

Transforming Spine Care via Multidisciplinary Pathways: Value Based Algorithms

Virginia Mason™

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Past Chair, Safety and Value, Scoliosis Research Society
Board of Directors, Scoliosis Research Society
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Disclosures

I have no financial relationships to disclose.

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2

Greetings from Seattle USA



amazon.com™



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A bit about me

- American, British and Indian
- Born in United Kingdom
- Moved to USA at age 2
- Health services research in spine
- Perform surgery on complex spine conditions
- Have presented in 26 countries over the past 11 years on new paradigms in spine care



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Operating and learning from others is a passion

Indonesia 2016



Sri Lanka 2015



What is population health?

“the health outcomes of a group of individuals, including the distribution of such outcomes within the group.”

Kindig, DA, Stoddart G. (2003). What is population health? American Journal of Public Health, 93, 366-369.

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Value in Healthcare

$$\text{Value} = \frac{\text{Health outcomes}}{\text{Costs of delivering the outcomes}}$$

Porter, Michael : HBS Healthcare initiative and healthcare club, March 7 2012

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How to increase value in healthcare?



Quality

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How to increase value in healthcare?



Quality



Outcomes

<http://combibollensleeds.com/keywords/outcome-1.html>

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How to increase value in healthcare?



Quality



Outcomes



Pay for it!

<http://combibollensleeds.com/keywords/outcome-1.html>

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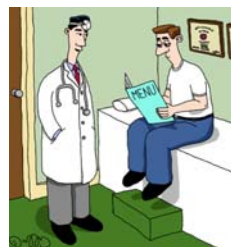
How to pay for healthcare?



Fee For Service

<http://www.fckdinger.net/blog/2013/03/12/compensating-emergency-physicians-if-not-fee-for-service-what/>

How to pay for healthcare?



Fee For Service

- Quantity of Care

<http://www.fckdinger.net/blog/2013/03/12/compensating-emergency-physicians-if-not-fee-for-service-what/>

How to pay for healthcare?



<http://www.fickelinger.net/blog/2013/09/12/compensating-emergency-physicians-if-not-fee-for-service-what/>

Fee For Service

- Quantity of Care
- Incentive to treat

How to pay for healthcare?



<http://www.fickelinger.net/blog/2013/09/12/compensating-emergency-physicians-if-not-fee-for-service-what/>

Fee For Service

- Quantity of Care
- Incentive to treat
- Resources

How to pay for healthcare?



<http://www.fickelinger.net/blog/2013/09/12/compensating-emergency-physicians-if-not-fee-for-service-what/>

Fee For Service

- Quantity of Care
- Incentive to treat
- Resources
- Value?

Value Based Reimbursement

Value Based Reimbursement

Capitation

Value Based Reimbursement

Capitation

Bundled Payment

Capitation



<http://willchangehealthcare.com/resurgence-of-capitation/>

Capitation



<http://willchangehealthcare.com/resurgence-of-capitation/>

- \$/Patient/Unit time

Capitation



<http://willchangehealthcare.com/resurgence-of-capitation/>

- \$/Patient/Unit time
- Risk is spread

Capitation



<http://willchangehealthcare.com/resurgence-of-capitation/>

- \$/Patient/Unit time
- Risk is spread
- Improvement at population level

Capitation



<http://willchangehealthcare.com/resurgence-of-capitation/>

- \$/Patient/Unit time
- Risk is spread
- Improvement at population level
- Health systems competition
- Virginia Mason vs. Allina
- Choose the best
- Beauty is in the eye of the beholder!

Bundled Payment



<http://www.sequentphysicians.com/practices-preparing-for-macra/>

Bundled
Payment

- Single payment → Entire Care cycle



<http://www.sequentphysicians.com/practices-preparing-for-macra/>

<https://hbr.org/2016/07/>

Bundled
Payment

- Single payment → Entire Care cycle
- Contingent on delivering outcomes



<http://www.sequentphysicians.com/practices-preparing-for-macra/>

<https://hbr.org/>

Bundled
Payment

- Single payment → Entire Care cycle
- Contingent on delivering outcomes
- Adjusted for risks



<http://www.sequentphysicians.com/practices-preparing-for-macra/>

<https://hbr.org/>

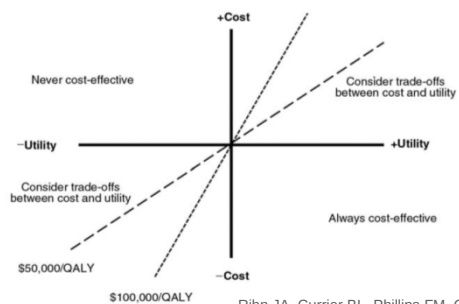
Bundled
Payment

- Single payment → Entire Care cycle
- Contingent on delivering outcomes
- Adjusted for risks
- Fair profit for efficient care

