSIC

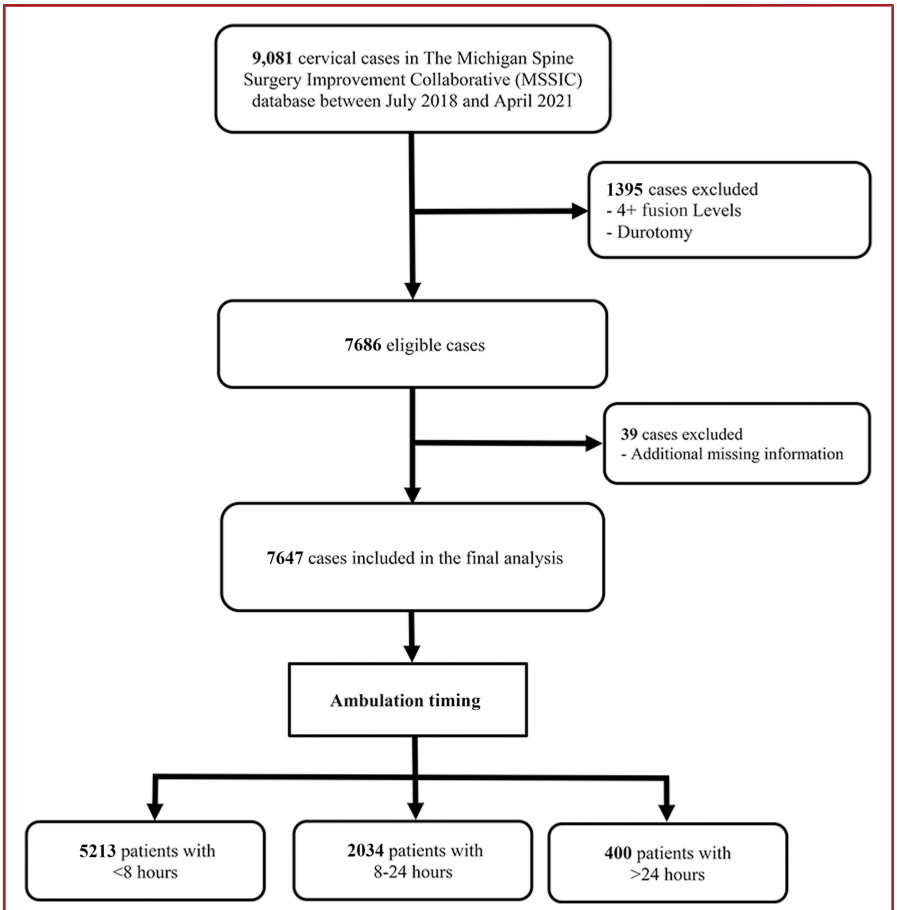

FIGURE 1. *Patient attrition diagram for cervical cases.*

registry because the project has been deemed exempt as a quality improvement initiative.

Data Availability Statement

Data are available on request from the corresponding author.

RESULTS

Univariate Analysis

A total of 25 263 patients were included in this study. There were 7647 cervical cases and 17 616 lumbar cases. Patients were categorized into 3 groups (<8 hours, 8-24 hours, and >24 hours) based on their ambulation timing after surgery (Table 1). There were some baseline differences noted among the 3 cohorts for both cervical and lumbar cases, as summarized in Table 2. It was also noted that patients who ambulated >24 hours after surgery had undergone generally more invasive surgeries (Table 3). Patients in the <8-hour ambulation cohort had the best outcome (Table 4).

Multivariate Analysis

With the significant baseline differences between cohorts, our multivariate regression analysis attempted to adjust for these covariates to evaluate associations between time to ambulation and outcome. Our regression analysis demonstrated significant differences in outcomes among the 3 groups with worse outcomes associated with increased time to first ambulation (Table 5).

