

# Patient Safety and Quality of Care

## *Benchmarks to measure safety and risk stratification*



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Professor in Residence  
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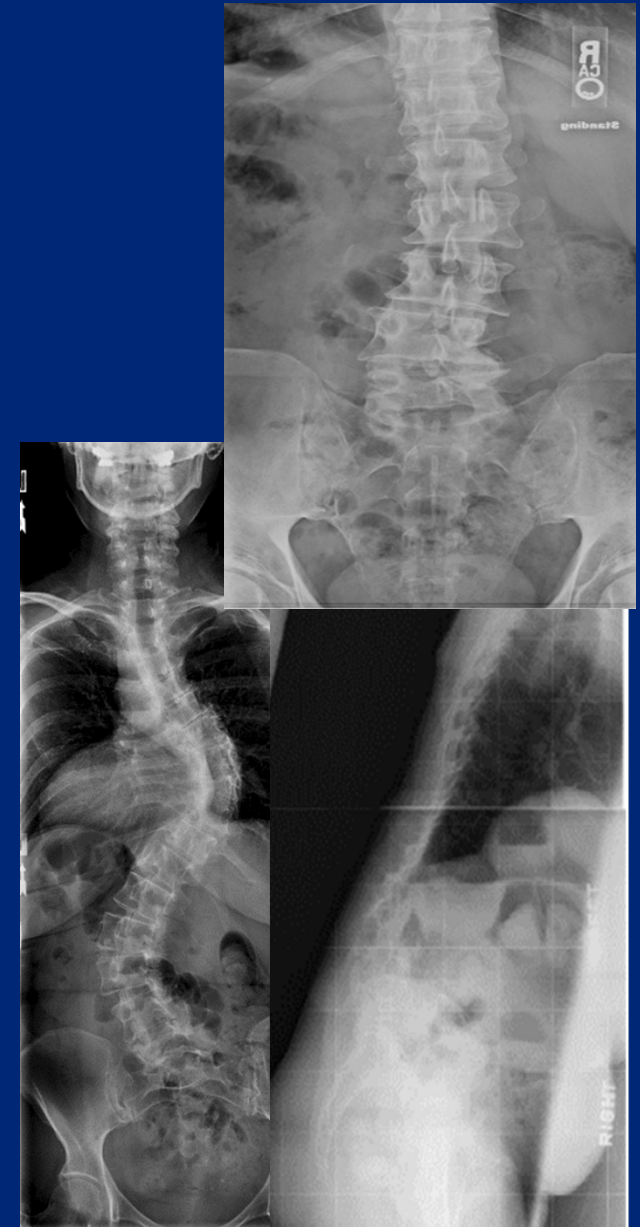


# Disclosures

- Research/Institutional Support:
  - NIH, AO Spine, OREF AOA
- Honoraria/Consultancy:
  - Innovasis, Medtronic, DePuy, Biomet, Stryker, Globus
- Ownership/Stock/Options:
  - Providence Medical, Baxano
- Royalties:
  - Medtronic, Stryker

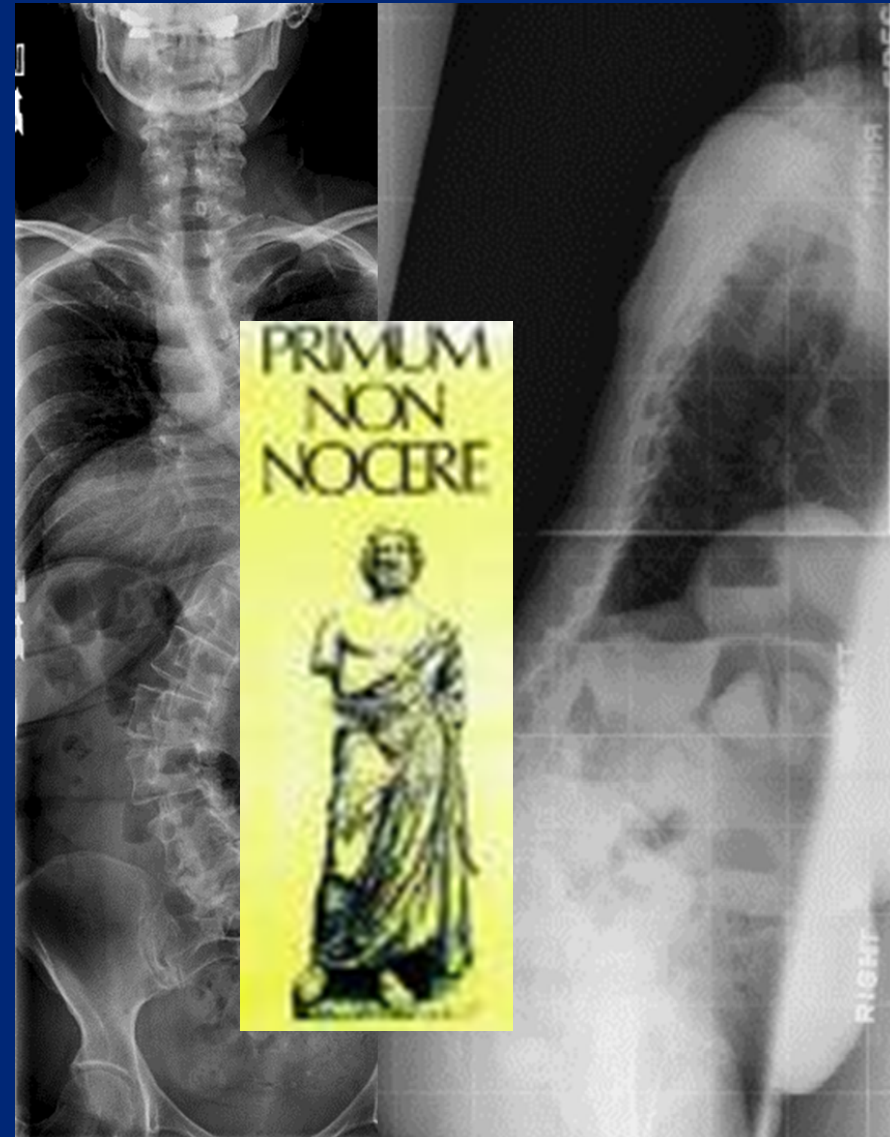
# Goals of Managing Spinal Disorders

- Decompress Neural Elements
- Improve Back Pain
- Improve Sagittal and Coronal Alignment
- Effective Arthrodesis
- Improve Self-Assessment of Health-related Quality of Life
- Optimize Value of Care
- Patient Safety



# Goals of Managing Spinal Disorders

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# Risk as the Basis of Informed Choice and Appropriate Care

Empowering informed choice in the management of Spinal Disorders

- Valid Information on Natural History
- Valid Information on Outcomes of operative and non-operative options
  - Risks of Care
  - Expected Benefits of Care



# Overview

- Surgical Risk
  - Basis for choosing appropriateness of care and informed choice
- Risk Stratification Tools-
  - Independent predictors of Risk
  - Development and Evolution
  - Data sources and limitations
- Standards for Complication Rates
  - Observed vs Expected
  - Adjusting Risk with preoperative optimization
- Predictive Modeling
  - Risk Stratification in establishing standards/Expected Rates
  - Tools for estimating risk

# What is Risk and Why is Risk Important?

- Quality metrics
  - Accurate Estimate of Expected rates of complication
- Patient and Payor and Hospital expectations
- Resource allocation decisions
  - When to Say No /When to Say Not Yet
- Shared Risk Alternative Payment Models
  - ACO
  - 90 day bundled payments
- Informed Consent and shared decision making



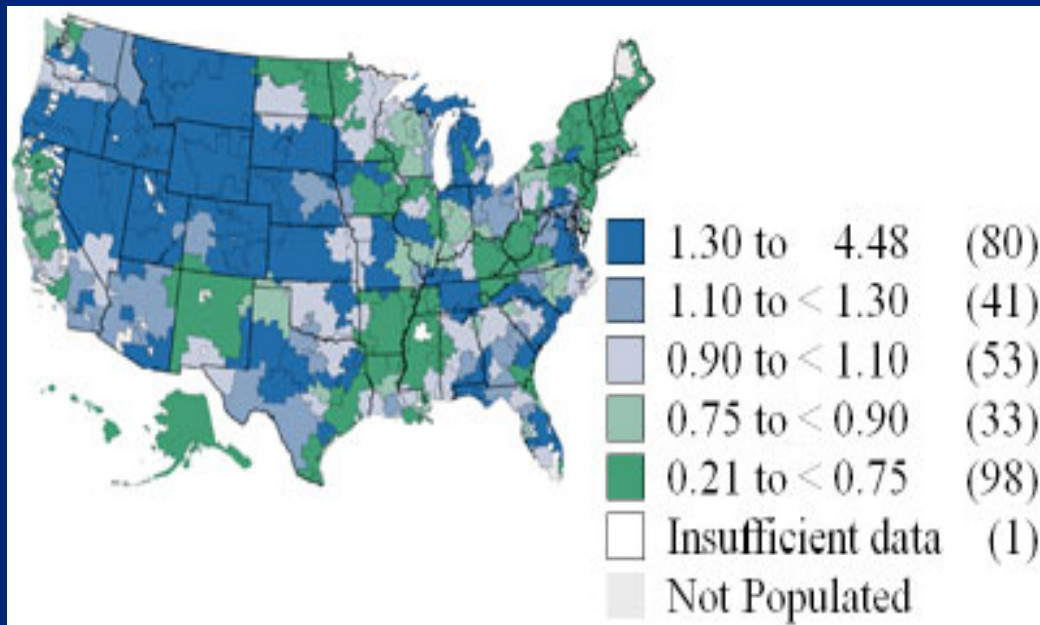
# Making Decisions under Conditions of Uncertainty





# Variability in approach to care

- Management of Spinal Deformity is Characterized by significant variability
  - Regional Variation/Surgical Signature
  - Patient Values and Preferences
  - Recognition of factors that predict outcome and risk

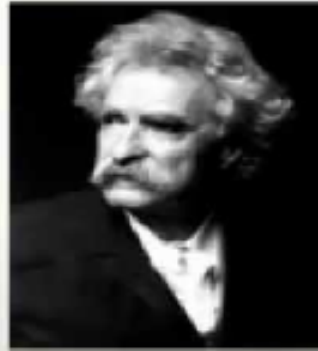


# Reducing Variability

- Variability is a proxy for quality of care
  - Reducing variability is related to improved quality of care
- Clinical Practice Guidelines
- Appropriate Use Criteria
  - Areas of Consensus
  - Areas of Discordance
  - Areas for Further Study



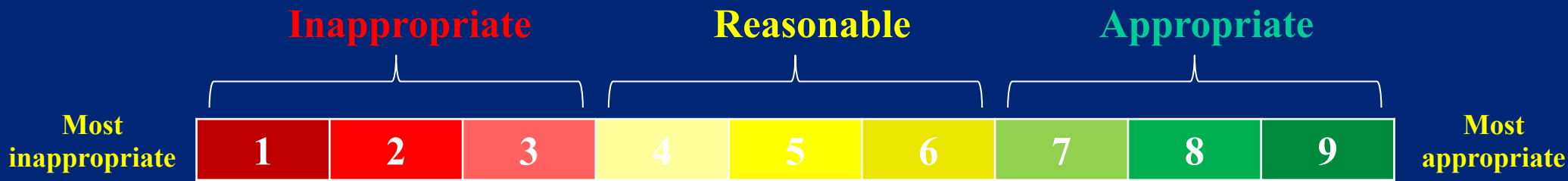
It ain't what you don't know  
that gets you into trouble. It's  
what you know for sure that  
just ain't so.



