CDMI

CENTER FOR DISRUPTIVE MUSCULOSKELETAL INNOVATIONS

Predictive Modelling of Long-Term 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 cost, the appropriateness of a given surgical procedure in a particular patient can be determined.

- Appropriate surgery is surgery in which the expected and observed benefits of surgery exceed the expected and observed complications of care.

Purpose

- Purpose
  - Identify predictor variables for:
    - Clinical improvement
    - Readmission
    - Revision surgery
    - Cost-effectiveness
    - 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
- Prospective model testing

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
  - Surgical complications
  - Medical complications: DVT/PE, cardiac, Pulm, UTI
  - Surgical site infection
  - Pain mgmt difficulty
  - Transfusion
  - Length of stay
  - Discharge to Home vs SNF vs ARU
  - 30 day and 90 day
    - Readmission
    - Re-operation

Retrospective Model

- Adjustments to project:
  - Focused analysis and predictive modeling of patients with diagnosis of adult spinal deformity only
  - Outcomes limited to 90 days

- Pending Items
  - Collect social support information
  - Frailty index
  - Cost analysis
  - Statistical analysis

Large Data Set Analysis

- Methods: Case control study, administrative claims database
- State inpatient database (SID) Healthcare Cost and Utilization Project - Agency for Healthcare Research and Quality
- North Carolina, Nebraska, New York, and Utah from 2005-2009 and California and Florida from 2005-2010
- Inclusion criteria: Age > 18, patients undergoing lumbar spine surgery using ICD9 codes, exclusion: cancer, infection, trauma diagnoses
- Data extracted for 30 day readmission as well as variables previously identified as risk factors for readmission

Large Data Set Analysis

- Randomly assigned to derivation or validation cohort
- Stepwise multivariate analysis: variables $p<0.01$ on univariate analysis included in logistic multivariate regression
- Readmission after posterior spine fusion (RAPSF) scoring created, including OR >1.1 and $p<0.01$ on multivariate analysis
- Numeric value assigned as [OR-1/Sum(OR-1)] x 100 , and each value was rounded to nearest whole number.
- Linear regression then used to validate model first in derivation cohort and then in validation cohort.

Large Data Set Analysis

- Results: 214788 patients, Derivation cohort: 108514, Validation cohort: 106273
- Readmission rate 12.4% in derivation cohort, 12.5% in validation cohort