Ambulation within 8 hours after surgery was associated with significantly improved outcome when compared with the >24-hour ambulation cohort. For cervical cases, patients who ambulated 8 to 24 hours (adjusted odds ratio [aOR] 1.38; 95% CI 1.11-1.70; $P = .003$) and >24 hours (aOR 2.20; 95% CI 1.20-4.03; $P = .011$) after surgery had higher complication rates than those who ambulated within 8 hours of surgery. Similar findings were noted for lumbar cases with patients who ambulated 8 to 24 hours (aOR 1.31; 95% CI 1.12-1.54; $P < .001$) and >24 hours (aOR 1.96; 95% CI 1.50-2.56; $P < .001$) after surgery having significantly higher complication rates than those ambulated <8 hours after surgery. Analysis of secondary outcomes for cervical cases demonstrated that <8-hour ambulation was associated with home

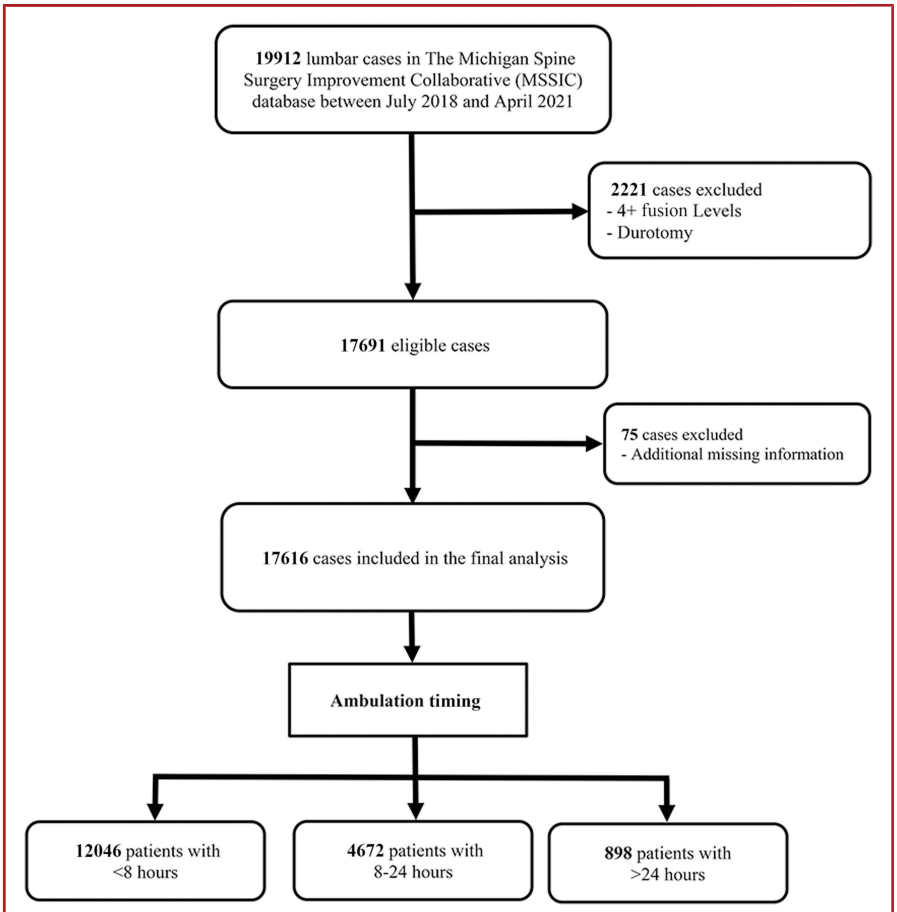

FIGURE 2. *Patient attrition diagram for lumbar cases.*

discharge, shorter hospital stay, lower 90-day readmission, and lower urinary retention rate. For lumbar cases, <8-hour ambulation was associated with shorter hospital stay, satisfaction with surgery, lower 30-day readmission, home discharge, and lower urinary retention rate (Table 5).