# Rand/UCLA AUC Methodology

Making Informed Choices under conditions of Uncertainty

Instructions for Rating Management Procedures and Strategies



An *inappropriate* procedure or management strategy is defined as one in which **the value (benefit per unit cost) is LOW**:  
The expected negative consequences exceeds the expected health benefit such that the procedure should not be performed.

A *reasonable* procedure or management strategy is one in which:  
The balance of risk and benefit are not known, but there is a reasonable chance of positive net benefit, with limited risk.

An *appropriate* procedure or management strategy is defined as one in which **the value (benefit per unit cost) is HIGH**:  
The expected health benefit exceeds the expected negative consequences by a sufficiently wide margin that the procedure is worth doing.

# Appropriate Use Criteria

- AUC indicate reasonable care based on available evidence combined with a rigorous, transparent recommendation process and well-defined scenarios.
- Appropriate Use Criteria (AUC) specify when it is appropriate to perform a medical procedure or service. An “appropriate” procedure is one for which the expected health benefits exceed the expected health risks by a wide margin.

# Surgery for Degenerative Lumbar Scoliosis: The Development of Appropriateness Criteria

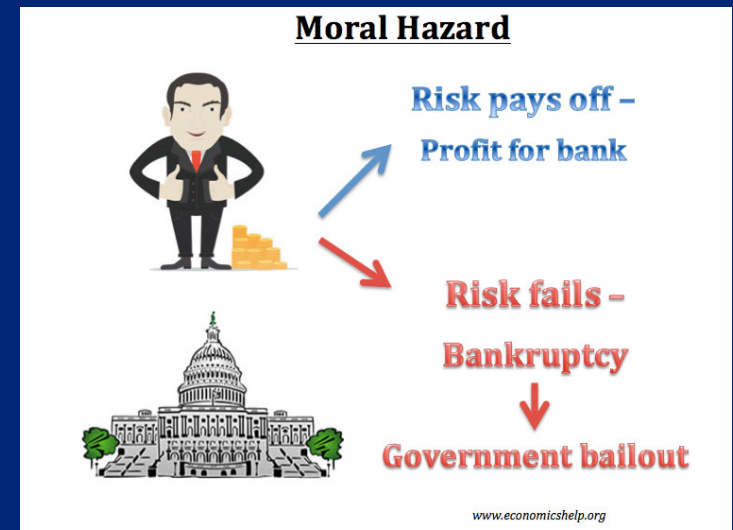
Chen, Peggy Guey-Chi MD, MSc, MHS; Daubs, Michael D. MD; Berven, Sigurd MD; Raasen, Laura B. MPH; Anderson, Ashaunta T. MD, MPH, MS; Asch, Steven M. MD, MPH; Nuckols, Teryl K. MD MSHS; and the Degenerative Lumbar Scoliosis Appropriateness Group

- Drivers of Appropriateness
  - Pre-operative Symptoms
  - Progression of Deformity
  - Sagittal Alignment
  - Comorbidities

| Necessary: Benefits Outweigh Risks and Would Be Improper Not to Offer |              |                  |   |                           |
|---|--------------|------------------|---|---------------------------|
| Moderate to severe  | Any          | None to mild     | Curve $\geq 30^\circ$                             |                           |
| Moderate to severe  | Severe       | None to moderate |   |                           |
| Moderate to severe  | Severe       | Severe           | Progression OR imbalance OR both                  |                           |
| Moderate to severe  | Severe       | Severe           | Curve $< 30^\circ$                                | Progression AND imbalance |
| Moderate to severe  | Moderate     | None to moderate | Progression OR imbalance OR both                  |                           |
| Moderate to severe  | Moderate     | Severe           | Progression, imbalance, AND curve $\geq 30^\circ$ |                           |
| Moderate to severe  | None to mild | None to moderate | Progression AND imbalance                         |                           |

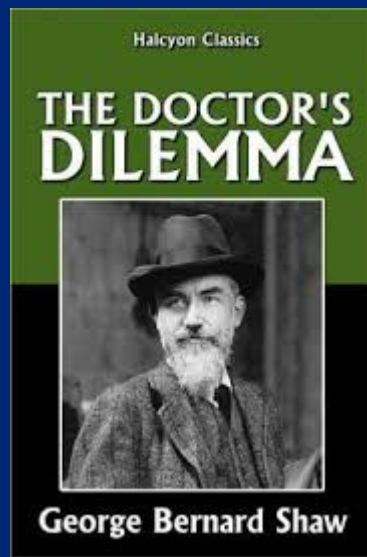
# Making Decisions under Conditions of Uncertainty

- Moral Hazard
  - Dissociation of the risk and benefit
    - Party that makes decision is recipient of benefit and shielded from risk
    - Insurance, Banking, Medicine



# Medical Decision Making

- Disassociation between the Decision maker and the Beneficiary
  - Judge and Executioner
  - Home Inspector and Contractor



# Multidisciplinary Care: Integrated Care=Optimal/Appropriate

- Spine Surgeons
- Physiatry
- Anesthesia
  - Pain management
- Physical Therapy
- Radiology
- Neurology
- Oncology
- Primary Care
- Emergency Care
- Rheumatology
- Infectious disease



# Multidisciplinary Care: Integrated Care=Optimal/Appropriate

- Spine Surgeons
- Physiatry
- Anesthesia
  - Pain
- Physiotherapy
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# What is an the Risk?

## What is an Acceptable/Appropriate Risk?

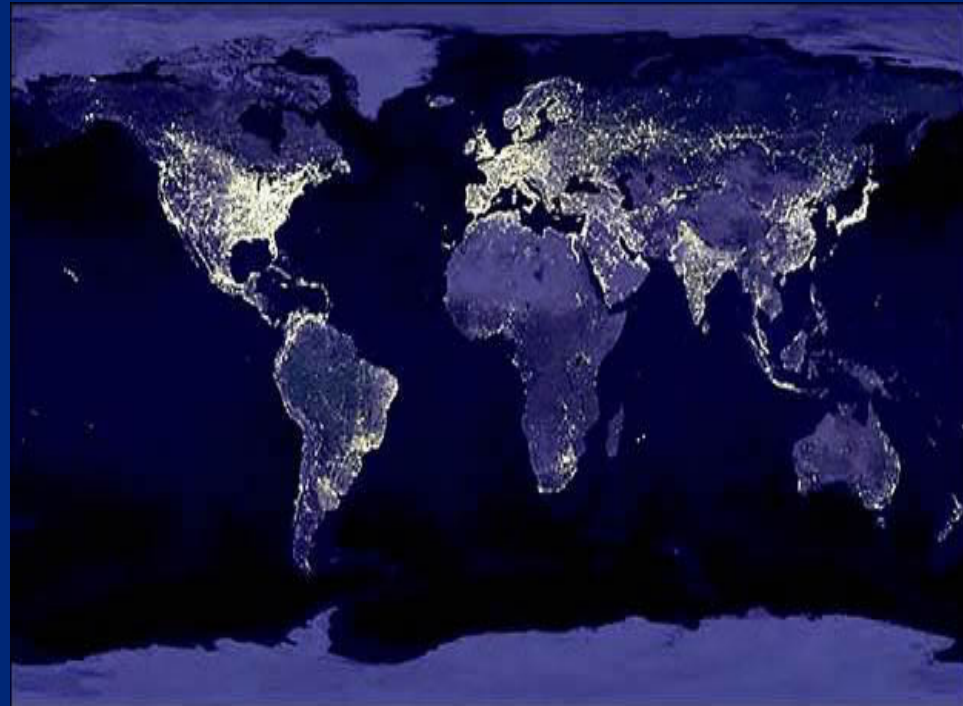
- Observed Rate of Complications
- Expected Rate of Complications
- O:E ratio provides a meaningful metric of quality of care
- Requires accurate risk stratification and global standardization/benchmarking



# Detecting Perioperative Complications

## Broad Spectrum of Reported Rates

- Database limitations
  - Institutional databases
  - Voluntary society databases
  - Insurance databases
- Need to return to OR for resolution
- Perioperative vs Late complications



# Scoliosis Research Society Morbidity and Mortality of Adult Scoliosis Surgery

Charles A. Sansur, MD, MHSc,\* Justin S. Smith, MD, PhD,† Jeff D. Coe, MD,‡ Steven D. Glassman, MD,||  
Sigurd H. Berven, MD,§ David W. Polly Jr., MD,¶ Joseph H. Perra, MD,# Oheneba Boachie-Adjei, MD,\*\*  
Christopher I. Shaffrey, MD†

SPINE Volume 36, Number 9, pp E593–E597

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- 108,480 cases submitted between 2004 and 2007
  - 4980 cases of adult scoliosis (AS)
- 521 patients with complications (10.5%)
  - total of 669 complications (13.4%)
- Predictors of complications:
  - Osteotomies
  - Revision Surgery
  - Combined Anterior/Posterior Approaches
- Age and type of scoliosis were not predictors

