Patient-Reported Functional Outcomes:

How to Collect and Report Risk-Adjusted Musculoskeletal Patient-Reported Functional Outcome Data in an Orthopaedic Practice

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California Orthopaedic Association
Patient-Reported Outcome Task Force

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How to Collect and Report Risk-Adjusted Musculoskeletal Patient-Reported Functional Outcome Data in an Orthopaedic Practice

This paper was initially commissioned by the California Orthopaedic Association (COA) in 2013. Jill R. Glassman, PhD, MSW and Lisa Unti, MPH of ETR were the principal researchers. The goal of the paper was to provide recommendations on practical, cost-effective processes and standards to encourage more widespread, consistent use of patient-reported outcome (PRO) instruments for orthopaedic surgeons treating shoulder, hand, spine, foot and ankle conditions. Specifically, the objectives were to:

- Educate COA members about the importance of beginning to collect PRO data from their patients;
- Identify the most appropriate, standardized, validated instruments for assessing PROs in patients with musculoskeletal conditions within the named sub-specialties;
- Identify processes and software tools by which these instruments can be administered routinely in clinical practice settings, both pre- and post-procedures;
- Identify PRO data flow issues – e.g., compatibility and integration with Electronic Medical Record/Electronic Health Record (EMR/EHR) systems; and,
- Educate COA members about issues surrounding interpretation and analysis of PRO data in a risk-adjusted manner.

The report outlined available validated PRO for the various orthopedic specialties that had not been previously highlighted. ETR attempted to find data that would support risk adjustment based upon patients’ co-morbidities for practices that administered PRO to their patients. ETR determined that, at that time, there was not reliable or sufficient data about normative populations with co-morbidities who had undergone orthopedic surgical procedures to provide a valid body of data for comparison to peri-operative patients that orthopaedists would encounter in their practices. Several years ago, Cardiothoracic Surgeons collected data regarding peri-operative infection and re-admissions in their STS database that was not properly risk adjusted. As a result, some surgeons’ surgical performance data was erroneously misinterpreted by public reporting agencies. Orthopaedics has the same problem. Currently the orthopaedic registries do not collect risk adjusted PRO data. Orthopaedic surgeon’s peri-operative complication rates are not risk adjusted for more than a minimal number of measures by Medicare. Medicare’s current risk adjustment methodology is flawed as their own tools fall below the cutoff for predictive ability and were intended for non-PRO outcome measures such as readmission, peri-operative infection, peri-prosthetic fractures and mortality. https://www.ncbi.nlm.nih.gov/m/pubmed/26604220/


Patient-reported outcomes (PROs), also called patient-reported functional outcomes are being widely recognized as critical tools to improve care management by enabling clinical providers to, in real-time, assess the results of their treatments for the purpose of continuous quality improvement (CQI). Historically, PROs were used routinely in controlled research studies as part of developing evidence-based practices. Now, their promise is to help clinicians ensure they are providing care that is likely to result in the best outcomes for patients, adjusted for various risk profiles. The demand for objective, useable measurement tools is driving the identification, development and study of standardized tools most appropriate for specific disease areas. Risk prediction tools should satisfy the three priorities of enhancing the informed consent process, guiding risk mitigation efforts, including reversible co-morbidities, and calculating accurate risk adjusted outcomes https://www.ncbi.nlm.nih.gov/m/pubmed/26604220/
The Centers for Medicare and Medicaid Services (CMS) have started to require that surgeons collect pre-and post-operative PRO data, particularly for total joint replacement procedures in the Comprehensive Care for Joint Replacement (CJR) demonstration project mandated in many cities nationwide. MACRA and MIPS will require collection and submission of quality measurement data in order to avoid downward penalty payments. The final rules will be announced at the end of October, 2016. It is not likely that any EMR system will realistically be prepared to collect and submit quality data on January, 2017. Group health payors are expected to follow the CMS lead. This PRO data will allegedly help to provide objective quality measurements, which will therefore determine some component of reimbursement levels to surgeons. Thus, begins the shift from volume to value based reimbursement for care.