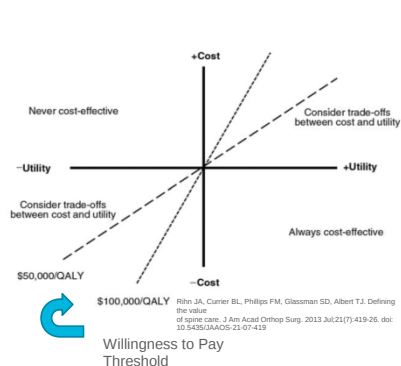


<http://www.sequentphysicians.com/practices-preparing-for-macra/>

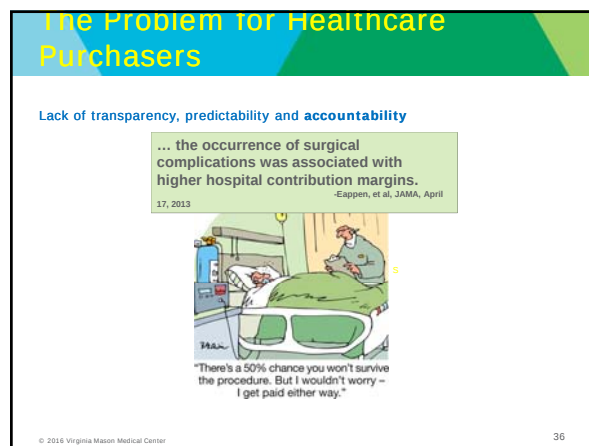
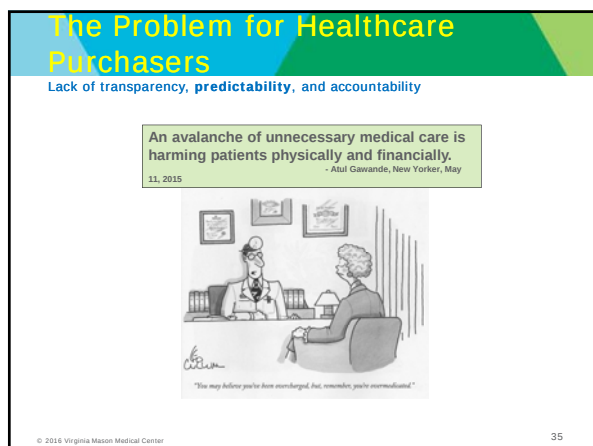
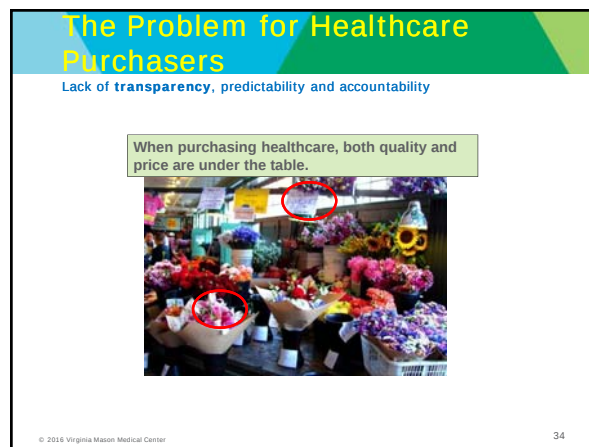
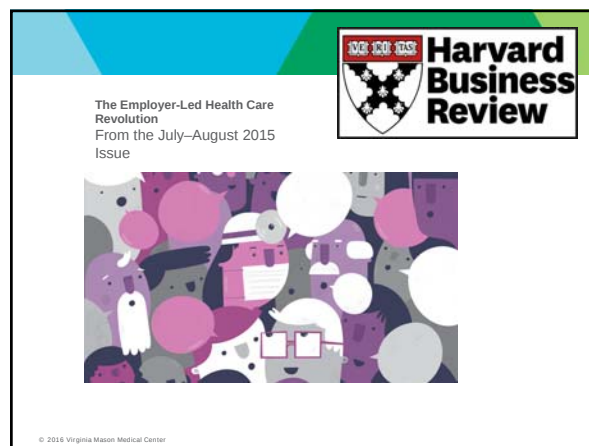
<https://hbr.org/>



Rihn JA, Currier BL, Phillips FM, Glassman SD, Albert TJ. Defining the value of spine care. J Am Acad Orthop Surg. 2013 Jul;21(7):419-26. doi: 10.5435/JAAOS-21-07-419



Rihn JA, Currier BL, Phillips FM, Glassman SD, Albert TJ. Defining the value of spine care. J Am Acad Orthop Surg. 2013 Jul;21(7):419-26. doi: 10.5435/JAAOS-21-07-419



ECONOMICS AND OUTCOMES PERSPECTIVE

Trends for Spine Surgery for the Elderly: Implications for Access to Healthcare in North America

Thomas M. O'Lynn, MD, MPH
Scott L. Zuckerman, MD
Peter J. Monson, MD
Michael C. Dewan, MD
Raul A. Vazquez-Castellanos, MD
Joseph S. Cheng, MD, MS

The proportion of the population over age 65 in the United States continues to increase over time, from 12% in 2000 to a projected 20% by 2030. There is an associated rise in the prevalence of degenerative spinal disorders with this aging population. This will lead to an increase in demand for both nonsurgical and surgical treatment for these disabling conditions, which will stress an already overburdened healthcare system. Utilization of spinal procedures and services has grown considerably. Comparing 1999 to 2009, lumbar epidural steroid injections have increased by nearly 900,000 procedures performed per year, while physical therapy evaluations have increased by nearly 1.4 million visits per year. We review the literature regarding the cost-effectiveness of spinal surgery compared to conservative treatment. Decompressive lumbar spinal surgery has been shown to be cost-effective in several studies, while adult spinal deformity surgery has higher total cost per quality-adjusted life year gained in the short term. With an aging population and unsustainable healthcare costs, we may be faced with a shortfall of beneficial spine care as demand for spinal surgery in our elderly population continues to rise.

KEY WORDS: Access to healthcare, Elderly, Spine surgery

Neurosurgery 77(10):1941-1951, 2013 DOI: 10.1016/j.neurosurg.2013.08.006 www.neurosurgeryonline.com

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Since we aren't driving reform, guess who is?