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**TABLE 1. Complications in 4980 Cases of Adult Scoliosis Patients from the Years 2004–2007 Stratified by Patient Age**

| Complication, N (%)                      | Patient Age* (yrs) |                |                |
|--|--------------------|----------------|----------------|
|  | All (n = 4980)     | ≤60 (n = 2920) | >60 (n = 2060) |
| Dural tear                               | 142 (2.9%)         | 77             | 65             |
| Wound infection                          |                    |                |                |
| Superficial                              | 46 (0.9%)          | 28             | 37             |
| Deep                                     | 73 (1.5%)          | 43             | 46             |
| Implant complication                     | 80 (1.6%)          | 50             | 30             |
| Acute neurological                       | 49 (1.0%)          | 31             | 18             |
| Delayed neurological                     | 41 (0.5%)          | 22             | 19             |
| Epidural hematoma                        | 12 (0.2%)          | 8              | 4              |
| Wound hematoma                           | 22 (0.4%)          | 12             | 10             |
| Cardiac                                  | 7 (0.1%)           | 1              | 6              |
| Pulmonary embolus                        | 12 (0.2%)          | 7              | 5              |
| Pulmonary (not PE)                       | 31 (0.5%)          | 21             | 10             |
| DVT                                      | 9 (0.2%)           | 4              | 5              |
| Death                                    | 17 (0.3%)          | 9              | 8              |
| Sepsis                                   | 6 (0.1%)           | 3              | 3              |
| Visual acuity change                     | 3 (0.06%)          | 2              | 1              |
| Other complication                       | 119 (2.4%)         | 65             | 54             |
| Total number patients with complications | 521 (10.5%)        | 295 (10.1%)    | 226 (11.0%)    |
| Total complication†                      | 669 (13.4%)        | 384 (13.2%)    | 321 (15.6%)    |

# Scoli-RISK-1: Neural Change

|                             | Total    |
|-----------------------------|----------|
| <b>Discharge (N = 266)</b>  |          |
| <b>Decline</b>              | 59 (23%) |
| <b>Six Weeks (N = 268)</b>  |          |
| <b>Decline</b>              | 48 (18%) |
| <b>Six Months (N = 268)</b> |          |
| <b>Decline</b>              | 30 (11%) |



# Prospective multicenter assessment of perioperative and minimum 2-year postoperative complication rates associated with adult spinal deformity surgery

J Neurosurg Spine February 26, 2016

Justin S. Smith, MD, PhD,<sup>1</sup> Eric Klineberg, MD,<sup>2</sup> Virginie Lafage, PhD,<sup>3</sup> Christopher I. Shaffrey, MD,<sup>1</sup> Frank Schwab, MD,<sup>3</sup> Renaud Lafage, MS,<sup>3</sup> Richard Hostin, MD,<sup>4</sup> Gregory M. Mundis Jr., MD,<sup>5</sup> Thomas J. Errico, MD,<sup>3</sup> Han Jo Kim, MD,<sup>5</sup> Themistocles S. Protopsaltis, MD,<sup>3</sup> D. Kojo Hamilton, MD,<sup>6</sup> Justin K. Scheer, BS,<sup>7</sup> Alex Soroceanu, MD,<sup>8</sup> Michael P. Kelly, MD,<sup>9</sup> Breton Line, BSME,<sup>10</sup> Munish Gupta, MD,<sup>2</sup> Vedat Deviren, MD,<sup>11</sup> Robert Hart, MD,<sup>12</sup> Douglas C. Burton, MD,<sup>13</sup> Shay Bess, MD,<sup>10</sup> Christopher P. Ames, MD,<sup>14</sup> and the International Spine Study Group

- Prospective study of 346 patients, 291 with 2 year f/u their mean age was 56.2 years.
- Overall, 203/291 patients (69.8%) had at least one complication
  - 52.2% of patients with perioperative complication
  - 42.6% of patients had a delayed complication
  - 28.2% required at least one revision

# Prospective multicenter assessment of perioperative and minimum 2-year postoperative complication rates associated with adult spinal deformity surgery

J Neurosurg Spine February 26, 2016

Justin S. Smith, MD, PhD.<sup>1</sup> Eric Klineberg, MD.<sup>2</sup> Virginia Lafage, PhD.<sup>3</sup>

TABLE 2. Rates of complications in 291 patients surgically treated for ASD who had a minimum 2-year follow-up

| Complication Category                           | Minor/Major Complications (%) |                  |                  |
|---|-------------------------------|------------------|------------------|
|   | Periop (<6 wks)               | Delayed (>6 wks) | Total            |
| Implant   | 3/8 (3.8)                     | 11/59 (24.1)     | 14/67 (27.8)     |
| Radiographic                                    | 4/10 (4.8)                    | 25/42 (23.0)     | 29/52 (27.8)     |
| Neurological                                    | 21/24 (15.5)                  | 16/20 (12.4)     | 37/44 (27.8)     |
| Operative                                       | 41/32 (25.1)                  | 0/1 (0.3)        | 41/33 (25.4)     |
| Cardiopulmonary                                 | 31/20 (17.5)                  | 1/3 (1.4)        | 32/23 (18.9)     |
| Infection                                       | 11/20 (10.7)                  | 5/7 (4.1)        | 16/27 (14.8)     |
| Gastrointestinal                                | 24/1 (8.6)                    | 0/0 (0)          | 24/1 (8.6)       |
| Wound (excluding infection)                     | 3/7 (3.4)                     | 0/5 (1.7)        | 3/12 (5.2)       |
| Vascular  | 4/0 (1.4)                     | 1/0 (0.3)        | 5/0 (1.7)        |
| Musculoskeletal                                 | 0/0 (0)                       | 3/0 (1.0)        | 3/0 (1.0)        |
| Renal   | 1/2 (1.0)                     | 0/0 (0)          | 1/2 (1.0)        |
| Other   | 2/1 (1.0)                     | 0/0 (0)          | 2/1 (1.0)        |
| Total (minor/major)                             | 270 (145/125)                 | 199 (62/137)     | 469 (207/262)    |
| Mean no. of complications/patient (minor/major) | 0.93 (0.50/0.43)              | 0.68 (0.21/0.47) | 1.61 (0.71/0.90) |
| Number of patients affected (%)                 | 152 (52.2)                    | 124 (42.6)       | 203 (69.8)       |



# Predictors of Complications

- Patient Factors
  - Age
  - Co-morbidities
  - Pre-operative Health Status
  - Prior surgery
- Surgical Factors
  - Surgical Invasiveness
  - Staged Surgeries
  - Osteotomies
  - Large correction of sagittal plane deformity



# EMR based Risk Stratification

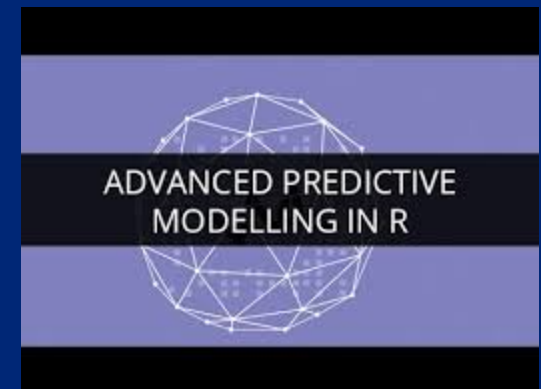
The screenshot shows the Epic EMR interface. The top navigation bar includes 'Hyperspace - ORTHO SPINE PARN - UCSF Production - SIGURD H BERVEN'. Below this is a toolbar with icons for 'Chart', 'Patient Station', 'Today's Pts', 'My Cases (Today)', 'All Areas', 'OR Schedules', 'Encounter', 'Remind Me', and 'Proc'. A search bar is visible. The main content area is titled 'Note Editor' and contains a list of clinical indicators and their associated data points:

- Blood Sugar = .labHgA1c
- Bone Health = .DEXA,.serumCA, .VitaminD)
- BMI= .BMI
- Nutrition= .serum albumin
- Infection risk= .labesr,{Microbiology Results:304002301}
- Smoking = .smoking
- Pain medications= .meds
- Coagulation status= .INR/Prothrombin Time, .NSAIDs
- Systemic Disease = .Creatinine, .liver function tests,.echocardiogram,
- Social Support = .RAPT|

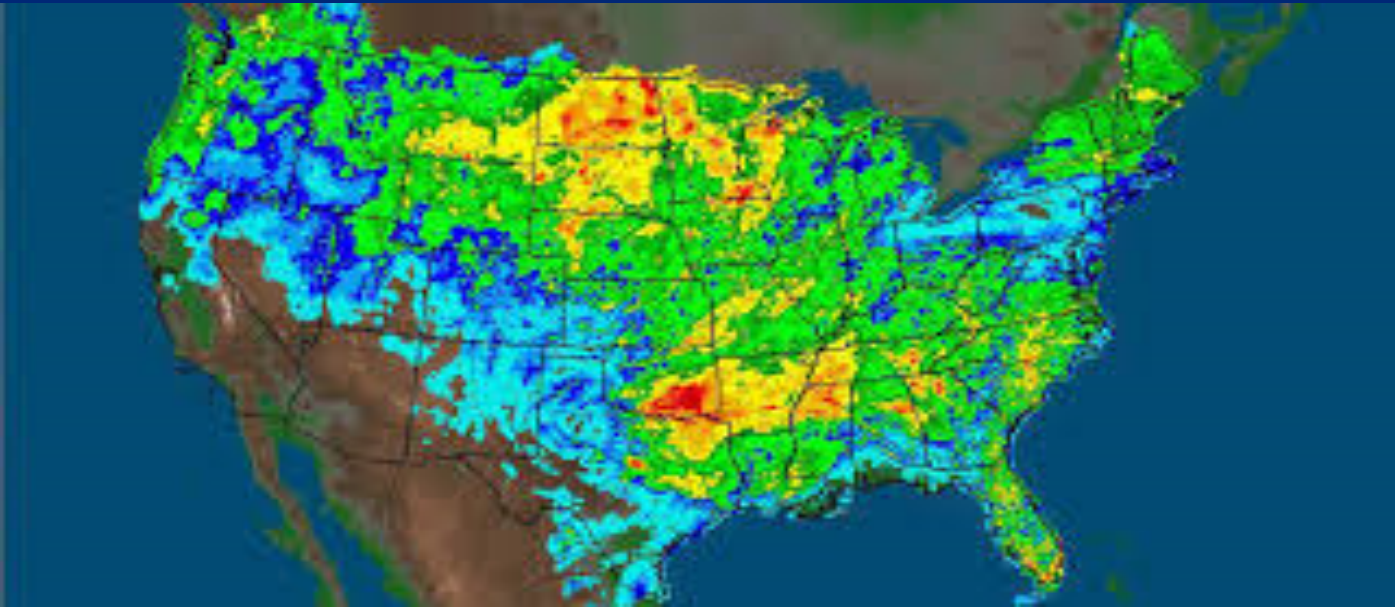
- Frailty- Edmonton Frailty Score
- Mental Health- Anxiety/Depression