Some healthcare systems voluntarily enrolled in the CJR program. Many of those smaller, lower volume systems have experienced a few re-admissions that have turned the program payment balance into a substantially negative balance with regards to the fixed payments that were received for patients undergoing total joint replacement surgery. When the data is examined in some of these centers, the re-admissions occurred in patients who had substantial underlying co-morbidities. One significant problem with the CMS CJR project is that the CJR does not permit the collection or submission of data that would allow risk adjustment for recognized co-morbidities in these patients. CMS’s own risk adjustment methodology is flawed and does not take into account many of the currently recognized co-morbidities that should result in risk adjustment for patients undergoing surgical intervention. [https://www.ncbi.nlm.nih.gov/m/pubmed/26604220/](https://www.ncbi.nlm.nih.gov/m/pubmed/26604220/)

In the original White Paper, it was important for orthopaedic surgeons to understand the full scope and functionality of possible patient-reported outcome data tools. In the last 3 years, the business climate and payor demands on surgeons to report outcome data has changed dramatically. Payors, including CMS, are starting to consolidate around and require a more limited number of data reporting tools. For example, CMS in CJR mandated counties and Blue Shield in California are requiring patient-reported outcome data to be reported using the HOOS, Jr and KOOS, Jr. for patients undergoing hip and knee arthroplasty as well as health measures such as VR-12. These abbreviated reporting tools have resulted in a higher percentage of patients providing feedback. Other payors may require other reporting tools.

The decision as to which PRO tool will be used for spine, shoulder, elbow, hand, hip, knee, or ankle and foot patients is quickly being taken away from the surgeon and is being decided by the payors. It is now critical that surgeons understand the risk associated with taking patients to surgery and how co-morbidities and other risk factors can affect outcomes. Surgeons need to educate payors to these issues, so that surgeons who take patients with these co-morbidities to surgery can be risk-adjusted when evaluating their outcomes.

**Co-Morbidity and Risk Adjustment for Patients Undergoing Orthopaedic Surgery**

National orthopaedic sub-specialties are taking a more active role in identifying and recommending the most effective data collection tools to their members. The American Academy of Orthopaedic Surgeons formed the Quality Outcomes Data (QOD) Work Group made up of representatives of the national orthopaedic sub-specialty organizations, to investigate and evaluate data collection tools. The Work Group published a report in March, 2016 which can be found at: [http://www.coa.org/docs/WhitePapers/AAOSQualityTaskForce.pdf](http://www.coa.org/docs/WhitePapers/AAOSQualityTaskForce.pdf)

To improve patient compliance, the data collection tools are becoming more straightforward with fewer and more focused questions.

The American Association of Hip and Knee Surgeons (AAHKS) has worked with CMS and the Surgical Outcomes Group at Yale University in an attempt to determine which identifiable patient co-morbidities can assist with risk adjustment for outcomes such as readmission and mortality in patients undergoing orthopedic surgical procedures.
The result of the AAHK’s committee’s work resulted in a publication entitled, “AAHK Primer on Orthopedic Risk Stratification and Co-Morbidity Coding” by Frank Voss, MD, David Halsey, MD, Thomas Fehring, M.D. and the AAHK Risk Adjustment Task Force. The AAHK Primer can be found at:

While the AAHK Task Force performed yeoman’s work in starting to define co-morbidity for patients undergoing hip and knee arthroplasty, they did not define patient peri-operative risk factors that are associated with risk adjustment for patients undergoing shoulder, elbow, hand, spine, foot and ankle surgery or sports related reconstruction procedures. Their Primer also asked AAHK participants to help to improve their documentation within their in-patient facility based EMRs by including a list of various risk factors when they appear in patient history and physical examination.