DISCUSSION

Key Results

This study analyzed 7647 elective cervical and 17 616 elective lumbar spine cases. Each group was further divided into 3 cohorts based on the timing of ambulation after surgery (<8 hours, 8-24 hours, and >24 hours). We observed that patients in the <8-hour ambulation cohort had significantly better primary and secondary outcomes, and there was a clear trend of increasing complications across the 3 cohorts as time to ambulation increased.

In our multivariate regression analysis, patients who ambulated <8 hours after surgery had significantly superior outcomes even when compared with patients who ambulated 8 to 24 hours after surgery. Ambulation within 8 hours of surgery was also associated with improved length of stay, home discharge, readmission, functional performance, patient satisfaction, and urinary retention. Our results support earlier postoperative mobilization (<8 hours) compared with the previous standard (24 hours).

Interpretation

Early postoperative mobilization has been incorporated into ERAS protocols for various surgical procedures because it has been shown to improve outcomes, and spine surgery is no exception.[1-4,12,13,17,18,23-26] However, there are significant variations in methodology, definition, and patient selection in current spine ERAS protocols without sufficient supporting evidence. To illustrate, Bradywood et al analyzed the effects of mobilization immediately after "noncomplex" lumbar fusion, whereas another article recommended mobilization within 8 hours of multilevel thoracolumbar fusion surgeries.[12,31] Rupich et al[24] also published a study suggesting that implementing a nurse-led protocol encouraging mobilization within 6 hours of surgery led to significant

TABLE 1. Patient Demographics, Medical History, and Functional Status by Postoperative Ambulation Timing

	Cervical				Lumbar			
Variable	<8 h (N = 5213)	8-24 h (N = 2034)	>24 h (N = 400)	*P*-value	<8 h (N = 12 046)	8-24 h (N = 4672)	>24 h (N = 898)	*P*-value
Age (year ± SD)[a,b]	56.1 ± 11.7	57.9 ± 11.8	60.7 ± 12.4	<.001	58.9 ± 14.3	61.6 ± 13.2	62.4 ± 13.1	<.001
Male sex[a,b]	2547 (49%)	1048 (52%)	228 (57%)	.002	6348 (53%)	2303 (49%)	425 (47%)	<.001
Race/ethnicity[a,b]				<.001				.002
White	2798 (88%)	879 (83%)	117 (82%)		6492 (88%)	2262 (85%)	384 (85%)	
Black	258 (8%)	129 (12%)	20 (14%)		541 (7%)	257 (10%)	44 (10%)	
Others	138 (4%)	57 (5%)	6 (4%)		360 (5%)	129 (5%)	22 (5%)	
Private insurance[a,b]	2938 (56%)	1028 (51%)	162 (40%)	<.001	6092 (51%)	1984 (42%)	339 (38%)	<.001
Diabetes[a,b]	1083 (21%)	499 (25%)	126 (32%)	<.001	2724 (23%)	1308 (28%)	271 (30%)	<.001
DVT[a,b]	301 (6%)	148 (7%)	43 (11%)	<.001	692 (6%)	318 (7%)	80 (9%)	<.001
CAD[a,b]	581 (11%)	273 (13%)	71 (18%)	<.001	1666 (14%)	784 (17%)	171 (19%)	<.001
Depression[b]	2061 (40%)	764 (38%)	155 (39%)	.300	3981 (33%)	1695 (36%)	351 (39%)	<.001
Anxiety	2031 (39%)	750 (37%)	141 (35%)	.118	3837 (32%)	1543 (33%)	306 (34%)	.172
Osteoporosis[b]	479 (9%)	216 (11%)	42 (10%)	.150	1366 (11%)	684 (15%)	143 (16%)	<.001
ASA class >2[a,b]	2700 (52%)	1239 (61%)	304 (76%)	<.001	6125 (51%)	2789 (60%)	600 (67%)	<.001
Current smoker[b]	663 (21%)	214 (20%)	27 (19%)	.890	1241 (17%)	349 (13%)	67 (15%)	<.001
Preoperative daily opioid use >6 mo[a,b]	602 (19%)	220 (21%)	40 (30%)	.006	1375 (20%)	620 (24%)	111 (26%)	<.001
Previous spine surgery[b]	2043 (42%)	815 (44%)	158 (44%)	.482	5243 (47%)	2317 (52%)	462 (54%)	<.001