# Risk Stratification Tools

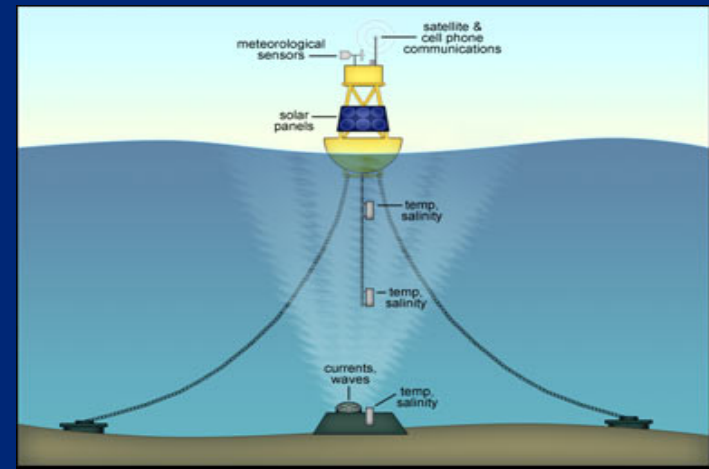
- Personal Experience
- Peer Review/ Case Conferences
- Expert Opinion
  - Delphi Panels
- Modelling based upon identification of Predictor variables



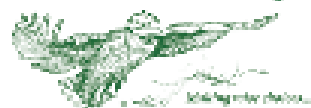
# Predictive Modelling



IR7\_



Proud To Be



Spine Patient Outcomes Research Trial

Part of the Answer

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## YOUR SPINE TREATMENT CALCULATOR

This calculator shows possible patient results for physical activity, pain and overall health after surgical or [non-surgical](#) treatment for low back related pain. The data used come from the Spine Patient Outcomes Research Trial (SPORT)<sup>®</sup>. This tool is for people whose doctor has told them that they have one of the diagnoses listed below.

### Choose one of the diagnoses below.

**Sciatica/Ruptured Disc (Herniated Disc):** A vertebral disc is a soft gel-like structure with a normally strong covering that sits between each vertebra in your back and acts like a cushion. A herniated disc happens when this disc has broken down and part of it is pressing on a nerve. The pressure causes pain that most often runs from your back through your buttocks and down one leg.

**Pinched Nerve (Spinal Stenosis):** This is usually from arthritis in the back. The pain is generally in the lower back and it may also shoot down your leg from your buttocks when walking, but not sitting.

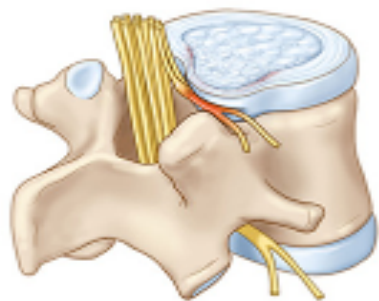
**Slipped Vertebra (Degenerative Spondylolisthesis or DS):** DS is a condition in which one or more vertebrae move out of place, usually forward, and cause pain similar to that felt with spinal stenosis (see above).

This calculator does not apply to other diagnoses or to a combination of diagnoses.

Select your diagnosis:

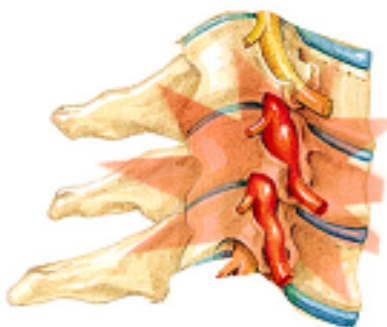
- Sciatica/Ruptured Disc (Herniated Disc)
- Pinched Nerve (Spinal Stenosis)
- Slipped Vertebra (Degenerative Spondylolisthesis or DS)

[Proceed to Calculator](#)



### **Sciatica/Slipped Disc** (Herniated Disc)

A spinal disc is a soft gel-like structure with a strong covering that sits between each vertebra in your back and acts like a cushion. Sometimes the covering gets weak and the gel can poke out against a nerve. This causes pain that most often runs from your back through your buttocks and down your leg.



### **Spinal Stenosis**

This is from arthritis in the back that narrows the spaces around the nerves. Along with pain in the lower back there is also pain in one or both legs when walking. The pain usually improves with sitting down or bending forward.

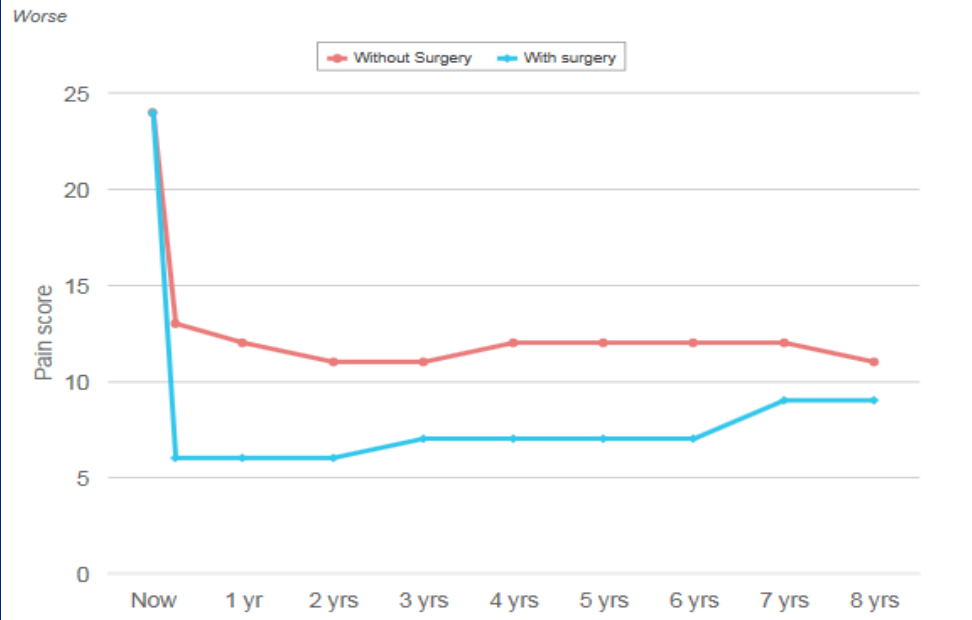


### **Slipped Vertebra** (Degenerative Spondylolisthesis)

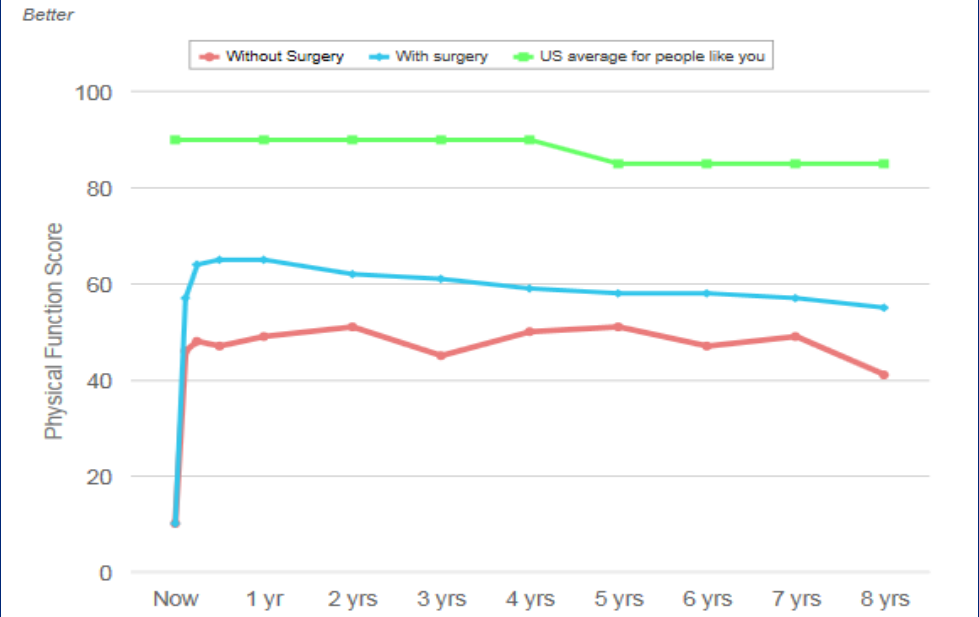
This is a condition in which one or more vertebrae move out of place, usually forward, and cause pain similar to that felt with spinal stenosis (see above).

- Dartmouth Spine Calculator

### Your pain score over time



### Your ability to be physically active over time





**SpineSage is a predictive modeling tool based on data from the Spine End Results Registry: 1476 patients**

## **The Spine End Results Registry**

**Prospectively collected data registry for all patients undergoing spine surgery at Harborview Medical Center and University of Washington Medical Center from January 1st 2003, to December 31st, 2004.**

- Extensive co-morbidity and demographic data were defined a priori and collected prospectively for each surgical patient.**
- Complications were defined a priori and were prospectively recorded for at least 2 years following the surgery.**

**Several multivariate log-binomial analyses were performed to identify and quantify risk factors for these complications after spine surgery and have been published in the peer-refereed literature.**

# Predicting medical complications after spine surgery: a validated model using a prospective surgical registry

*Spine J.* 2014 February 1; 14(2): 291–299.

