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Predictive Modelling of Surgical Outcomes for Lumbar Degenerative Disorders and Complex Spinal Deformity: Multidisciplinary conference versus computer modeling

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# Background

- Complex degenerative and adult deformity spine surgery
  - Significant variability in
    - Surgical approaches
    - Expected clinical outcomes
    - Expected rates of complication
- Predictive modeling
  - Empower informed choice for patients
  - Guides evidence-based treatment recommendations
- With a better understanding of expected outcomes, complications, and the appropriateness of a given surgical procedure in a particular patient can be determined.

# Purpose

- Purpose
  - Identify predictor variables for:
    - Clinical improvement
    - Readmission
    - Revision surgery
    - Appropriateness of surgery
  - Develop a prospective predictive model based upon patient specific and diagnosis specific variables
  - Compare with this model and established models with accuracy of a multidisciplinary conference

# Project Components

- Retrospective chart review based model
- Retrospective large data set model
- Multidisciplinary case based model

# Retrospective Data Analysis

- Retrospectively reviewed 100 consecutive patient charts
  - Patients >60 years old
  - >3 level surgery
  - Diagnosis: Adult spinal deformity
- Pre-operative variables of interest
  - Age
  - Gender
  - ASA class
  - Mets Score
  - BMI
  - Smoking status
  - Narcotic usage
  - Staged surgery
  - Number of levels
  - Depression
  - Circumferential fusion
  - Fracture hx
  - DEXA
  - Diabetes status
  - Nutrition
  - Infection hx
  - Renal disease
  - Liver disease
  - DVT/PE hx
  - Cardiac disease
  - Social Support
  - Frailty

# Retrospective Model

- Outcomes
  - Length of stay
  - 30 day and 90 day
    - Readmission
    - Re-operation

## Length of Stay Multivariate Analysis

LOS Linear Multivariate Regression				
Variable	LOS Estimate (Days)	Lower 95% CI	Upper 95% CI	P-Value
Age: 74-89	5.839	0.051	11.627	0.048
Poor Wound Healing	14.996	6.283	23.709	0.0010
Liver Disease	16.149	0.047	32.251	0.049
Respiratory Disease	5.492	0.499	10.484	0.031

## Multivariate Analysis Results 30 and 90 Day Readmission/Reoperation

Readmission and Reoperation Multivariate Regression Results				
	Odds Ratio	Lower 95% CI	Upper 95% CI	P-value
<b>30 - Day Readmission</b>				
Infection History	6.715	1.439	31	0.015
<b>30 - Day Reoperation</b>				
Renal Disease	35.554	1.647	768	0.023
Narcotic_MME	27.717	1.378	557	0.030
<b>90 - Day Readmission</b>				
Renal Disease	13.923	3.1	63	0.0006
Rheumatic disorder	11.419	2.4	54	0.0022
<b>90 - Day Reoperation</b>				
Renal Disease	12.0	2.5	58.7	0.0021
Rheumatic disorder	9.2	1.745	48.0	0.0088



# Retrospective Model

Reasons for Readmission	
	N
<b>30 - Day Readmission</b>	
Wound Dehiscence	2
Wound Infection	3
Radiculopathy /Neuro Deficit	2
Colonic Perforation	1
Lymphocele	1
Pelvic Hematoma	1
<b>90 - Day Readmission</b>	
Wound Infection	2
Wound Dehiscence	6
Hardware Complication	1
Radiculopathy /Neuro Deficit	1
Pneumonia	1
Delayed Fusion	1
Pelvic Hematoma	1

Reasons for Re-Operation	
	N
<b>30 - Day Reoperation</b>	
Wound Revision Closure	2
Wound Irrigation and debridement	2
Revision Decompression	2
Pelvic Hematoma Evacuation	1
<b>90 - Day Reoperation</b>	
Wound Revision Closure	5
Wound Irrigation and Debridement	2
Revision Fusion	1
Pelvic Hematoma Evacuation	1
Hardware Revision	1
Revision Decompression	1

# Retrospective Model

- **UPDATE**
  - Presented at State of Spine Surgery Think Tank
  - Pending: Submission to Spine Deformity

# Large Data Set Analysis

- Purpose

- To identify the risk factors associated with readmission and quantify the increase in risk in patients undergoing short lumbar fusions
- Create a scale that can accurately predict the risk of readmission
- To validate this scale in a separate cohort of patients.