Centers of Excellence

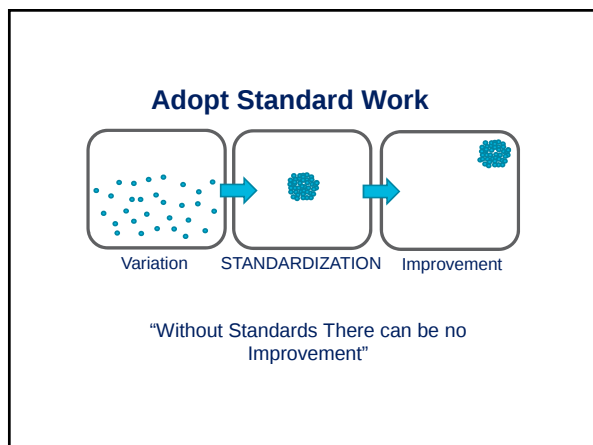
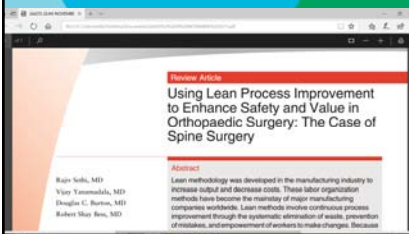
Cardiac: Cleveland Clinic, Cleveland, OH; University of Michigan, Ann Arbor, MI; Scott & White Memorial Hospital, Temple, TX; Virginia Mason Medical Center, Seattle, WA

Hip and knee replacements: Johns Hopkins Medical Center, Baltimore, MD; Kaiser Permanente, Irvine, CA; Mayo Hospital, Springfield, Illinois, IL; Virginia Mason Medical Center, Seattle, WA

Spine: Mayo Hospital, Springfield, Illinois, IL; Scott & White Memorial Hospital, Temple, TX; Virginia Mason Medical Center, Seattle, WA

Transplants: Mayo Clinic, Rochester, MN; Indiana University, Indianapolis, IN; University of Pittsburgh Medical Center, Pittsburgh, PA

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Sethi et al., November 2017

- Eliminate provider variability
- Appropriateness criteria for all surgeons
- Transparency
- Multidisciplinary
- Best practices
- 3 fold improvement in the worst complications
- 12 fold decrease in return to surgery in the first three months postop

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Spine Deformity

Spine Deformity 2 (2016) 91-101

Clinical Series

The Seattle Spine Team Approach to Adult Deformity Surgery: A Systems-Based Approach to Perioperative Care and Subsequent Reduction in Perioperative Complication Rates

Rajiv K. Sethi, MD^{1,*}, Ryan P. Pong, MD², Jean-Christophe Leveque, MD³, Thomas C. Deane, MD⁴, Stephen J. Oliver, MD⁵, Stephen M. Rogers, MD⁶

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²Department of Neurosurgery, Group Health Physicians and Virginia Mason Medical Center, Seattle, WA, USA
³Department of Neurosurgery, Group Health Physicians and Virginia Mason Medical Center, Seattle, WA, USA
⁴Department of Neurosurgery, Group Health Physicians and Virginia Mason Medical Center, Seattle, WA, USA
⁵Department of Neurosurgery, Group Health Physicians and Virginia Mason Medical Center, Seattle, WA, USA
⁶Department of Neurosurgery, Group Health Physicians and Virginia Mason Medical Center, Seattle, WA, USA

Received 1 May 2015; revised 4 December 2015; accepted 4 December 2015

Case presentation to and approved for surgery by a live multidisciplinary spine conference

Mandatory completion of patient education course in preparation for surgery and post-op care

Two attending surgeons trained in neurosurgery and orthopedics for complex cases

Intraoperative standardized protocol without case to case variability

3 fold reduction in readmissions and 12 fold decrease in return to surgery in the first year

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SPINE An International Journal for the study of the spine Publish Ahead of Print

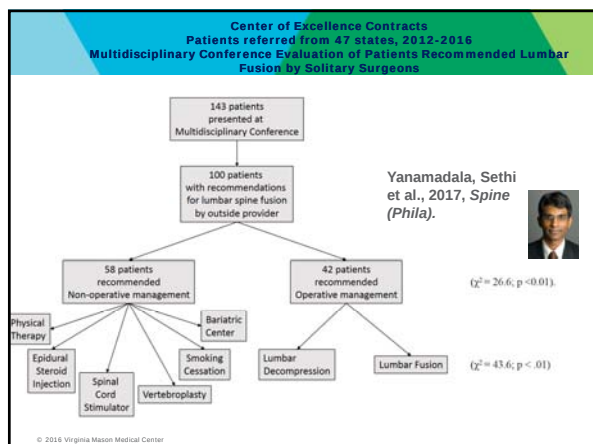
DOI: 10.1097/BRS.0000000000002065

Multidisciplinary Evaluation Leads to the Decreased Utilization of Lumbar Spine Fusion

An Observational Cohort Pilot Study

Vijay Yanamadala, MD, MBA^{1,2,3}, Yourie Kim, RN, BSN^{1,4}, Quinlan D. Buchlak, MPsych¹, Anna K. Wright, PhD¹, James Babington, MD^{1,4}, Andrew Friedman, MD^{1,4}, Robert S. Mecklenburg, MD¹, Farrokh Farrokhi, MD^{1,2}, Jean-Christophe Leveque, MD^{1,2}, and Rajiv K. Sethi, MD^{1,2,6}

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Reasons for Alternative Approaches for 1-2 levels of spine fusion offered for back pain

Yanamadala, Sethi et al., *Spine*, 2017

	Number of Patients	Percentage
Misdiagnosis by Outside Surgeon	3	6%
Morbid Obesity (BMI > 40)	5	10%
Active Smoking	5	10%
Likely to Benefit from Additional Physical Therapy	11	22%
Likely to Benefit from ESI	3	6%

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60 percent of spinal fusions in this cohort did not get a spinal fusion operation at Virginia Mason.