Michael J. Lee, MD\*, Amy M. Cizik, MPH, Deven Hamilton, PhD, and Jens R. Chapman, MD

Department of Orthopaedic Surgery and Sports Medicine, University of Washington Medical Center, Seattle, WA 98195, USA

- Predictive Model for Medical Complication after spine surgery
- Input Variables:
  - Age, gender, smoking status, alcohol use, diabetes, body mass index, insurance status, surgical approach, revision surgery, surgery region, diagnosis, surgical invasiveness
  - Hypertension, CHF, COPD
  - Rheumatoid arthritis, renal disease, liver disease, cancer, anemia, bleeding disorder

$$\text{Predicted Probability of Adverse Event} = B_{1(\text{Gender})} + B_{2(\text{COPD})} + B_{3(\text{HYTN})} + B_{4(\text{PrevCardiac})} + B_{5(\text{Age})} + B_{6(\text{SII})} + B_{7(\text{Trauma})} + B_{8(\text{OtherDx})} + B_{0(\text{Intercept})}$$

# **Predicting medical complications after spine surgery: a validated model using a prospective surgical registry**

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**Michael J. Lee, MD\***, Amy M. Cizik, MPH, Deven Hamilton, PhD, and Jens R. Chapman, MD

Department of Orthopaedic Surgery and Sports Medicine, University of Washington Medical Center, Seattle, WA 98195, USA

[Spine Sage Complication Calculator](#)

# A Novel Approach to Global Benchmarking of Risk-Adjusted Surgical Outcomes Beyond Perioperative Mortality Rate

**JAMA Surgery**  
**Published online**  
**April 6, 2016**

- Commission on Global Surgery recommendation on improving quality in surgery by reporting O:E rates
- The risk calculator was built using data collected from > 2.7 million operations from 586 hospitals participating in ACS NSQIP from 2010-14.

# A Novel Approach to Global Benchmarking of Risk-Adjusted Surgical Outcomes Beyond Perioperative Mortality Rate

JAMA Surgery  
Published online  
April 6, 2016

## Box. A Minimal Data Set for Global Benchmarking in Surgery<sup>a</sup>

### Patient Demographic Characteristics

Age

Sex

Height

Weight

### Procedure-Related Variables

Name of procedure (converted to *Current Procedural Terminology* code by the risk calculator)

Emergency case (yes or no)

American Society of Anesthesiologists classification (class I-V)

Wound class (clean, clean-contaminated, contaminated, or dirty-infected)

### Preoperative Risk Assessment

Steroid use for chronic condition (yes or no)

Ascites within 30 days prior to surgery (yes or no)

Systemic sepsis within 48 hours prior to surgery (none, systemic inflammatory response syndrome, sepsis, or septic shock)

Ventilator dependent (yes or no)

Disseminated cancer (yes or no)

Diabetes (none, oral medication, or insulin medication)

Hypertension requiring medication (yes or no)

Previous cardiac event (yes or no)

Congestive heart failure in 30 days prior to surgery (yes or no)

Dyspnea (none, with moderate exertion, or at rest)

Current smoker within 1 year (yes or no)

History of severe chronic obstructive pulmonary disease (yes or no)

Dialysis (yes or no)

Acute renal failure (yes or no)

### Outcome Measures

Pneumonia (yes or no)

Cardiac complication (yes or no)

Surgical site infection (yes or no)

Urinary tract infection (yes or no)

Venous thromboembolism (yes or no)

Renal failure (yes or no)

Unplanned return to the operating theater (yes or no)

Death (yes or no)

<sup>a</sup> Adapted from the American College of Surgeons National Surgical Quality Improvement Program Surgical Risk Calculator.<sup>4</sup>

# A Novel Approach to Global Benchmarking of Risk-Adjusted Surgical Outcomes Beyond Perioperative Mortality Rate

**JAMA Surgery**  
**Published online**  
**April 6, 2016**

- [NSQIP Calculator](#)

Please enter as much of the following information as you can to receive the best risk estimates.  
A rough estimate will still be generated if you cannot provide all of the information below.

Age Group

Sex

Functional Status 

Emergency Case 

ASA Class 

Steroid use for chronic condition 

Ascites within 30 days prior to surgery 

Systemic Sepsis within 48 hours prior to surgery 

Ventilator Dependent 

Disseminated Cancer 

Diabetes 

Hypertension requiring medication 

Congestive Heart Failure in 30 days prior to surgery 

Dyspnea 

Current Smoker within 1 Year 

History of Severe COPD 

Dialysis 

Acute Renal Failure 

BMI Calculation: 

Height (in)

Weight (lbs)

# Development and Validation of a Prediction Model for Pain and Functional Outcomes After Lumbar Spine Surgery

Sara Khor, MASC; Danielle Lavalley, PharmD, PhD; Amy M. Cizik, PhD, MPH; Carlo Bellabarba, MD;  
Jens R. Chapman, MD; Christopher R. Howe, MD; Dawei Lu, MD; A. Alex Mohit, MD; Rod J. Oskouian, MD;  
Jeffrey R. Roh, MD, MBA; Neal Shonnard, MD; Armagan Dagal, MD; David R. Flum, MD, MPH

- Development of PRO response prediction tool, informed by population-level data
  - 1965 patients treated with lumbar fusion from SCOAP**
  - **Empowering informed choice by physicians and patients regarding likelihood of clinical outcomes**



# Development and Validation of a Prediction Model for Pain and Functional Outcomes After Lumbar Spine Surgery

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Table 2. Model Odd Ratios

| Characteristics                      | ODI                |         | NRS Back Pain      |         | NRS Leg Pain       |         |
|--------------------------------------|--------------------|---------|--------------------|---------|--------------------|---------|
|                                      | Odds Ratio (95%CI) | P Value | Odds Ratio (95%CI) | P Value | Odds Ratio (95%CI) | P Value |
| Age                                  | 1.00 (0.98-1.02)   | .75     | 1.02 (1.00-1.03)   | .03     | 0.99 (0.97-1.02)   | .59     |
| Male                                 | 0.92 (0.64-1.33)   | .67     | 0.92 (0.64-1.31)   | .63     | 0.80 (0.48-1.34)   | .40     |
| Insurance <sup>a</sup>               |                    |         |                    |         |                    |         |
| Medicaid                             | 0.38 (0.14-1.02)   | .06     | 0.41 (0.24-0.69)   | <.001   | 0.75 (0.27-2.07)   | .58     |
| Workers' compensation                | 0.20 (0.07-0.53)   | <.001   | 0.52 (0.27-1.02)   | .06     | 0.48 (0.19-1.2)    | .12     |
| Other                                | 0.74 (0.46-1.19)   | .22     | 0.74 (0.45-1.21)   | .23     | 1.44 (0.76-2.73)   | .27     |
| Race/ethnicity nonwhite <sup>a</sup> | 0.97 (0.55-1.69)   | .91     | 0.89 (0.51-1.54)   | .67     | 0.58 (0.27-1.28)   | .18     |
| ASA score ≥3                         | 0.84 (0.55-1.27)   | .41     | 0.79 (0.57-1.08)   | .14     | 0.66 (0.41-1.04)   | .07     |
| Smoking status <sup>a</sup>          |                    |         |                    |         |                    |         |
| Current                              | 0.43 (0.22-0.84)   | .01     | 0.58 (0.35-0.96)   | .03     | 0.64 (0.25-1.64)   | .35     |
| Previous                             | 0.66 (0.44-0.99)   | .05     | 0.81 (0.60-1.09)   | .17     | 0.76 (0.48-1.2)    | .23     |
| Prior surgery                        | 0.61 (0.35-1.06)   | .08     | 0.83 (0.55-1.26)   | .39     | 0.98 (0.56-1.69)   | .93     |
| Spondylolisthesis                    | 1.74 (0.93-3.27)   | .08     | 1.63 (1.19-2.22)   | <.001   | 1.3 (0.71-2.35)    | .40     |
| Disc herniation                      | 1.64 (0.96-2.82)   | .07     | 1.12 (0.73-1.73)   | .61     | 1.61 (0.72-3.59)   | .24     |
| Postlaminectomy/failed back syndrome | 0.92 (0.48-1.76)   | .81     | 0.94 (0.63-1.40)   | .75     | 0.44 (0.25-0.77)   | <.001   |
| Stenosis                             | 1.13 (0.67-1.91)   | .64     | 1.07 (0.74-1.56)   | .70     | 1.17 (0.63-2.18)   | .61     |
| Pseudarthrosis                       | 0.35 (0.11-1.10)   | .07     | 0.47 (0.22-1.02)   | .06     | 0.6 (0.2-1.79)     | .36     |
| Radiculopathy                        | 0.63 (0.31-1.27)   | .20     | 0.97 (0.54-1.74)   | .91     | 0.38 (0.12-1.19)   | .10     |
| Prescription opiate use              | 1.05 (0.74-1.49)   | .77     | 0.65 (0.50-0.86)   | <.001   | 0.72 (0.48-1.09)   | .13     |
| Asthma                               | 0.54 (0.30-0.98)   | .04     | 0.86 (0.55-1.32)   | .48     | 0.87 (0.45-1.68)   | .67     |
| Baseline                             |                    |         |                    |         |                    |         |
| ODI score                            | 1.05 (1.03-1.07)   | <.001   |                    |         |                    |         |
| NRS back pain score                  |                    |         | 1.53 (1.44-1.64)   | <.001   |                    |         |
| NRS leg pain score                   |                    |         |                    |         | 0.80 (0.48-1.34)   | <.001   |

# Conclusions

- Patient safety is the primary goal of management of spinal disorders
- Risk stratification is important in empowering informed choice regarding surgery, and in determining the appropriateness of surgical management in spinal deformity
- Risk assessment is based upon variables that are difficult to measure including patient-based and surgery-based factors
- It is important to establish reasonable and accurate standards for complications with risk stratification as we move toward an era of accountability for care