# Large Data Set Analysis

- Methods

- Case control study of an administrative claims database.
- Utilized the State Inpatient Database (SID)
- Part of the Healthcare Cost and Utilization Project under the Agency for Healthcare Research and Quality.
- Largest all-payer database comprising all hospital admissions.
- Each patient is assigned a unique identifying number which can then be tracked across different time points and hospitals.

# Large Data Set Analysis

- Inclusion/Exclusion Criteria
  - All patients age > 18 undergoing 1-2 level lumbar spine fusion were included
  - Patients were identified using International Classification of Diseases, Ninth Revision (ICD-9) procedure codes 81.62 AND 81.07, 81.08, 81.37, or 81.38.
  - Excluded if they had ICD-9 codes for any of the following diagnoses: bone cancer/metastases, infection, and trauma.

# Large Data Set Analysis

- Results:
- 92,262 patients in the derivation cohort
- 90,257 in the validation cohort.
- The thirty-day readmission rates: 10.9% and 11.1%
- Average RAPSIF score in the derivation cohort was 11.6 (std dev 6.8)

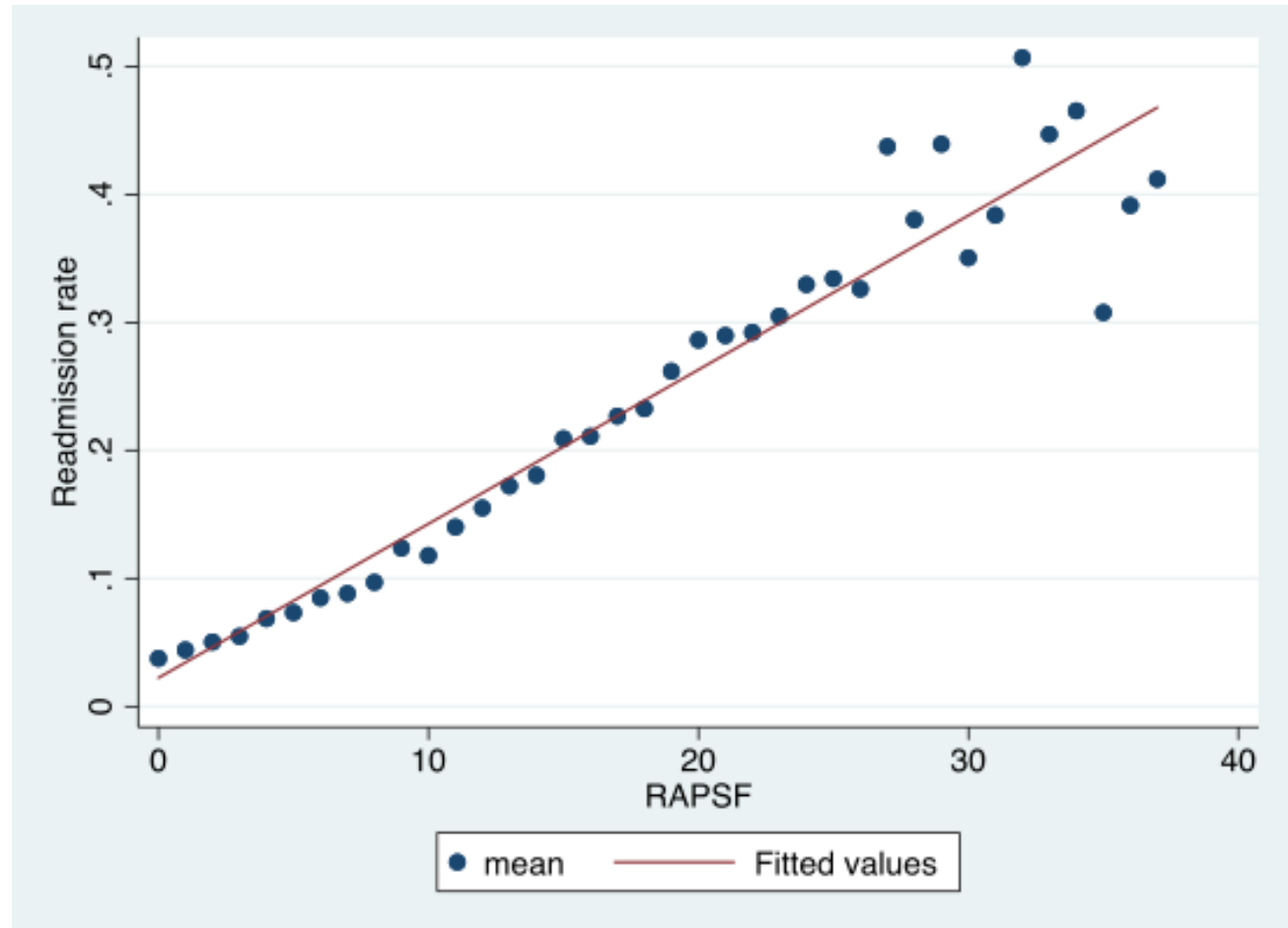
# Large Data Set Analysis

- Readmission after posterior spine fusion (RAPSf score)

Variable	Score
Age	
<40	0
40-49	0
50-59	2
60-69	4
70-79	7
>80	13
Gender	
Male	0
Female	1
Race	
White	0
Hispanic	2
Black	4
Other	0
Insurance	
Commercial	0
Medicare	3
Medicaid	6
Other	1
Levels	
1-2 Levels	0
3-7 levels	4
>7 levels	15
Anterior Approach	3
Cerebrovascular disease	1
Chronic Pulmonary Disease	1
Congestive Heart Failure	2
Diabetes without Chronic Comp	1
Diabetes with Chronic Comp	2
Hemiplegia/Paraplegia	9
Mild Liver Disease	1
Renal Disease	1
Rheumatic disease	1
Drug abuse	3
Electrolyte disorder	3
Osteoporosis	1
Depression	1
Malnutrition	2
Obese	2
Morbidly obese	4
Total Score	100

# Large Data Set Analysis

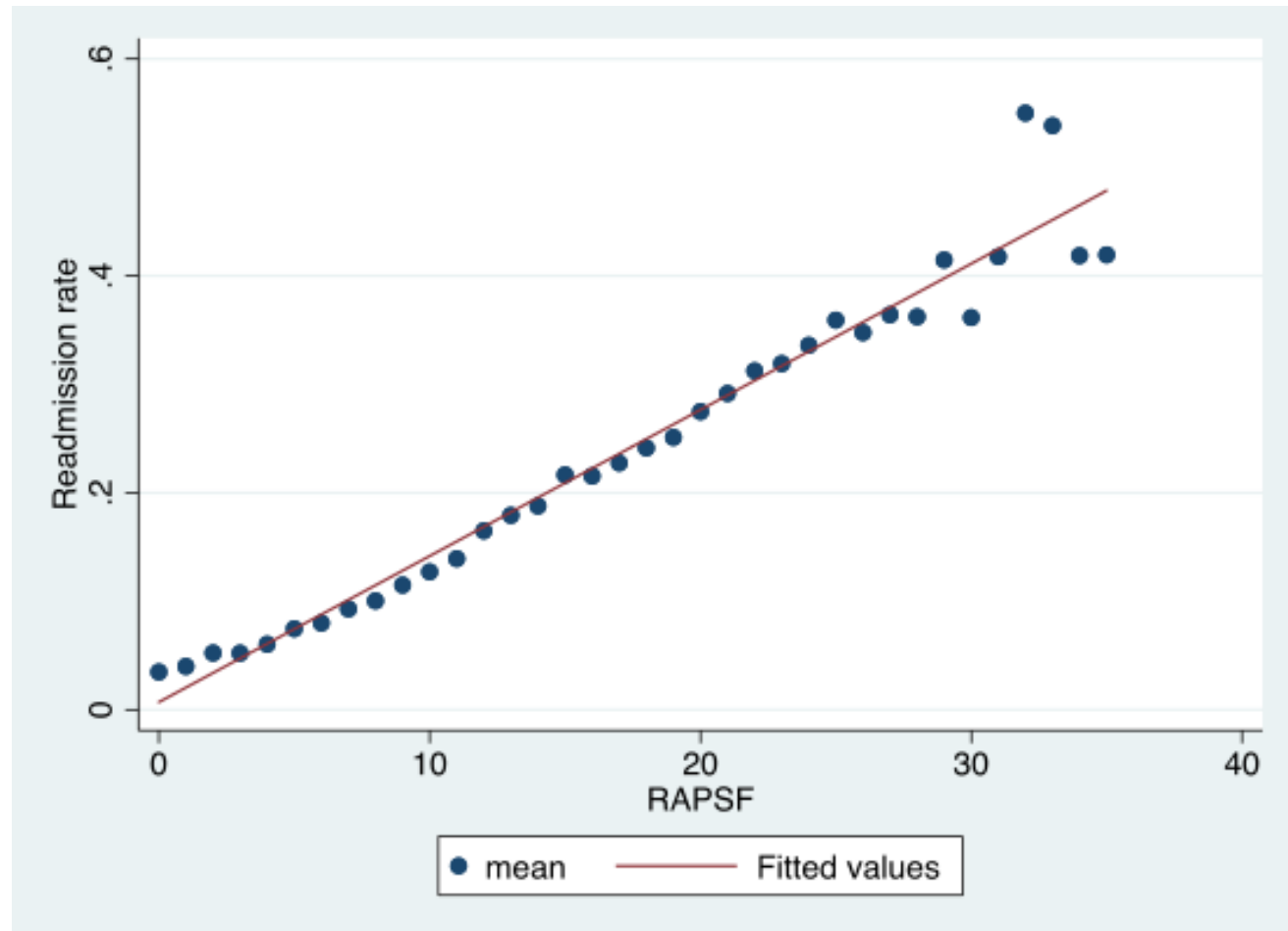
- Derivation cohort
- Coefficient: 0.012
- $R^2 = 0.92$