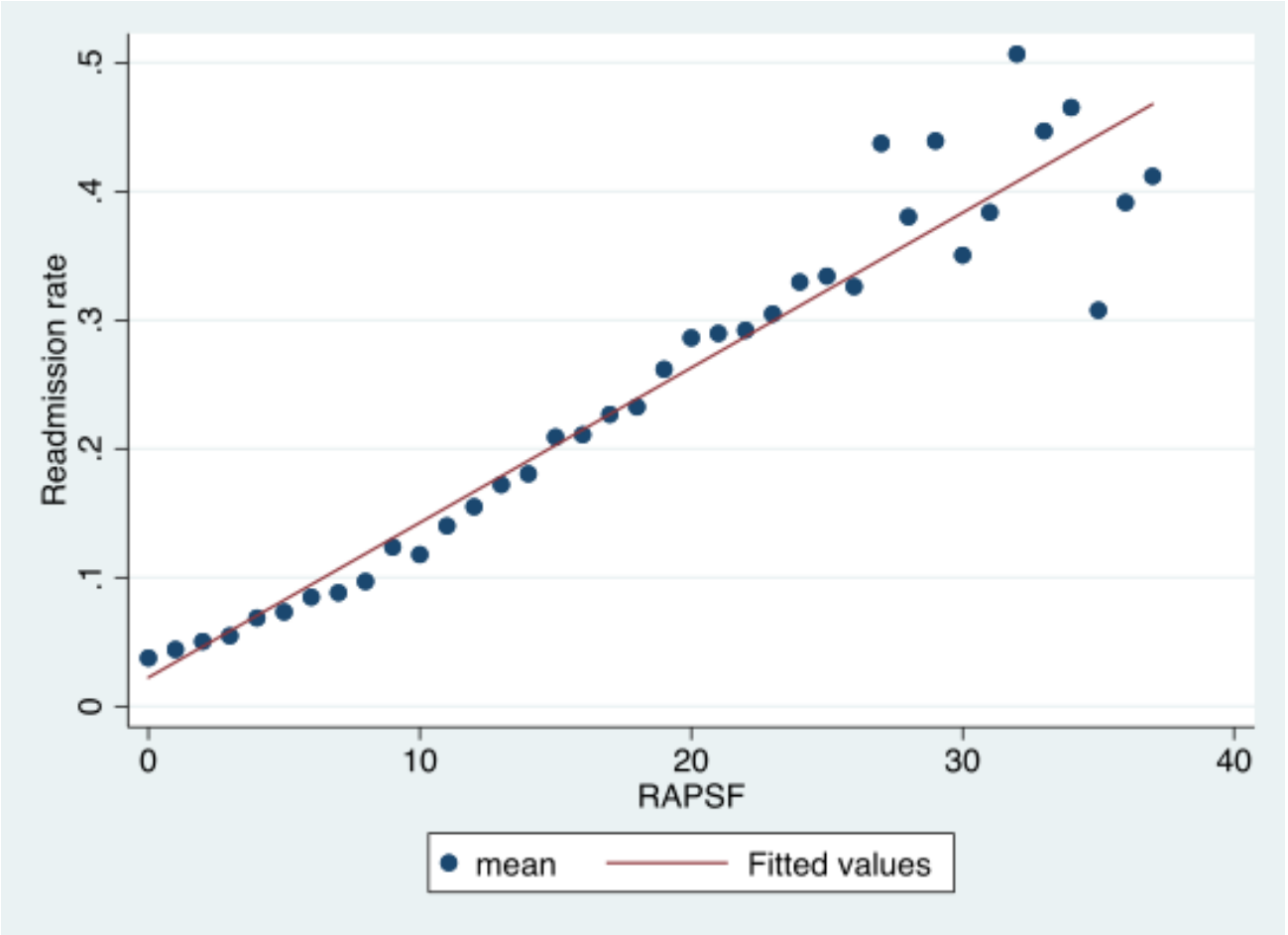
Large Data Set Analysis

- 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

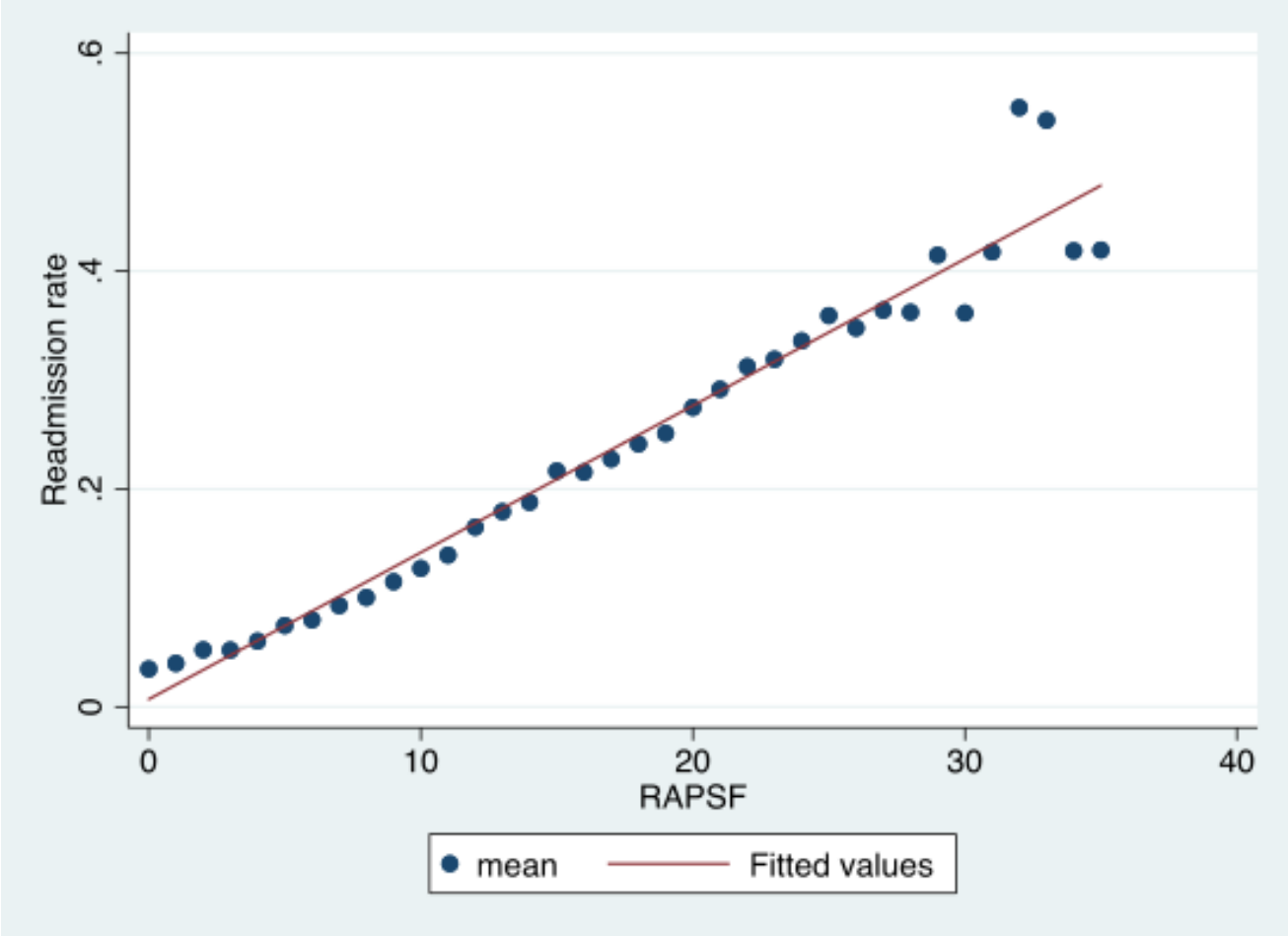
Large Data Set Analysis

- Derivation cohort
- Coefficient: 0.012
- R2 = 0.92



Large Data Set Analysis

- Validation cohort:
- Coefficient: 0.013
- R2 = 0.95



Multidisciplinary Group Model

https://ucsf.co1.qualtrics.com/jfe/form/SV_9sr32Xa6hPb8UXH

UCSF
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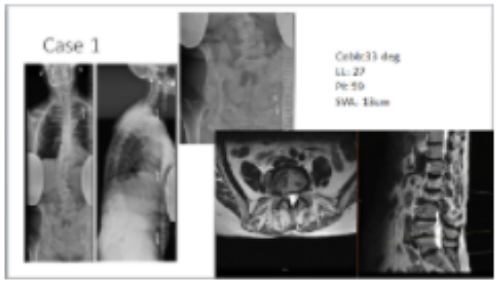
Name(s) of evaluator(s)

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



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

Multidisciplinary Group Model

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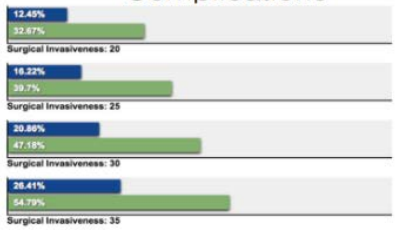