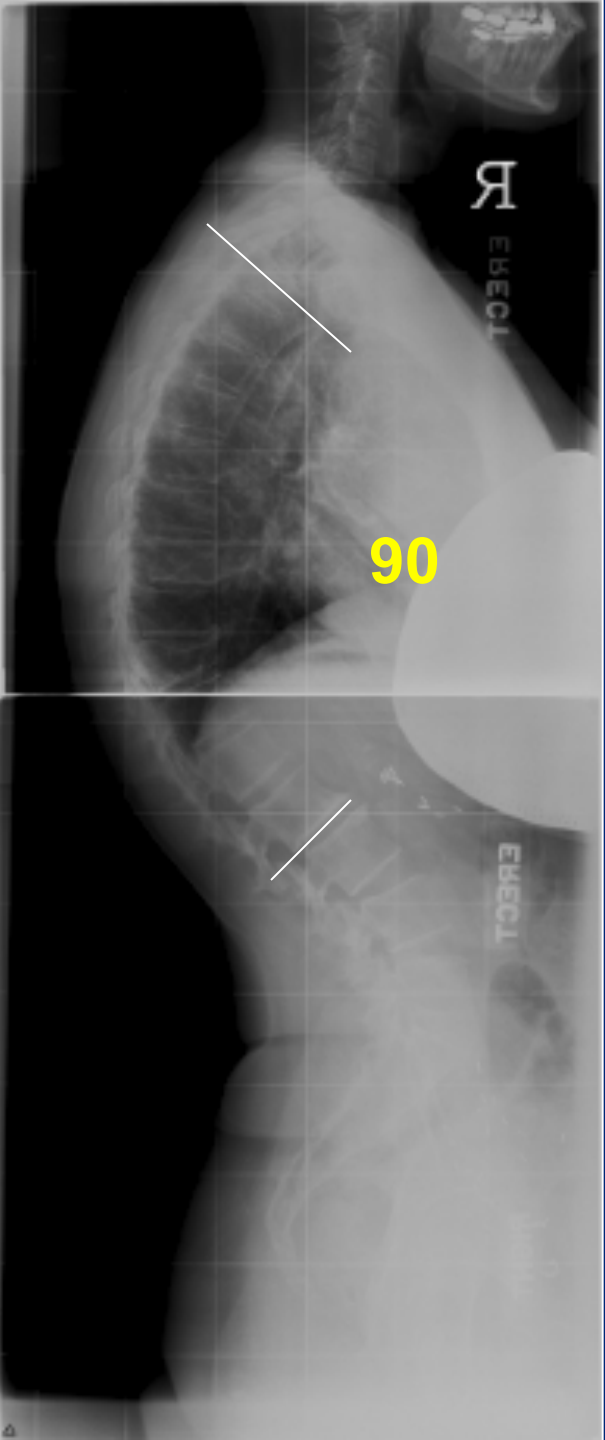


UCSF Center for Outcomes Research

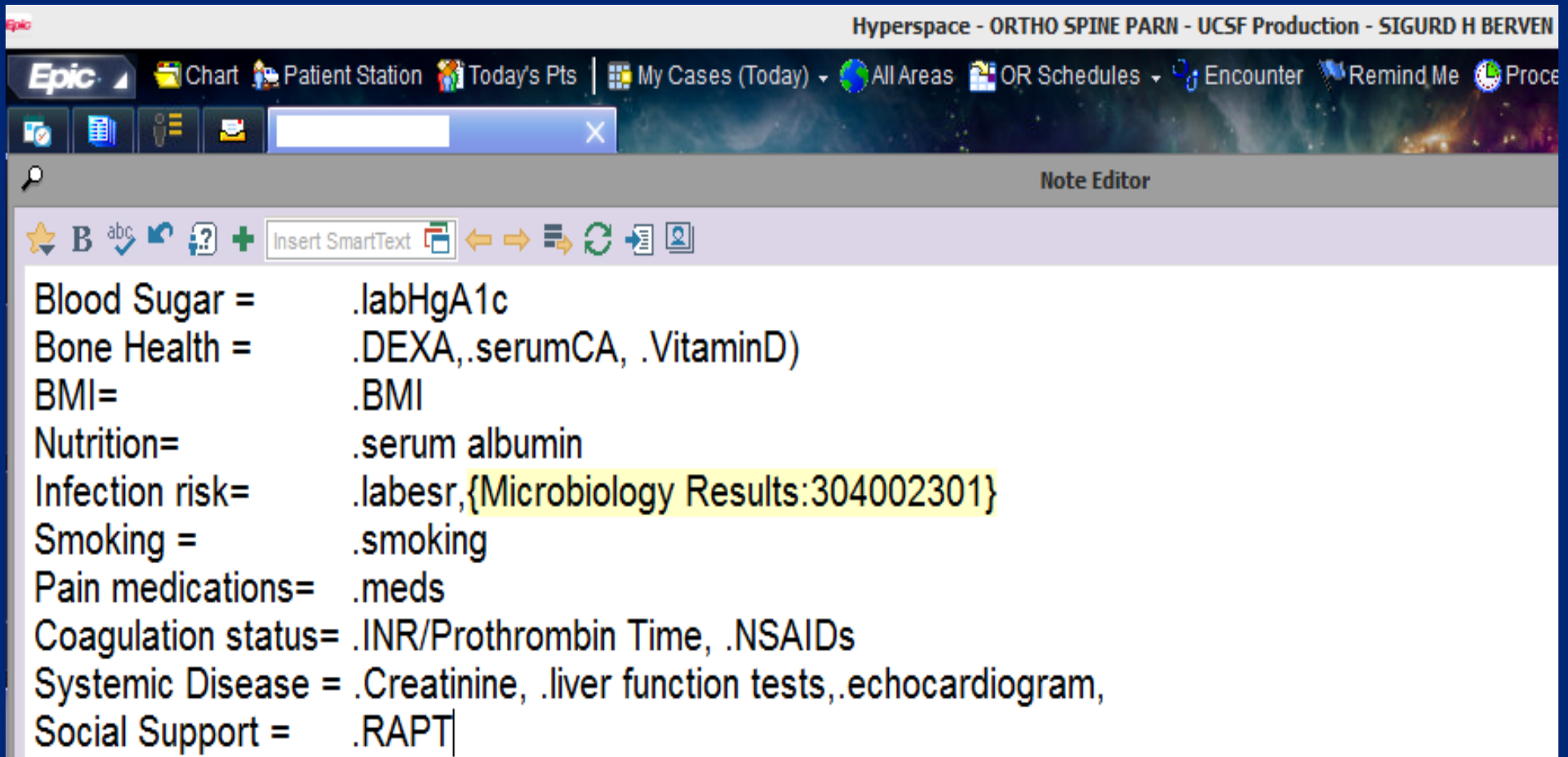
- 78yo female SF socialite
- Lives independently- active philanthropist
- Progressive deformity with pain to the thoracolumbar spine and difficulty standing upright
- Persistence of pain despite PT, Exercise, pain medications







# EMR based Risk Stratification



The screenshot shows the Epic EMR interface. The top navigation bar includes "Hyperspace - ORTHO SPINE PARN - UCSF Production - SIGURD H BERVEN". Below this is a secondary navigation bar with "Epic" logo and various icons for "Chart", "Patient Station", "Today's Pts", "My Cases (Today)", "All Areas", "OR Schedules", "Encounter", "Remind Me", and "Process". A search bar is visible. The main content area is titled "Note Editor" and contains a list of clinical indicators and their corresponding data points:

- Blood Sugar = .labHgA1c
- Bone Health = .DEXA,.serumCA, .VitaminD)
- BMI= .BMI
- Nutrition= .serum albumin
- Infection risk= .labesr,{Microbiology Results:304002301}
- Smoking = .smoking
- Pain medications= .meds
- Coagulation status= .INR/Prothrombin Time, .NSAIDs
- Systemic Disease = .Creatinine, .liver function tests,.echocardiogram,
- Social Support = .RAPT|

- Edmonton Frailty Score
- Mental Health



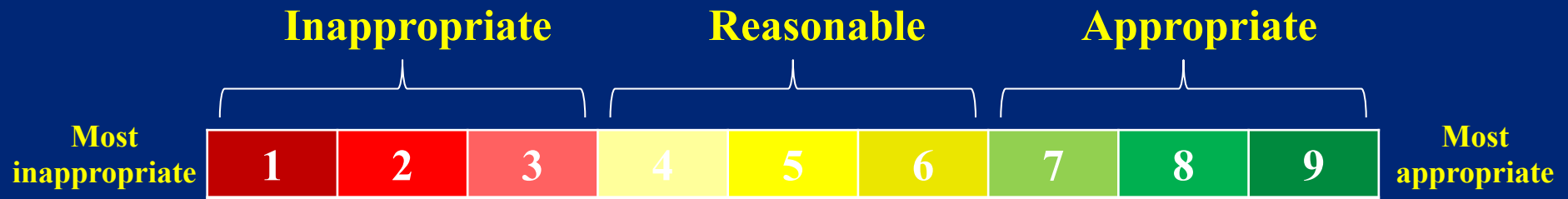
# Risk Stratification

- DEXA = -2.1 (On Forteo for 6 mos)
  - Prior compression fractures at T10 and T11
- Lives Alone
  - Home support with live in staff
  - Family nearby