# Large Data Set Analysis

- Validation cohort:
- Coefficient: 0.013
- $R^2 = 0.95$



# Large Data Set Analysis

## Update

- Published in Spine
- Accepted for presentation at:
- NASS
- Western Orthopedic Association meetings

# Multidisciplinary Group Model

[https://ucsf.co1.qualtrics.com/jfe/form/SV\\_9sr32Xa6hPb8UXH](https://ucsf.co1.qualtrics.com/jfe/form/SV_9sr32Xa6hPb8UXH)

**UCSF**  
University of California  
San Francisco


Name(s) of evaluator(s)

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**CASE 1:**

- 70F independent non smoker, c/o low back pain, limited walking ability, and paresthesias to buttocks, diagnosed with scoliosis, DDD, and lumbar stenosis.
- Prior Spine Surgeries: none
- PMH: supraventricular tachycardia, GERD, HTN
- Meds: verapamil, omeprazole, vitamin D3
- Bone: +Osteopenia
- BMI: 25
- ASA: 2
- Exam: motor: 4/5 Left iliopsoas, EHL; sensory: diminished Left L4; no myelopathy
- ODI: Preop(-76) 48
- EQ5d : Preop(-76) 0.708

**Case 1**



Colic33 4mg  
LL: 27  
P6: 50  
SW: 110m

Please predict the likelihood (%) that the patient will experience a MAJOR medical complication: MI, pneumonia, renal failure, readmission, death

0 10 20 30 40 50 60 70 80 90 100

Experience a MAJOR medical complication

Please predict which MAJOR medical complication the patient will experience:

MI

Pneumonia

Renal failure

Readmission

Death

Other

Please predict which SURGICAL complication the patient will experience:

Dural tear

Neurological deficit related to surgery (weakness, paralysis, numbness/tingling)

Return to OR

Do you anticipate a Minimal Clinically Important Difference (MCID) as measured by either ODI (+10 points) or EQ5D (+0.15 point) at 6 months post-operatively?