60 percent recommended nonoperative options when reviewed by a multidisciplinary panel where all panelists are given an equal vote as to the suitability of surgery

2 percent of these patients chose to have surgery in their home community after returning home from Seattle

Further study about patient satisfaction underway

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JNS^{SPINE} CLINICAL ARTICLE

A systematic multidisciplinary initiative for reducing the risk of complications in adult scoliosis surgery

Rajiv Sethi, MD,^{1,2} Quinlan D. Buchlak, MPsych,¹ Vijay Yanamadala, MD, MBA,¹ Melissa L. Anderson, MS,¹ Eric A. Baldwin, MS,¹ Robert S. Mecklenburg, MD,¹ Jean-Christophe Leveque, MD,¹ Alicia M. Edwards, MBA,¹ Mary Shea, MA,¹ Lisa Ross, MPH,¹ and Karen J. Wernli, PhD¹

Population health, cost and value and scoliosis surgery

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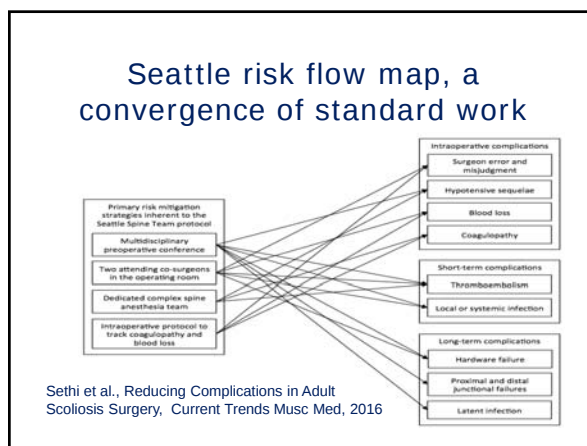
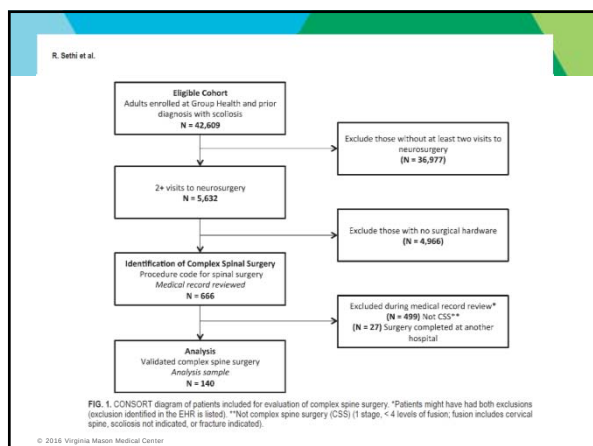


TABLE 3. Risk of any complication 30 days and 1 year after complex spine surgery, according to study period

Any Overall Complication	No. of Patients (%)		RR (95% CI)*
	Preintervention Period	Postintervention Period	
30 days	34 (48)	17 (25)	0.49 (0.30–0.78)
1 yr	19 (27)	16 (23)	0.98 (0.55–1.77)

* Analyses were adjusted for age (< 65 or ≥ 65 years) and Charlson/Deyo comorbidity score (0 or ≥ 1).

6 J Neurosurg Spine March 31, 2017 Sethi et al.

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Is Spinal Fusion Surgery Affordable on the NHS?

British Association of Spinal Surgeons 2017 annual meeting
Rajiv Sethi MD, USA, Keynote Speaker

Mr Ashley Cole

Clinical Lead Improving Spinal Care

Project

Spinal Chair Orthopaedic Expert Working
Group

Spinal Service CRG Chair



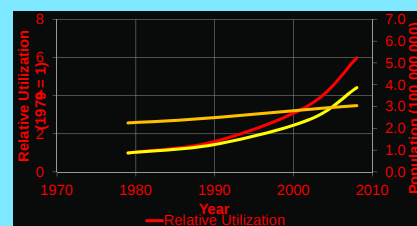
NHS
England

Slide
Courtesy of
Mr. Ashley
Cole, NHS

The Utilization of Spine Surgery in the United States

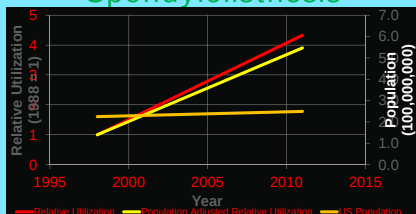


Utilization of Lumbar Fusion in the United States



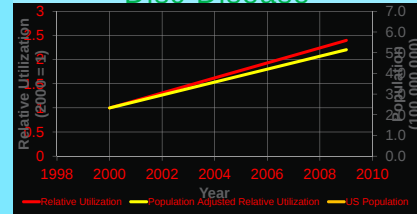
Davis, H. Increasing rates of cervical and lumbar spine surgery in the United States, 1979-1990. Spine (Phila Pa 1976). 1994; 19(18): p. 1117-24. discussion 1123-4.
Deyo, R.A., et al. United States trends in lumbar fusion surgery for degenerative conditions. Spine (Phila Pa 1976). 2005; 30(12): p. 1441-5. discussion 1446-7.
Dagostino, P.R., et al. Impact of bone morphogenetic proteins on frequency of revision surgery, use of autograft bone, and total hospital charges in surgery for lumbar degenerative disease: review of the Nationwide Inpatient Sample from 2002 to 2008. Spine J. 2014; 24(2): p. 20-30.

Utilization of Lumbar Fusion for Spondylolisthesis



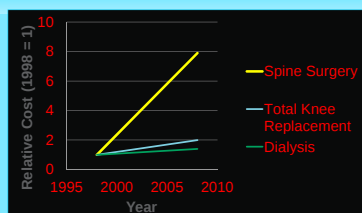
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Utilization of Lumbar Fusion for Degenerative Disc Disease



Davis, H. Increasing rates of cervical and lumbar spine surgery in the United States, 1979-1990. Spine (Phila Pa 1976). 1994; 19(18): p. 1117-24. discussion 1123-4.
Deyo, R.A., et al. United States trends in lumbar fusion surgery for degenerative conditions. Spine (Phila Pa 1976). 2005; 30(12): p. 1441-5. discussion 1446-7.
Dagostino, P.R., et al. Impact of bone morphogenetic proteins on frequency of revision surgery, use of autograft bone, and total hospital charges in surgery for lumbar degenerative disease: review of the Nationwide Inpatient Sample from 2002 to 2008. Spine J. 2014; 24(2): p. 20-30.