# Rand/UCLA AUC Methodology

Making Informed Choices under conditions of Uncertainty

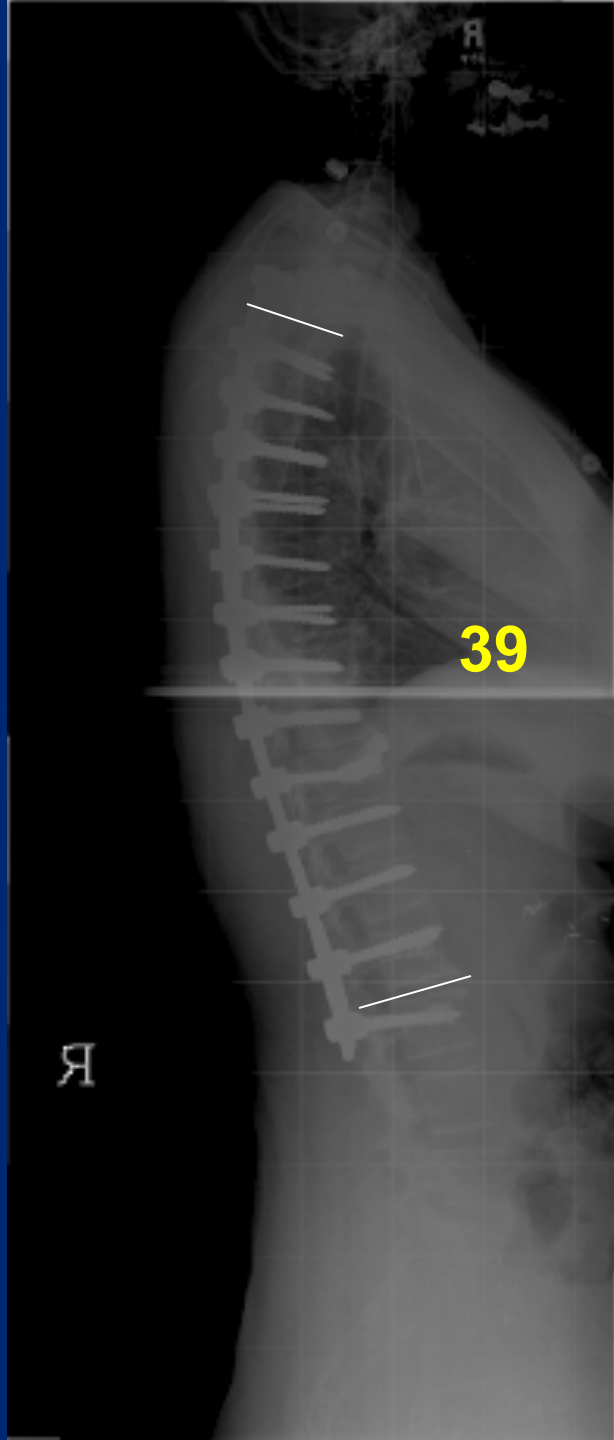
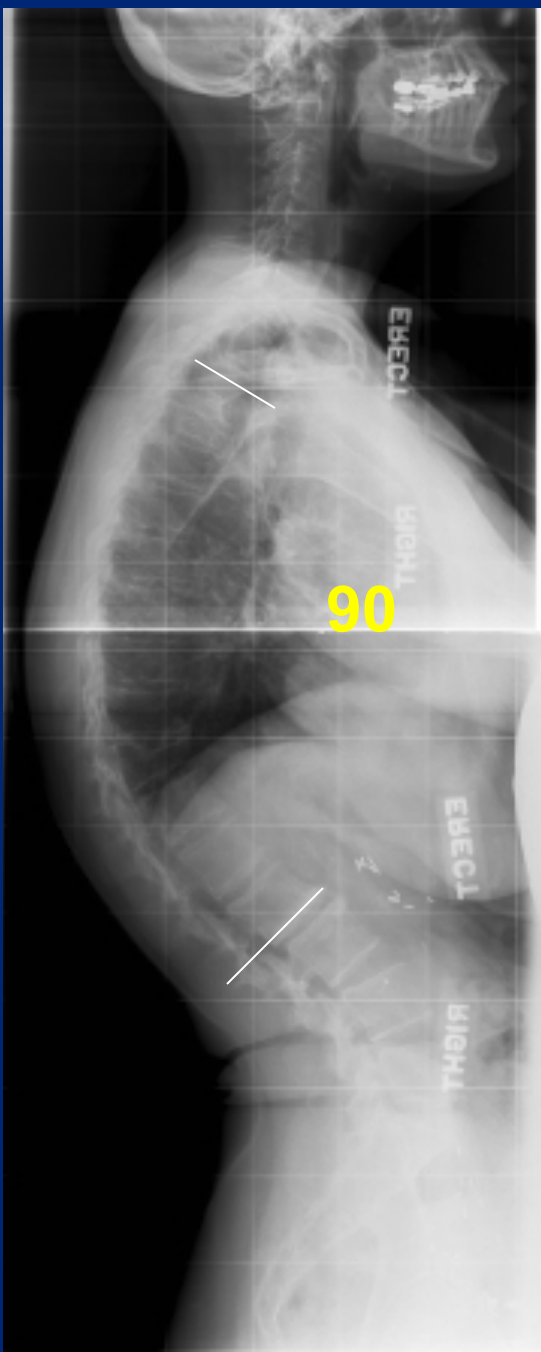
Instructions for Rating Management Procedures and Strategies



|   |  |  |
|---|--|--|
| <p>An <i>inappropriate</i> procedure or management strategy is defined as one in which <b>the value (benefit per unit cost) is LOW</b>:<br/>The expected negative consequences exceeds the expected health benefit such that the procedure should not be performed.</p> | <p>A <i>reasonable</i> procedure or management strategy is one in which:<br/>The balance of risk and benefit are not known, but there is a reasonable chance of positive net benefit, with limited risk.</p> | <p>An <i>appropriate</i> procedure or management strategy is defined as one in which <b>the value (benefit per unit cost) is HIGH</b>:<br/>The expected health benefit exceeds the expected negative consequences by a sufficiently wide margin that the procedure is worth doing.</p> |
|---|--|--|

Fitch et al. 2001







# 4 weeks post-op Patient with severe cervicothoracic pain



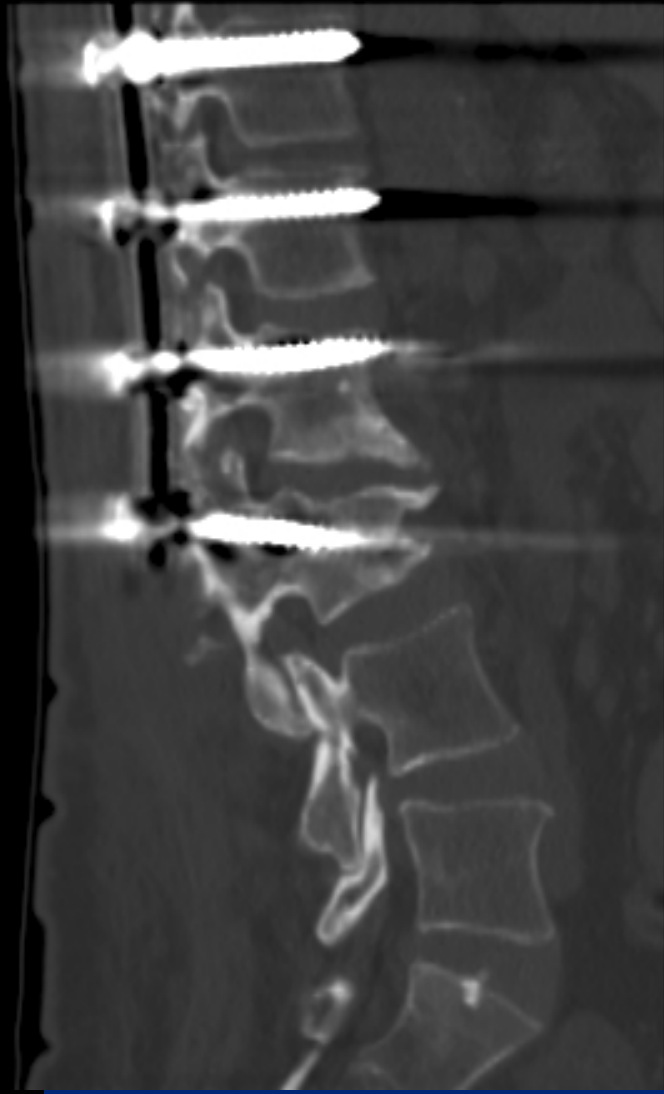
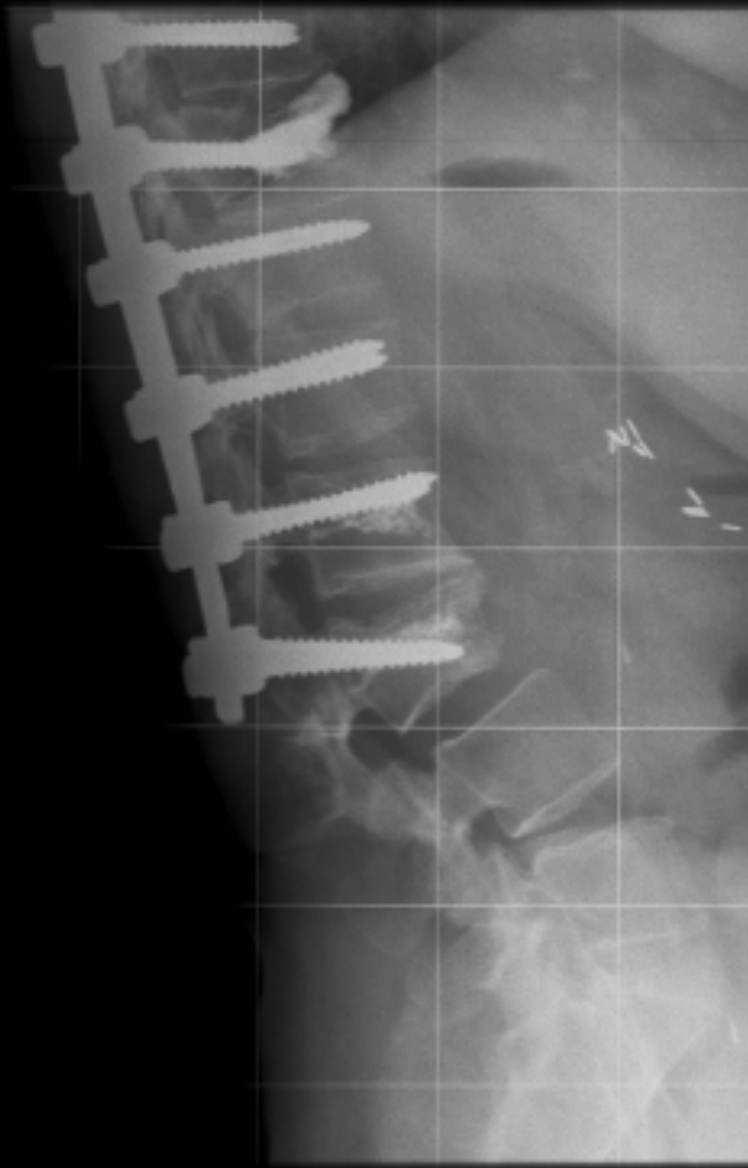