COA’s Patient-Reported Outcome Task Force was convened to determine if there is currently enough data in the various orthopedic subspecialty literature or specialty societies to permit simultaneous collection of co-morbidity data that would permit risk adjustment of PRO data at this time. This should also occur in a fashion that would not just be for research purposes, but allow the clinician to determine how their patients are truly functioning prior to and after orthopedic surgery. Some of the goals of risk adjustment include proper informed consent, identifying correctable risk factors, determining which environment is most suitable for patients to undergo operative intervention and subsequent post-operative care. There are many risk adjusting tools cited in an article by Manning (https://www.ncbi.nlm.nih.gov/m/pubmed/26604220/). Most of these models score in the 70% range for overall accuracy of predictability.

Even though pain, function and health assessment PROMIS questionnaires are available for various areas of the body and are license free, they appear to be primarily for aggregate population evaluation and are not as useful as the Hip injury and Osteoarthritis Outcome, Jr. (HOOS, Jr.) and the Knee injury and Osteoarthritis Outcome, Jr. (KOOS, Jr.) for hip and knee surgery. PROMIS are apparently also not widely used for other orthopedic subspecialties.

Co-morbidity and risk adjustment assessments should help clinicians decide which patients are more suitable for an outpatient surgical environment and who might require the resources of an inpatient facility and skilled nursing or acute rehab post-operatively. The current system encourages “cherry picking” and can reduce patient access to qualified care in their local communities. Many of these patients are unnecessarily shifted to the most expensive hospitals in the country which can be located far away from their homes. Most communities have sufficient resources to take care of patients with mild to moderate co-morbidities. Patients with severe co-morbidities might not fare well with orthopedic surgery in any health care environment, tertiary or community.

We need to start to collect and tabulate co-morbidity and patient-reported outcome data in a fashion that will permit assembly of a normative data base for our communities. We should not use this data to penalize practitioners who attempt to mitigate poor peri-operative outcomes.

We can eventually use this data to establish “best practices” and attempt to match patients to the environment where they will experience the optimal peri-operative outcomes. The data currently being released to the public by reporting agencies is not in the strictest sense, properly risk-adjusted.

In the case of purely elective procedures, we would hope that modifiable factors such as anemia, nutritional status and smoking status can attempt to be mitigated or modified in advance of the procedure so that outcomes are optimized. In some cases, there may be a “hard ceiling” (e.g., if a patient has hemoglobin levels below a certain defined floor) so that elective procedures are delayed until the patient is a better surgical risk. Individual surgeons may set their own “hard ceilings.”
Ultimately a goal can be to use collected normative co-morbidity data to help calculate the risk of various potential peri-operative complications for a specific individual patient based on complex risk calculators. In this way we can then provide calculated risk of complications such as infection, readmission and venous thromboembolism to the individual patient at the preoperative visit. Risk calculators estimate the chance of an unfavorable outcome (such as a complication or death) after surgery. The risk is estimated based upon information the patient gives to the health care provider about prior health history. The estimates are calculated using data from a large number of patients who had a similar surgical procedure to the one the patient is undergoing. Surgical risk calculators are only estimates. The risk estimate only takes certain information into account. There may be other factors that are not included in the estimate which may increase or decrease the risk of a complication or death. These estimates are not a guarantee of results. A complication after surgery may happen even if the risk is low. (ACS NSQIP Website - http://riskcalculator.facs.org/RiskCalculator/) If the percentage risk of a peri-operative complication is documented for an individual patient in the chart, it enhances the informed consent and shared decision-making with that patient in advance of the procedure.

Our hope is that this discussion will lend itself to further work to define known risks for individual patients for known co-morbidities that help payors understand the unique surgical risks associated with that patient and help to insure that reimbursement rates are set in such a way that surgeons who choose to take on patients with "known risk as defined by co-morbidity" are appropriately compensated if they choose, in consultation with the patient, to operate in a milieu of increased or adjusted risk.

In addition, physicians should improve their documentation of patient co-morbidities in their peri-operative admission notes in their electronic charting as this may eventually start to show up in CMS and hospital databases. We have included in the White Paper a list of potential co-morbidities/risk factors that can be associated with negative outcomes in patients undergoing orthopaedic surgery. Some of these have support in the various subspecialty literature and others do not yet have published support.