Costs of Spine Surgery



Davatz, M., Increasing rates of cervical and lumbar spine surgery in the United States, 1979-1990. *Spine (Phila Pa 1976)*. 1994. 19(10): p. 1137-39. discussion 1129-31.
 Deyo, R.A., et al., United States trends in lumbar fusion surgery for degenerative conditions. *Spine (Phila Pa 1976)*. 2005. 30(12): p. 1465-6. discussion 1466-7.
 Degenstein, P.B., et al., Impact of bone morphogenetic proteins on frequency of revision surgery, use of autograft bone, and total hospital charges in surgery for lumbar degenerative disease: review of the Nationwide Inpatient Sample from 2002 to 2006. *Spine J*. 2014. 24(1): p. 30-36.

Is spinal fusion surgery COST EFFECTIVE?

We have very little "standard work"

Perverse economic incentives and fee for service

Private payors and governments are fed up

Physicians must understand health care economics and delivery

Better algorithms in systems will win

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Spine surgery in America today!



Fig 5.5. Spine Surgery

The prevalence of spine surgery varies widely by state. The highest prevalence is in the Northeast and the Midwest. Data from the Healthcare Cost and Access Survey (HCAS) 2010.

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Surgeons and hospitals should drive reform!



THE NEW YORKER

NEWS CULTURE BOOKS & FICTION SCIENCE & TECH BUSINESS HUMOR MAGAZINE VIDEO

ANNALS OF HEALTH CARE | MAY 11, 2015 ISSUE

OVERKILL

An avalanche of unnecessary medical care is harming patients physically and financially. What can we do about it?

BY ATUL GAWANDE

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The Virginia Mason multidisciplinary clearance conference, 1100 spinal deformity patients presented over the past 6 years from all 50 states



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If teamwork and...coordination could be built into...the surgical multidisciplinary team, high-risk patients might be...less likely to have complications or require rehospitalization.

Glance, Osler, Neuman. Redesigning Surgical Decision Making for High-Risk Patients. *NEJM* 2015

Multi-disciplinary Preoperative Eligibility Case Conference

Team Members:

- Complex Spine Surgeons (Ortho and Neuro)
- Anesthesia Spine Team (MD and CRNA)
- Physiatrists
- Neurophysiologist
- Internist
- Pain Management Physicians
- Spine PAs
- Critical Care MD
- Spine Clinic RNs
- Research Personnel
- Community Spine Surgeons



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All proposed lumbar spine fusions need this note prior to booking the case

Document Type: Multidisciplinary Complex Spine Clearance Conference
 Document Date: August 26, 2016 10:52
 Document Status: Auth (Verified)
 Document Title/Subject: Multidisciplinary Complex Spine Clearance Conference
 Performed By/Author: Nold PA-C, Kellen A on September 01, 2016 10:55
 Verified By: Nold PA-C, Kellen A on September 01, 2016 10:55
 Encounter info: 28358212, VM DT CLINIC, Clinic -Z Rad-Radiology Procedure, 08/05/2016 - 08/05/2016



Final Report *

Virginia Mason Medical Center

[Multidisciplinary Complex Spine Conference](#)

Patient was discussed at multidisciplinary complex spine conference on 08/26/2016. Representatives from the departments of Anesthesia, Physical Medicine and Rehab, VM Neurosurgery Spine, Physical Therapy, Anesthesia Pain Service, VM Ortho spine and UW Ortho Spine were present for the discussion.

Concerns:

- History of left main ablation, would like cardiology clearance
- Smoking cessation with 2 documented negative urine cotinine
- Neuro psych pending, needs to be completed, patient should be re-presented if Orange/Red
- Otherwise clear to proceed for surgery. Represent if problems/concerns arise.

Signature Line

(Electronically Signed on 09/01/16 10:55 AM)
 Nold PA-C, Kellen A

TEAM
TRANSPARENCY

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Why are we facing this conundrum?

No good algorithm to choose the best patient
 Unable to say "NO"
 Variability in use of healthcare resources
 Variability in outcomes from center to center
 Perverse healthcare economics



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Boosting medical diagnostics by pooling independent judgments

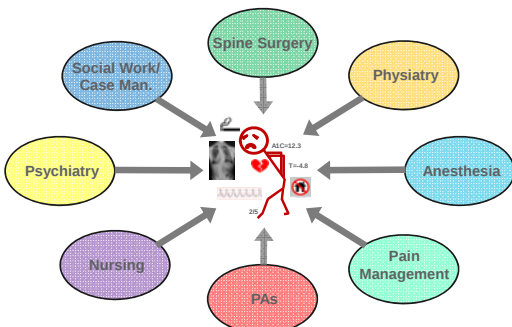
Ralf H. J. M. Kurvers^{1,2}, Stefan M. Herzog³, Ralph Hertwig⁴, Jens Krause⁵, Patricia A. Corney^{1,6}, Andy Bogaert⁷,
 Giuseppe Argenteau⁸, Iris Zaluska⁹, and Max Wolf¹⁰

¹Center for Adaptive Rationality, Max Planck Institute for Human Development, 14195 Berlin, Germany; ²Department of Biology and Ecology of Fishes, Leibniz Institute of Freshwater Ecology and Inland Fisheries, 12585 Berlin, Germany; ³Department of Family Medicine, Knight Cancer Institute, Oregon Health & Science University, Portland, OR 97239; ⁴Department of Public Health & Decision Sciences, Knight Cancer Institute, Oregon Health & Science University, Portland, OR 97239; ⁵Center for Health Research, Seattle, WA 98101; ⁶Department of Mathematics, Second University of Naples, 80131 Naples, Italy; and ⁷Department of Mathematics and Neuroscience, Medical University of Graz, 8036 Graz, Austria