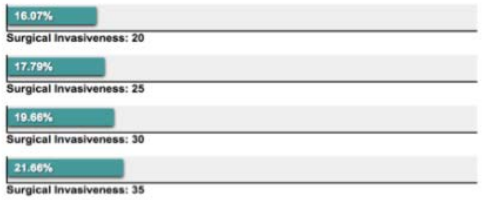
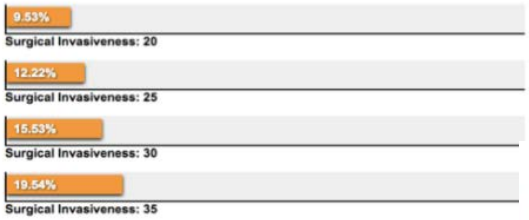
SAGE Major/Minor Complications



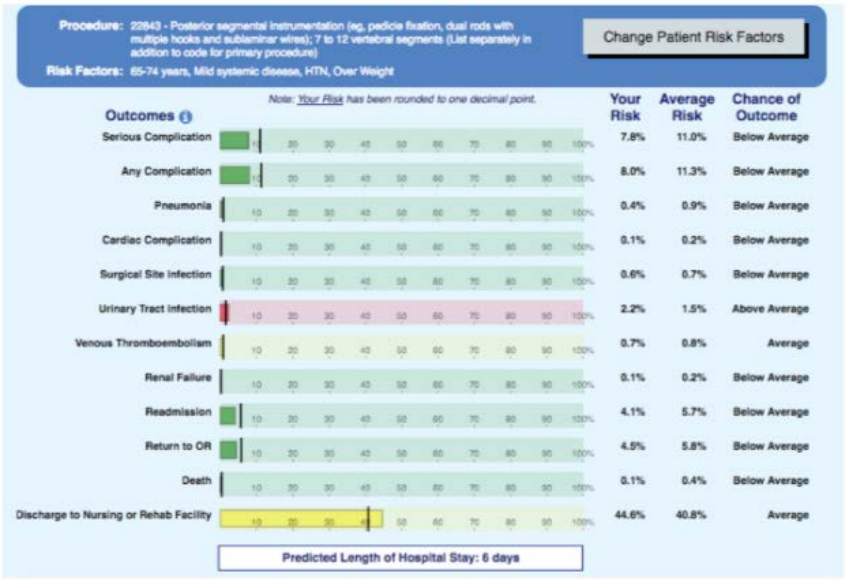
SAGE Dural Tear



SAGE Infection



NSQIP



Multidisciplinary Group Model

- Adjustments to project:
  - 20 representative cases presented to group then compared against established predictive models (Sage NSQIP)
  - Online Survey instead of group conference with questionnaire

- Pending Items
  - Collect online survey data
    - Email
    - Group conference
  - Data analysis

Prospective Model Testing

- Pending Items
  - Retrospective data collection and analysis completion
  - Develop/train prospective model with observations gather retrospectively
  - Apply model prospectively - Multi-center