Yes

No

Please estimate the Length of Stay (days):

Please rate the appropriateness of surgery (Scale of 1-10)

Inappropriate	Borderline	Appropriate	Mandatory
1	2 3 4 5	6 7 8	9 10

# Multidisciplinary Group Model

Predicted Likelihood (%) of patient outcomes

Outcome	Minimum	Maximum	Mean	Std Deviation	Count
Major Complic.	5	20	11.5	5.2	8
Minor Complic.	3	50	26.75	15.25	8
SSI	4	40	14.5	10.63	8
Surgical Complic.	5	50	22	13.9	8
LOS	4	8	6.13	1.17	8
Appropriateness	4	9	6.38	1.65	8

### Predicted Major Complications

Renal failure	12.50%
Readmission	75.00%
Death	0.00%
Other	12.50%

### Predicted Minor Complications

DVT	12.50%
UTI	12.50%
Other	75.00%

### Predicted Surgical Complications

Dural tear	50.00%
Neurological deficit related to surgery (weakness, paralysis, numbness/tingling)	37.50%
Return to OR	12.50%

### Do you anticipate an MCID?

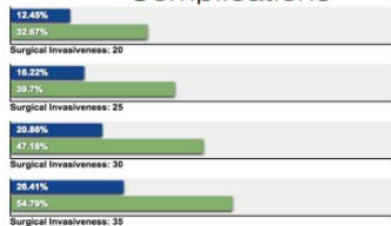
Yes	100.00%
No	0.00%

### Actual Patient Data

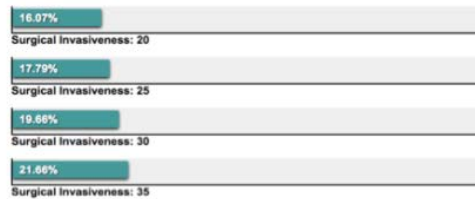
LOS	8
Complic.	Dural tear; underwent tendon transfer for foot drop after 1 year
MCID?	No

# Multidisciplinary Group Model

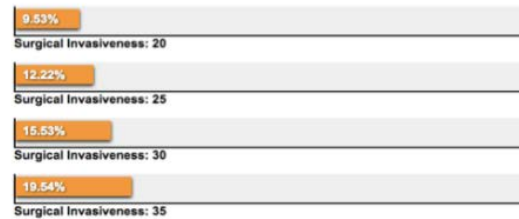
## SAGE Major/Minor Complications



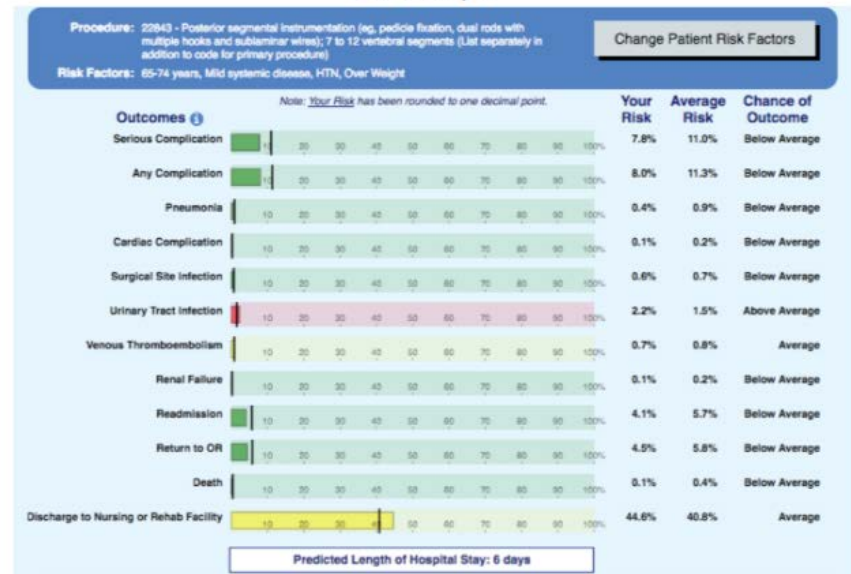
## SAGE Dural Tear



## SAGE Infection



## NSQIP



# Multidisciplinary Group Model

- Current Data
  - 8 representative cases presented to group then compared against established predictive models (Sage NSQIP)
  - 56 individual responses for all 8 cases
- Update
  - Pending: Complete case presentations (20 total cases)
  - Pending: Data analysis
  - Pending: Manuscript preparation

# Multidisciplinary Group Model

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Thank You