Edited by Lee D. Ross, Stanford University, Stanford, CA, and approved June 7, 2016 (received for review February 2, 2016)

"Aggregating the independent judgments of doctors outperforms the best doctor in a group"

Multidisciplinary Decision-Making Before Spinal Fusion Surgery



Criticisms of the Seattle Protocol

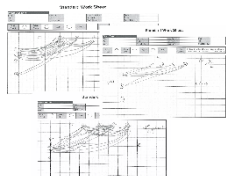
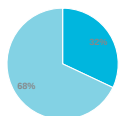
- Time Consuming
- Uncompensated / Unbillable
- Loss of Provider Autonomy
- ~~Improved Value~~

Mechanisms of Efficiency in MDC

Virginia Mason Production System Tools:

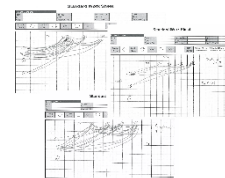
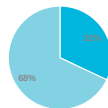
- Timing Conference Conversations
- Mapping Conference Conversations

Percent Cases Beyond Takt
Time May 30th-June 13th 2017
(n=22)



Mechanisms of Efficiency in MDC

Percent Cases Beyond Takt
Time May 30th-June 13th
2017 (n=22)

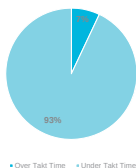


- Targets for Improvement:
 - Most cases run over takt time
 - Discussion can be work or waste
 - Unknown when group has reached **consensus**

Mechanisms of Efficiency in MDC

- First Interventions:
 - Introduced concept of takt time
 - Display presentation cycle timer showing countdown

Percent Cases Beyond Takt Time
June 20th-July 18th 2017 (n=30)



- All pts presented
- No conference time overrun

Mechanisms of Efficiency in MDC

Current Interventions:

- Standard Presentation Format
 - Thorough but not excessive information presented in the same order every time

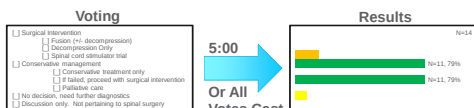
Treatment team: ...
Diagnosis: ...
Clinical question: ...
Case Summary (include temporality of every finding):
Demographics (Age, Sex): ...
Prior surgery: ...
Pain Location (to us 'N): ...
Pain Distribution (dermatome): ...
Other Neurological Signs (motor, sensory, myelopathy): ...
PRO measures: ODIND: ... PROMIS-P: ... PHQ/GAD: ...
Key Imaging Findings:
MRI: ...
CT/CT Myelogram: ...
X-ray (alignment and dynamic mobility (if any)):
EMG/NCV Findings:
Inpatient Specific Types and Results: ...
Physical Therapy (Time and Benefit): ...
Psych/Depression Screen: ...
Smoking: ...
Diabetes: ...
Obesity: ...
Low Bone Density (current T-score and current/prior treatment): ...



Mechanisms of Efficiency in MDC

Current Interventions:

- Smart Device Voting App
 - Records and instantly reports each provider's clinical plan



Utility:

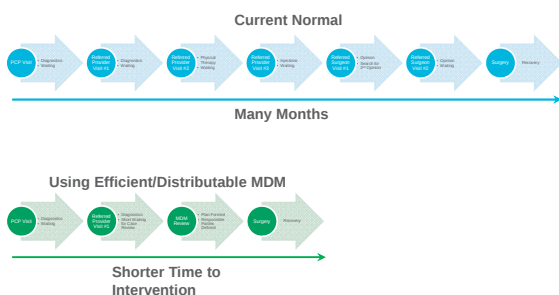
- Detects Consensus vs. Equipose
- Avoids non-work / swirl discussion
- Reduces mean time per case

Future Benefits of Efficiency in MDC

When cycle times are reduced sufficiently to reliably exceed the institutional demand referring providers can telepresent cases in remaining time



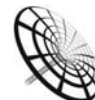
Future Benefits of Efficiency in MDC



Future Benefits of Efficiency in MDC

Efficient MDC Can Be:

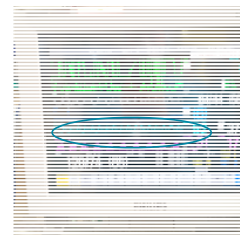
1. Mechanism for **Enhancing** Care Quality
2. Mechanism for **Distributing** Expertise and Quality Culture
3. Mechanism for Efficiently **Gathering** Surgical Cases to Centers of Excellence
4. Asset Highly **Marketable** to Providers, Patients, and Payors