ASA, American Society of Anesthesia; CAD, coronary artery disease; DVT, deep venous thrombosis.
[a]Denotes statistical significance ($P < .05$) for cervical cases.
[b]For lumbar cases.

reduction in length of stay. In addition, other protocols have recommended mobilization within the first few hours after simple decompression.[23,25,26]

Zakaria et al[22] reported on the benefit of ambulation on postoperative day 0 or within 12 hours of surgery end time after elective lumbar spine surgery using a large-scale, multi-institutional database. Given those findings, as well as supporting literature in other surgical disciplines, ambulation on postoperative day 0 became a performance measure for quality improvement at all MSSIC hospitals in 2019. Given the heterogeneity of practice environments within MSSIC, this has required considerable buy-in from surgeons and hospital administrations as well as requiring a multidisciplinary approach to implementation. An additional consideration is the unique culture of each hospital and the individual dynamics between postanesthesia care units, nursing staff in the general practice units, and physical therapists.

As MSSIC plans to recommend the implementation of a statewide ERAS protocol, we wanted to further examine whether a

TABLE 2. Operative Variables by Postoperative Ambulation Timing

	Cervical				Lumbar			
Variable	<8 h (N = 5213)	8-24 h (N = 2034)	>24 h (N = 400)	*P*-value	<8 h (N = 12 046)	8-24 h (N = 4672)	>24 h (N = 898)	*P*-value
Fusion[b]	4411 (85%)	1759 (86%)	341 (85%)	.134	5676 (47%)	3174 (68%)	668 (74%)	<.001
No. of levels[a,b]				<.001				<.001
1	2071 (40%)	649 (32%)	99 (25%)		6210 (53%)	2201 (48%)	354 (40%)	
2	2048 (40%)	806 (40%)	149 (38%)		3532 (30%)	1454 (32%)	307 (35%)	
3	1061 (20%)	558 (28%)	141 (36%)		2001 (17%)	959 (21%)	223 (25%)	
Duration of surgery, h (95% CI)[a,b]	1.5 (1.1, 2.1)	1.7 (1.2, 2.4)	1.9 (1.3, 2.9)	<.001	1.6 (1, 2.4)	2.3 (1.6, 3.3)	2.6 (1.7, 3.7)	<.001
Surgery Invasiveness Index (95% CI)[a,b]	8 (5, 10)	8 (5, 10)	8 (5, 11)	<.001	4 (2, 7)	6 (3, 9)	7 (4, 10)	<.001

[a]Denotes statistical significance ($P < .05$) for cervical cases.
[b]For lumbar cases.

TABLE 3. Summary of Ambulation Timing After Surgery

Time to ambulation (h)	Cervical N (%)	Lumbar N (%)
<8	5213 (68%)	12 046 (68%)
8-24	2034 (26%)	4672 (26%)
>24	400 (5%)	898 (5%)
Total	7647	17 616

more stringent ambulation goal within 8 hours of surgery could lead to additional quality improvement. Lowering the threshold to 8 hours from the end of surgery represents additional logistical challenges for implementation, especially considering that cases may end late in the afternoon or evening. One can imagine the challenges in ambulating late-arrival patients during a midnight shift when ancillary staffing is typically low. Therefore, we sought to assess whether postoperative ambulation within 8 hours of surgery is associated with even more benefit compared with patients ambulated between 8 and 24 hours. In agreement with our previous findings for lumbar spine surgery alone, we observed that patients ambulated after 24 hours had poorer outcome than the other 2 cohorts.[22]