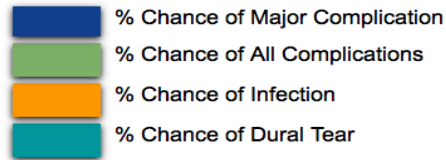






|  |                 |
|--|-----------------|
| Patient Age  | 65              |
| Patient Gender   | Female          |
| Does the patient have Cerebrovascular Disease?               | No              |
| Does the patient have Chronic Obstructive Pulmonary Disease? | No              |
| Does the patient have Asthma?                                | No              |
| Does the patient have Hypertension?                          | Yes             |
| Does the patient have Rheumatoid Arthritis?                  | No              |
| Does the patient have Renal Conditions?                      | No              |
| Does the patient have pre-existing Neoplasm?                 | No              |
| Does the patient have a history of Syncope or Seizure?       | No              |
| Does the patient have Anemia?                                | No              |
| Does the patient have a bleeding disorder?                   | No              |
| Does the patient have diabetes?                              | Yes             |
| Does the patient have congestive heart failure?              | No              |
| Is this a revision surgery?                                  | No              |
| Has the patient had a previous spinal surgery?               | No              |
| Has the patient had previous cardiac complications?          | No              |
| What is the patients BMI?                                    | Greater than 30 |
| Primary Diagnosis  | Degenerative    |
| Level of Surgery   | Lumbosacral     |
| Surgical Approach  | Combined        |

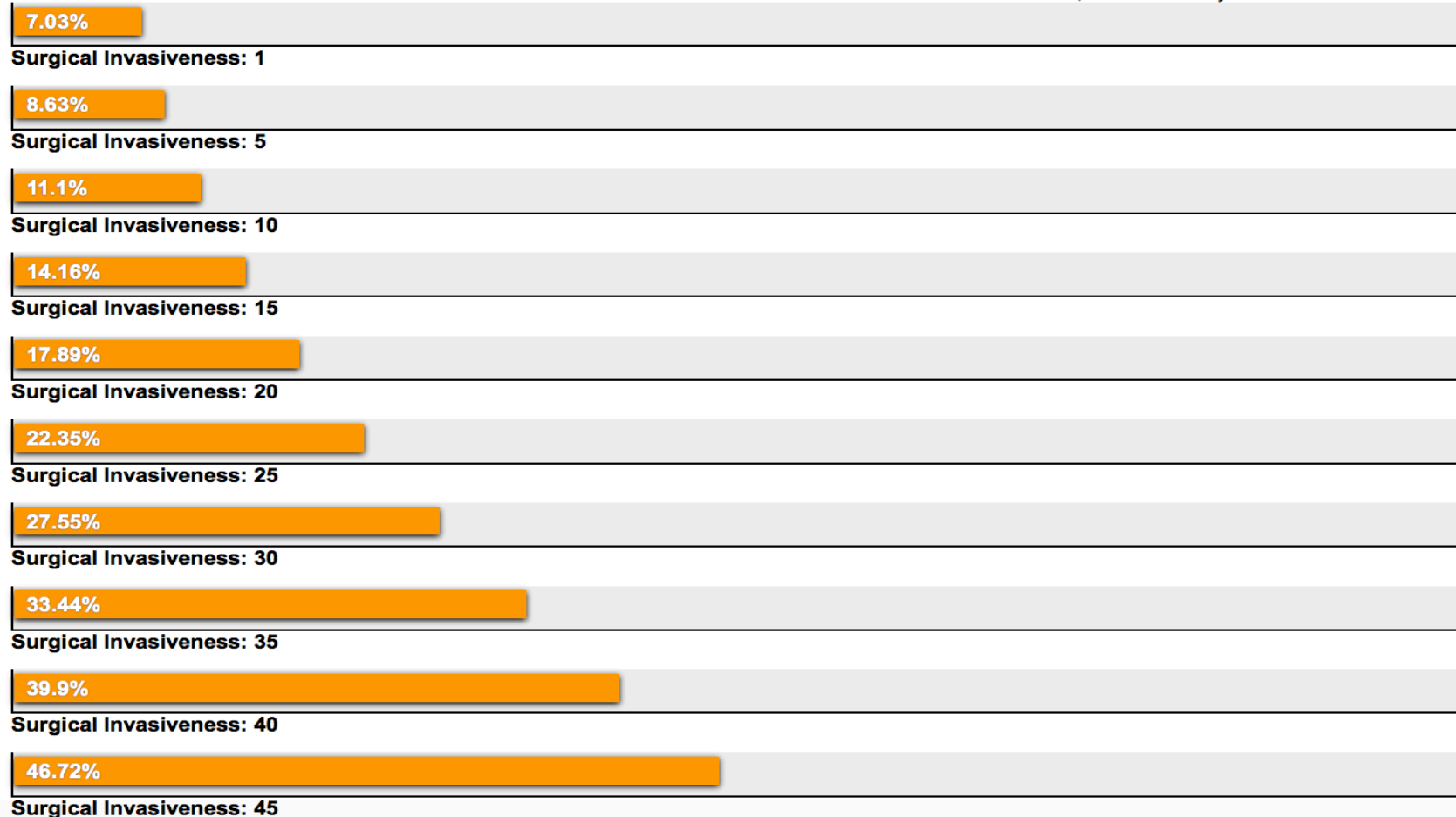
**Graph Key**







**Surgical Invasiveness Examples**

*What's This?*

| Level | Procedure   |
|-------|---|
| 1     | L45 microdiscectomy; C56 foraminotomy   |
| 3     | L2-5 laminectomy  |
| 5     | L45 laminectomy, posterior lateral instrumented fusion; C56 anterior cervical discectomy and fusion                                     |
| 8     | L45 TLIF with cage, posterior lateral instrumented fusion   |
| 14    | L2-S1 laminectomy; L2-S1 instrumented posterior lateral fusion (NO interbody); C3-7 laminectomy with C3-7 posterior instrumented fusion |
| 20    | T10- S1 Posterior lateral instrumented fusion, L5-S1 interbody fusion   |
| 26    | T10- S1 Posterior lateral instrumented fusion, L2-S1 interbody fusion   |



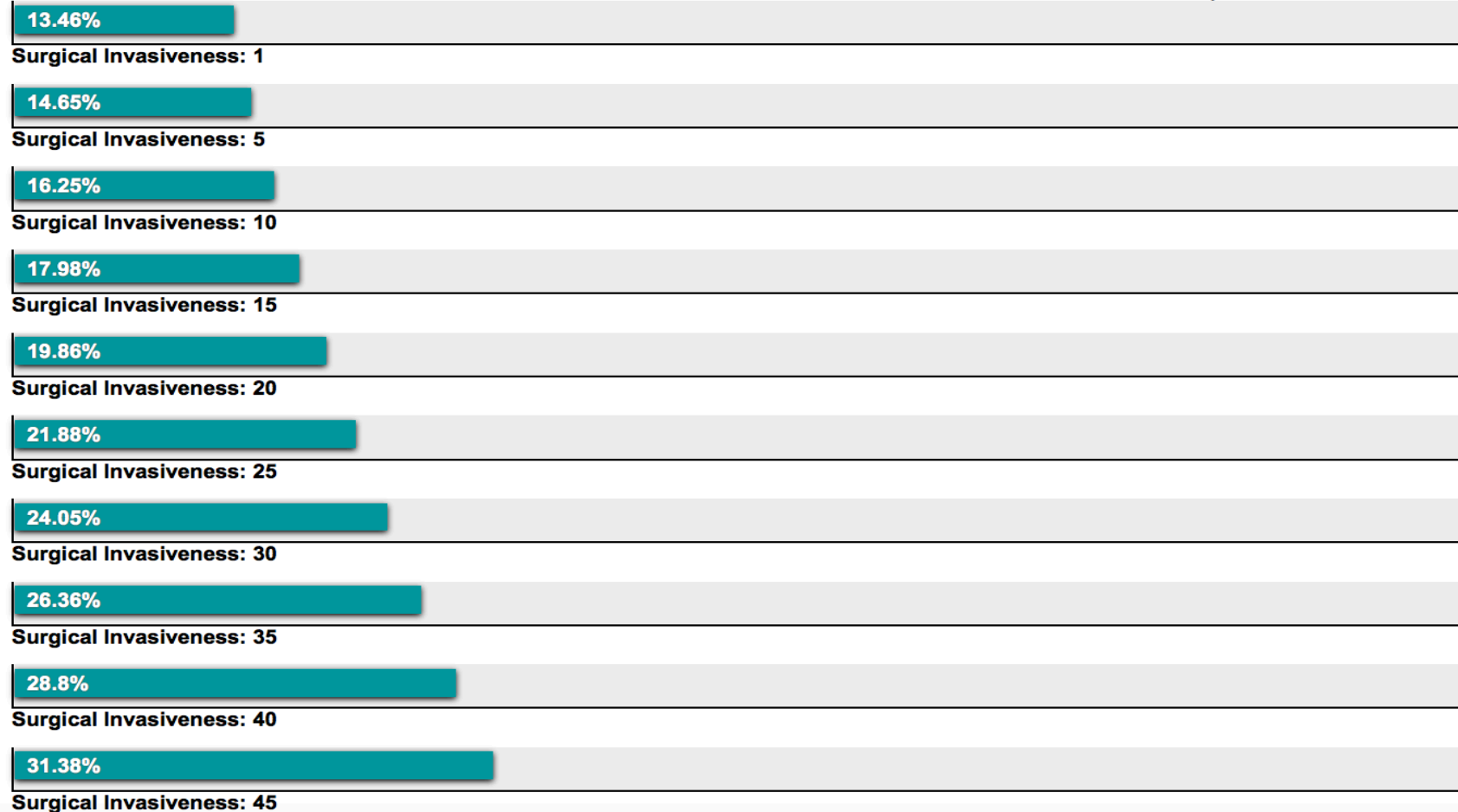
**Graph Key**

-  % Chance of Major Complication
-  % Chance of All Complications
-  % Chance of Infection
-  % Chance of Dural Tear

**Surgical Invasiveness Examples**

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# Limiting Perioperative Risk

- Preoperative Planning
  - Multidisciplinary conferences
  - Patient Goals/ Surgical Goals
- Preoperative Optimization of Modifiable Risk Factors
  - Smoking
  - Bone Density/Strength
  - Cardiac/Pulmonary Disease
  - BMI
  - Social Support