**Potential Orthopaedic Co-morbidities/Risk Factors:**

The following is a list of co-morbidities that may be applicable to the musculoskeletal patient and should be considered by the orthopaedic surgeon prior to surgery:

- Alcoholism - Chronic
- Allergies – Metal, Suture
- Angular Deformity >15 degrees
- Anticoagulant use – Chronic
- Bacterial Colonization - Chronic Pre-op
- Catastrophic Thinking
- Chondrosis
- Chromosomal Translocation
- Chronic Pain Syndrome
- Collagen Vascular Disorder-Rheumatoid Arthritis, Lupus, Psoriatic Arthritis – often Immunocompromised - Ehlers/Danlos Syndrome
- Congenital Deformities of Operative Region
- C-Reactive Protein (CRP)
- COPD
- Depression/Psychiatric Disorders
- Diabetes - Not Well Controlled-HgA1c above 7.0
- Dialysis
• DVT or PE – history of
• Emotional Health
• Erythrocyte Sedimentation Rate (ESR)
• Fractures – Acute/Open
• Fragility
• Heart Disease
• Hemophilia
• Hemoglobin Levels
• Hepatitis C - Chronic Active
• Increased Age – over 80 years of age
• Infection – Active or Previous at Surgical Site
• Insulin - Long-term Use of
• Intra-Articular Infection (previous)
• Liver Disease - Chronic
• Medications – Statins
• Metabolic Syndrome
• Narcotic Use – Chronic - Opioid Abuse, Continuous
• Neurological Disorders –Chronic – Parkinson, prior CVA, Polio, Peripheral Neuropathy, Epilepsy
• Non-Prescription Drug Dependence
• Nutrition Deficiency-low Albumin
• Obesity – Morbid - BMI >40
• Open Reduction of Internal Fixation (ORIF) of a Body Region
• Osteoporosis - Severe - BMD >3.5
• Peripheral Neuropathy
• Peripheral Vascular Disease
• Peritoneal
• Renal Failure-BUN/CR-GFR
• Revision Surgery
• Skin Disorders – Chronic
• Sleep Apnea – Obstructive
• Socioeconomic Factors
• Steroid or Immunosuppressive Medication Usage - Chronic
• Suture or Metal Allergy
• Systemic Inflammatory Disease- Rheumatoid Arthritis, Psoriatic Arthritis, Ankylosing Spondylitis, Gout
• Tobacco Dependency - Smoking
• Ulceration of the Body Area - current or past
• Vascular Disease
• Venous Stasis Disease
• Worker’s Compensation Case - Adverse Effects of Work Environment
• Wound Healing Problems (history of) or Plastic Reconstruction of Wound

Other Risk Factors:
• Family Support
• Facility where procedure will be performed
• Ability to engage in pre-op learning
• Primary care provider
• Surgeon’s experience
• Surgical TEAM factors – Anesthesia (regional and multi-modal experience)
• Therapy Services
Race

Demographic Information that is helpful in assessing risk:
- Alcohol Use
- Revision Surgery
- Heart Disease
- Diabetes
- Rheumatoid Arthritis
- Peripheral Vascular Disease
- Peripheral Neuropathy
- History of DVT or PE
- Socioeconomic Status
- Race
- Incarceration

Some risk factors are modifiable and should be discussed with the patient prior to surgery and improved if possible. Some risk factors are absolute and cannot be improved prior to surgery.

Risk factors need to be clearly documented in the patient’s record. This will likely be the responsibility of the surgeon. They could also serve as a checklist in the hospital medical record.

These risk factors may not apply to pediatric patients or trauma care.

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See Table A for a summary of co-morbidities by orthopaedic sub-specialty.
Co-morbidities/risk factors by orthopaedic sub-specialty

Hand and Wrist

**Diabetes**
Impact of Diabetes on Outcomes in Hand Surgery.

Peri-operative Management of Diabetic Patients Undergoing Hand Surgery.