Our study shows a significant trend of improved outcome with <8-hour ambulation even when compared with ambulation 8 to 24 hours after surgery. For cervical cases, patients who ambulated at 8 to 24 hours and >24 hours after surgery were 1.4 and 2.2 times, respectively, more likely to experience any complication. For lumbar cases, patients who ambulated at 8 to 24 hours and >24 hours after surgery were 1.3 and 2 times, respectively, more likely to experience any complication. In addition, <8-hour ambulation was associated with significantly improved secondary outcomes such as length of stay, home discharge, functional performance, satisfaction with surgery, readmission, and urinary retention which are key quality measures after elective spine surgery.

This is the first multicenter study that demonstrates the potential benefits of ambulation within 8 hours of elective cervical or lumbar spine surgery. For elective spine surgery, ambulation <8 hours within a supervised, safe environment carries minimal risk, and we recommend its inclusion in ERAS protocols.

Limitations and Generalizability

This study has limitations that are inherent in the study design and database. Our cohort analyses are subject to unknown confounders, and unrecorded variables could be adjusted in our multivariate analysis. The biggest limitation of this study is its observational and retrospective nature. We are unable to control for baseline patient factors that might influence how early a patient ambulates after surgery. Certainly, patients with less functional derangement or lower comorbidity burden could be expected to be able to ambulate earlier after surgery, if encouraged to do so. In our multivariate model, we were able to account for factors available to us, in particular baseline PROMIS-PF. In addition, despite being a performance measure, there is still a great deal of variability within institutions and their rates of early ambulation after surgery, but we were able to account for that with our model. However, any other hidden bias that might influence patient fitness is unaccounted for in our analysis and should be considered when interpreting the data. In addition, minimally invasive approaches were not considered in our analysis, and satisfaction at 90 days after surgery may have significant procedural bias (ie, microdiskectomy vs multilevel

TABLE 4. Univariate Analysis of Outcomes by Postoperative Ambulation Timing

	Cervical				Lumbar			
Variable	<8 h (N = 5213)	8-24 h (N = 2034)	>24 h (N = 400)	*P*-value	<8 h (N = 12 046)	8-24 h (N = 4672)	>24 h (N = 898)	*P*-value
Any complication[a,b]	525 (10%)	322 (16%)	102 (26%)	<.001	1459 (12%)	837 (18%)	235 (26%)	<.001
Length of stay (d)[a,b]				<.001				<.001
0-1	3588 (69%)	960 (47%)	61 (15%)		5739 (48%)	893 (19%)	47 (5%)	
2-3	1298 (25%)	733 (36%)	139 (35%)		4671 (39%)	2379 (51%)	342 (38%)	
4+	327 (6%)	341 (17%)	200 (50%)		1636 (14%)	1400 (30%)	590 (57%)	
PROMIS MCID at 90 d[b]	860 (53%)	275 (50%)	29 (43%)	.096	2481 (61%)	941 (58%)	128 (51%)	.002
Satisfied with surgery at 90 d[a,b]	2177 (87%)	805 (82%)	122 (76%)	<.001	5452 (61%)	2098 (84%)	352 (79%)	.003
Readmitted within 30 d[a,b]	119 (2%)	79 (4%)	30 (8%)	<.001	405 (3%)	215 (5%)	65 (7%)	<.001
Readmitted within 90 d[a,b]	219 (4%)	125 (6%)	35 (9%)	<.001	667 (6%)	334 (7%)	94 (10%)	<.001
Discharge home[a,b]	5052 (97%)	1852 (91%)	276 (69%)	<.001	11449 (95%)	4101 (88%)	640 (71%)	<.001
SSI[b]	40 (1%)	12 (1%)	3 (1%)	.762	177 (1%)	122 (3%)	37 (4%)	<.001
Urinary retention[b]	479 (9%)	216 (11%)	42 (10%)	.150	351 (3%)	244 (5%)	79 (9%)	<.001

MCID, minimum clinically important difference; PROMIS, Patient-Reported Outcomes Measurement Information System; SSI, surgical site infection.
[a]Denotes statistical significance ($P < .05$) for cervical cases.
[b]For lumbar cases.