Teams combat stress situations in many arenas



“By FAILING TO PREPARE, you are preparing to fail”- Benjamin Franklin



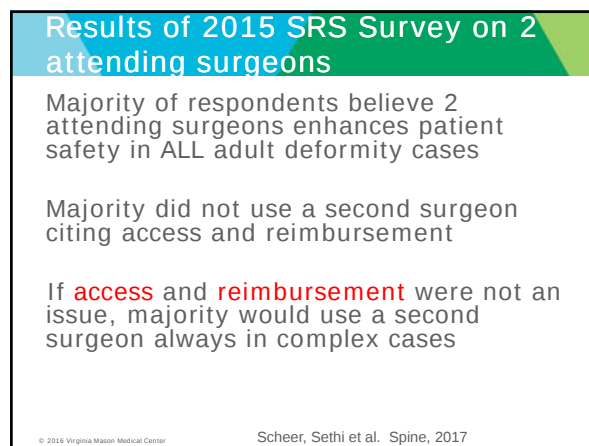
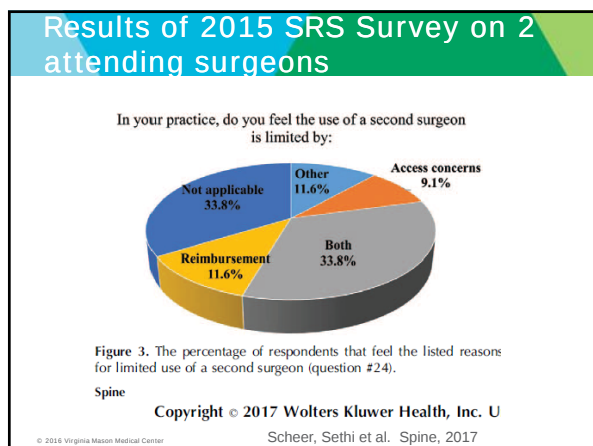
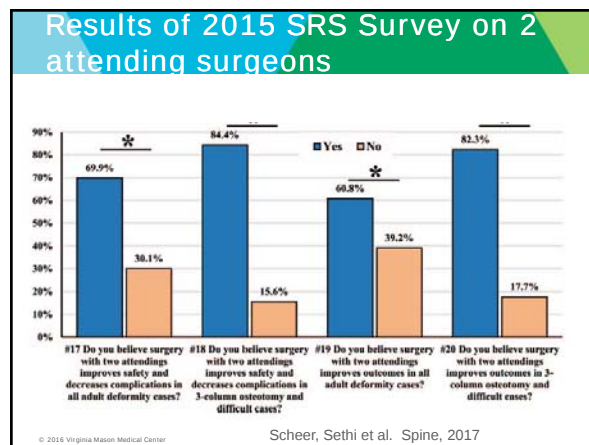
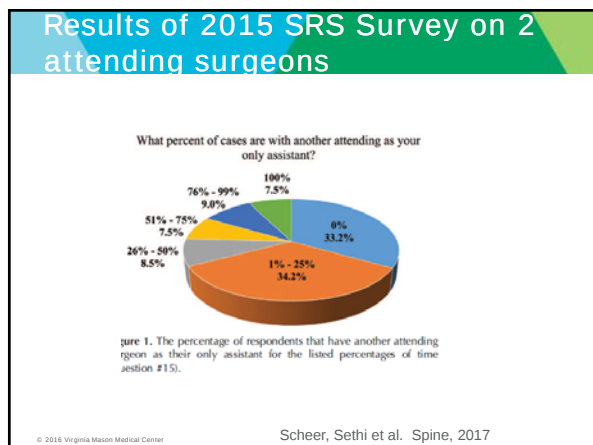
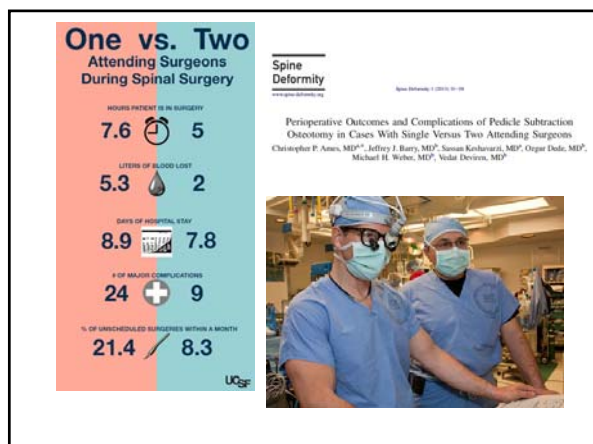
Two attending surgeons are required for complex spine cases

Spine Deformity

Clinical Series
The Seattle Spine Team Approach to Adult Deformity Surgery: A Systems-Based Approach to Perioperative Care and Subsequent Reduction in Perioperative Complication Rates
Rajiv K. Sethi, MD^{1,*}, Ryan P. Pong, MD², Jean-Christophe Lavoie, MD³, Thomas C. Dean, MD⁴, Stephen J. Oliver, MD⁵, Stephen M. Rogers, MD⁶
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Results of 2015 SRS Survey on 2 attending surgeons

REASONS FOR 2 SURGEONS IN MAJORITY OF THOSE FAVORING THIS PRACTICE

Its safer and reduces complications

It decreases operative time

It decreases blood loss

It improves outcomes

Its less work and stress for me

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Scheer, Sethi et al. Spine, 2017

"High-Value Care" of the Future

INNOVATIONS IN HEALTH CARE DELIVERY
Integrating Predictive Analytics Into High-Value Care
The Dawn of Precision Delivery

United States health care costs are twice as high as spending in most industrialized countries. Low key opportunity for health systems to improve value by limiting excessive of costly resources, is part by focusing on preventing or lowering high-risk patient groups. Some health systems have been using predictive analytics to identify high-risk individuals, however, most systems to date are doing little in the way of risk stratification, and physicians often find it difficult to apply these stratifications of risk to the care of an individual patient.

Electronic health records (EHRs) have the promise of allowing clinicians and health systems to determine an individual's real-time risk of a clinical event through predictive analytics. The use of EHRs is becoming ubiquitous in the United States. This new change can be linked with advances in big data techniques and computational decision support to transform health care delivery. Just as "precision medicine" is generally linked to the concept of using genetic and genomic data to personalize treatment, "precision delivery" involves using individual electronic health data to predict risk and personalize care to substantially improve value. In this paper, we make the case for precision delivery by describing how new health systems are integrating predictive analytics into practice and discussing future directions for using predictive analytics to improve value.

At-risk patients are those who are at high risk of rehospitalization and hospital readmission. As organizations like Amazon and Google have shown, however, development of these models is only a first step. For health systems currently using predictive analytics to identify at-risk patients, the next step is to use predictive analytics to identify at-risk patients and deliver targeted interventions to improve outcomes.