Outcome after carpal tunnel release: impact of factors related to metabolic syndrome.

**Narcotic use – Chronic (limited literature on this)**

**Morbid obesity (BMI > 45)**
The Impact of Obesity on Complications of Elbow, Forearm, and Hand Surgeries.

**Open Fractures (Gustilo-Anderson Type 3)**
Factors Influencing Infection Rates After Open Fractures of the Radius and/or Ulna.

**Osteoporosis - Increased age, decreased bone mineral density**
Factors Delaying Recovery After Volar Plate Fixation of Distal Radius Fractures.

**Depression**
Pain catastrophizing, anxiety, depression

The Impact of Depression and Pain Catastrophization on Patient-Rated Outcomes Before and After Treatment for Atraumatic Hand Conditions.
*Journal of Hand Surgery, 38*(10), e48–e49.

Determinants of Grip Strength in Healthy Subjects Compared to That in Patients Recovering From a Distal Radius Fracture.

**Rheumatoid Arthritis**
Peri-operative Management of Rheumatoid Medications.

**Tobacco Dependence: Smoking**
Smoking and Hand Surgery.

**Worker's Compensation**
Workers' compensation and outcomes of upper extremity surgery.

Factors predictive of patient outcome following total wrist arthrodesis.
Co-morbidities/risk factors by orthopaedic sub-specialty

Hip and Knee Arthroplasty

Incidence of and risk factors for 30-day readmission following elective primary total joint arthroplasty: analysis from the ACS-NSQIP
AJ Pugely, JJ Callaghan, CT Martin, P Cram... - The Journal of ..., 2013 - Elsevier
... Univariate analysis identified the following patient characteristics as risk factors for 30-day readmission after ... INR, elevated serum creatinine, elevated ASA Class, and dependent functional status as risk factors. ... Univariate Analysis of TKA Patients With and Without Readmission. ...

Risk factors for readmission of orthopaedic surgical patients
... these required diagnosis codes to be included, and therefore may not represent actual patient use of ... readmission group (5.9 ± 8.1 days) than it was in the group of patients who were ... Disposition to a skilled nursing facility was associated with a risk of readmission that was 2.03 ...

Angular knee deformity >8 degrees varus and > 11 degrees of valgus
Preoperative Malalignment Increases Risk of Failure After Total Knee Arthroplasty
Merrill A. Ritter, MD; Kenneth E. Davis, MS; Peter Davis, BA; Alex Farris, BA; Robert A. Malinzak, MD; Michael E. Berend, MD; John B. Meding, MD
J Bone Joint Surg Am, 2013 Jan 16; 95 (2): 126 -131

Chronic anticoagulant use - Long-term (current) use of anticoagulants
Patients with Atrial Fibrillation Undergoing Total Joint Arthroplasty Increase Hospital Burden
Vinay K. Aggarwal, BA; Eric H. Tischler, BA; Zachary D. Post, MD; Ian Kane, BS; Fabio R. Orozco, MD; Alvin Ong, MD
J Bone Joint Surg Am, 2013 Sep 04; 95 (17): 1606 -1611

Congenital hip deformity –increased OR times and transfusion and dislocation
Does Previous Osteotomy Compromise Total Hip Arthroplasty? A Systematic Review
Stephen Duncan, Scott Wingerter, Angela Keith, Susan A. Fowler, John Clohisy
The Journal of Arthroplasty, Vol. 30, Issue 1, p79–85

Depression/psychiatric disease
Association of Depression with 90-Day Hospital Readmission After Total Joint Arthroplasty
Heather T. Gold, James D. Slover, Lijn Joo, Joseph Bosco, Richard Iorio, Cheongeun Oh