TABLE 5. Multivariate Analysis of Outcomes by Postoperative Ambulation Timing

	Cervical			Lumbar		
Variable	<8 h (reference)	8-24 h aOR (95% CI; *P*-value)	>24 h aOR (95% CI; *P*-value)	<8 h (reference)	8-24 h aOR (95% CI; *P*-value)	>24 h aOR (95% CI; *P*-value)
Any complication[a,b]		1.38 (1.11-1.70; 0.003)	2.20 (1.20-4.03; 0.011)		1.31 (1.12-1.54; <0.001)	1.96 (1.50-2.56; <0.001)
Length of stay (d)[a,b]		1.32 (1.22-1.43; <0.001)	2.20 (1.75-2.77; <0.001)		1.21 (1.16-1.26; <0.001)	1.53 (1.36-1.71; <0.001)
PROMIS MCID at 90 d		0.95 (0.86-1.04; 0.236)	0.80 (0.58-1.10; 0.168)		1.00 (0.94-1.06; 0.955)	0.90 (0.81-1.00; 0.056)
Satisfied with surgery at 90 d[b]		0.96 (0.91-1.01; 0.090)	0.89 (0.76-1.06; 0.200)		1.00 (0.99-1.02; 0.694)	0.89 (0.83-0.95; 0.001)
Readmitted within 30 d[b]		1.35 (0.83-2.19; 0.222)	2.64 (1.35-5.17; 0.004)		1.10 (0.83-1.46; 0.515)	1.68 (1.04-2.72; 0.034)
Readmitted within 90 d[a]		1.06 (0.072-1.55; 0.783)	1.69 (0.86-3.33; 0.131)		1.12 (0.83-1.50; 0.461)	1.45 (0.93-2.25; 0.101)
Discharge home[a,b]		0.38 (0.25-0.59; <0.001)	0.12 (0.06-0.23; <0.001)		0.60 (0.47-0.76; <0.001)	0.24 (0.16-0.36; <0.001)
Urinary retention[a,b]		1.64 (0.99-2.72; 0.054)	4.20 (1.30-13.52; 0.016)		1.31 (1.01-1.69; 0.040)	2.52 (1.72-3.70; <0.001)

aOR, adjusted odds ratio; MCID, minimum clinically important difference; PROMIS, Patient-Reported Outcomes Measurement Information System.
[a]Denotes statistical significance ($P < .05$) for cervical cases.
[b]For lumbar cases.

lumbar fusion) despite the adjustment from regression analysis. Finally, although the authors considered stratifying patients by types of surgery to provide procedure-specific results, such analysis would have significantly compromised our statistical power because of low sample size. Instead, we provided a well-powered analysis where the finding can be globally applied across all elective cervical and lumbar spine surgeries.

Overall, we believe our findings to be widely generalizable. MSSIC is a statewide registry that includes a wide range of hospitals in multiple settings (ie, academic institutions to smaller private hospitals) for both neurosurgeons and orthopedic surgeons. Despite this, there can be patient demographics or hospital settings unique to the state of Michigan that may not be applied universally.

CONCLUSION

Our analyses strongly suggest that ambulation <8 hours after elective cervical and lumbar spine surgery is associated with improved outcome, patient satisfaction, and shorter hospital stay. Implementing the goal of ambulation within 8 hours of surgery into a general spine ERAS protocol seems appropriate. Further studies are needed to investigate how protocol implementation changes postoperative outcomes.

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Disclosures

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