Using Predictive Analytics to Focus Intensity of Services Across the Care Continuum

Acute Care
 Predictive analytics can be used to identify patients at high risk of rehospitalization and hospital readmission. In the United States, Kaiser Permanente of the Western California (KPWC) integrated health care organization has used predictive analytics to identify at-risk patients and deliver targeted interventions. KPWC analyzed data from more than 600,000 discharges to determine the probability of early readmission rates. Using predictive analytics, KPWC identified patients at high risk of readmission. These data were linked with electronic clinical data from the readmission unit to assess the probability of readmission by categorizing readmissions as low, medium, or high risk of rehospitalization. KPWC identified and re-evaluated these specific cases to determine whether to deliver targeted interventions. After implementation of the algorithm, use of services, including rehospitalization and hospital readmission, was reduced.

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Risk Stratification & Protocol Development, The Seattle Spine Score

Contents lists available at ScienceDirect
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 journal homepage: www.elsevier.com/locate/jocn

Tools and techniques
The Seattle spine score: Predicting 30-day complication risk in adult spinal deformity surgery
 Quinlan D. Buchlak^{a,*}, Vijay Yanamadala^a, Jean-Christophe Leveque^a, Alicia Edwards^a, Kellen Noid^a, Rajiv Sethi^{a,b}

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87

Validated Multivariate Model

Multivariate Models:

- 81.4% accuracy
- Diabetes: 9 times more likely to experience complications

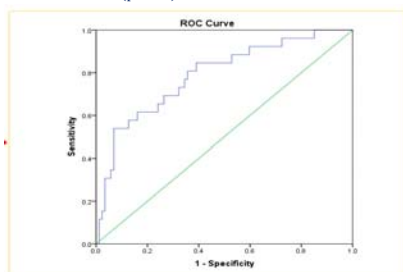
Variable	Model 1				Model 2				Model 3			
	Coefficient	p	OR	95% CI	Coefficient	p	OR	95% CI	Coefficient	p	OR	95% CI
Constant	-2.734	.000			-7.360	.000			-7.862	.000		
Smoking	0.894	.000	2.440	0.830	0.893	.000	2.440	0.830	1.107	.000	3.170	0.967
BMI (kg/m ²)	0.099	.010	1.104	1.019	1.104	.010	1.104	1.019	0.094	.010	1.100	1.022
Diabetes	1.920	.010	6.890	1.367	36.671	.000	6.890	1.367	36.671	.000	6.890	1.367
Age	0.023	.341	1.024	0.973	1.024	.341	1.024	0.973	0.026	.337	1.027	0.971
Sex	-0.202	.476	0.778	0.241	2.008	.460	0.794	0.241	-0.161	.794	0.883	0.204
Hypertension	-0.223	.084	0.798	0.270	2.004	.460	0.798	0.270	-0.223	.076	0.792	0.264
Anemia	2.240	.000	9.362	0.402	183.127	.000	9.362	0.402	2.080	.000	9.047	0.390
Acuity									0.201	.740	1.224	0.332
Reoperation									0.006	.914	1.009	0.460
Model Chi-square (df, p)	17.818 (3, p < .001)				21.229 (7, p < .001)				22.404 (9, p < .001)			
% Correct Predictions	76.6				81.4				77.0			
Nagelkerke R Square	.201				.269				.273			

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88

Receiver Operating Characteristics (ROC) Curve

AUROC: 0.788 (p < .01)



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89

Predictive modeling supports clinical practice, SYSTEM SPECIFIC RISK

The Seattle Spine Score (S3)

Input variables:

Age: 60 (p < .01, M = 0)

History of smoking: 0 (p < .01, M = 0)

Hypertension: 0 (p < .01, M = 0)

Diabetes: 1 (p < .01, M = 0)

Sex: 1 (p < .01, M = 0)

BMI: 40 (p < .01, M = 0)

Anemia: 1 (p < .01, M = 0)

Probability of complications occurring within 30 days of complete spine surgery:

S3 = 92%

Important Notes:

- The predictive algorithm using the S3 has a validated accuracy of 81.4%.
- The model should never be used as a substitute for the professional judgment of an experienced medical team.
- Complete spine surgery is defined as spinal fusion surgery meeting 6 or more vertebral levels.

Buchlak, Sethi et al., Podium at International Meeting of Advanced Techniques, Washington DC, July 15 2016

Journal of Clinical Neuroscience

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90

Predictive modeling supports clinical practice, SYSTEM SPECIFIC RISK

The Seattle Spine Score (S3)

Input variables:

Age (years)	60	Sex (F = 1, M = 0)	1
History of smoking (0 = yes, 1 = no)	0	BMI	26
Hypertension (0 = yes, 1 = no)	0	Anemia (0 = yes, 1 = no)	0
Diabetes (0 = yes, 1 = no)	0		

Probability of complications occurring within 30 days of complex spine surgery:

S3 = 3%

Important Notes:

1. The predictive algorithm driving the S3 has a validated accuracy of 82.4%.
2. This model should never be used as a substitute for the professional judgment of an experienced medical team.
3. Complex spine surgery is defined as spinal fusion surgery involving 4 or more vertebral levels.

Buchlak, Sethi et al., Podium at International Meeting of Advanced Techniques, Washington DC, July 15 2016
Journal of Clinical Neuroscience

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91

Conclusion

Standardization enhances patient safety

Pathways, protocols and dashboards can help us enhance the durability of what we do

The Seattle Spine Team provides an algorithm to reduce complications by employing the methods of the Toyota Production System

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We have to do better

Choosing patients better, we cant fix everything, we have to say "NO" much more than we currently do

Remove perverse fee for service incentives, e.g empower the team AND the surgeon.

Reward centers who do it better and standardize care, this is already happening

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Thank you

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