Preoperative Predictors of Pain Catastrophizing, Anxiety, and Depression in Patients Undergoing Total Joint Arthroplasty
Thomas J. Wood, Patrick Thornley, Danielle Petruccelli, Conrad Kabali, Mitch Winemaker, Justin de Beer Publication stage: In Press Corrected Proof  The Journal of Arthroplasty

Previous intra-articular infection - Late effect of other and unspecified infectious and parasitic diseases
Preoperative Hip Injections Increase the Rate of Periprosthetic Infection After Total Hip Arthroplasty
William W. Schairer, Benedict U. Nwachukwu, David J. Mayman, Stephen Lyman, Seth A. Jerabek

Does Timing of Previous Intra-Articular Steroid Injection Affect the Post-Operative Rate of Infection in Total Knee Arthroplasty?
Jourdan M. Cancienne, Brian C. Werner, Luke M. Luetkemeyer, James A. Browne
**Morbid obesity** BMI >40
**Obesity and Total Joint Arthroplasty: A Literature Based Review**
A Workgroup of the American Association of Hip and Knee Surgeons (AAHKS) Evidence Based Committee

**Morbid Obesity in Total Hip Arthroplasty: Redefining Outcomes for Operative Time, Length of Stay, and Readmission**
Richard J. Hanly, Salman K. Marvi, Sarah L. Whitehouse, Ross W. Crawford
Published online: December 18, 2014

**BMI >50**
**Primary Total Knee Arthroplasty in Super-obese Patients: Dramatically Higher Postoperative Complication Rates Even Compared to Revision Surgery**
Brian C. Werner, Cody L. Evans, Joshua T. Carothers, James A. Browne

**Chronic narcotic use - Opioid abuse, continuous**
**Preoperative and Postoperative Opiate Use by the Arthroplasty Patient**
Bradley J. Zarling, Sanar S. Yokhana, Darren T. Herzog, David C. Markel

**Preoperative Reduction of Opioid Use Before Total Joint Arthroplasty**
Long-Co L. Nguyen, David C. Sing, Kevin J. Bozic
Published online: March 16, 2016

**Open Reduction of Internal Fixation (ORIF)**
**Previous ORIF hip-increased incidence of periprosthetic fracture and dislocation**
Total Hip Arthroplasty After Failed Internal Fixation of Proximal Femoral Fractures
The Journal of Arthroplasty, Vol. 28, Issue 1, p168–171

Previous ORIF knee-increased infection, wound healing complications
Total Knee Arthroplasty in Patients With a Prior Tibial Plateau Fracture: A Long-Term Report at 15 Years
Matthew P. Abdel, Philipp von Roth, William W. Cross, Daniel J. Berry, Robert T. Trousdale, David G. Lewallen

**Tobacco Dependency - Smoking**
**Tobacco Use May Be Associated With Increased Revision and Complication Rates Following Total Hip Arthroplasty**
Bhaveen H. Kapadia, Kimona Issa, Robert Pivec, Peter M. Bonutti, Michael A. Mont
The Journal of Arthroplasty, Vol. 29, Issue 4, p777–780

Increased Revision Rates After Total Knee Arthroplasty in Patients Who Smoke
Bhaveen H. Kapadia, Aaron J. Johnson, Qais Naziri, Michael A. Mont, Ronald E. Delanois, Peter M. Bonutti
The Journal of Arthroplasty, Vol. 27, Issue 9, p1690–1695

**Worker’s Compensation - Adverse effects of work environment**
**Workers’ Compensation Patients After Total Joint Arthroplasty: Do They Return to Work?**
Corey T. Clyde, Nitin Goyal, Wadih Y. Matar, Daniel Witmer, Camilo Restrepo, William J. Hozack

Total knee arthroplasty in patients on workers’ compensation: Matched cohort study with an average follow-up of 4.5 years
Khaled Saleh, Charles Nelson, Rida Kassim, Patrick Yoon, Steven Haas
Co-morbidities/risk factors by orthopaedic sub-specialty

Foot and Ankle

Anticoagulant Use – Chronic
Balancing the risk of complications in foot and ankle surgical patients taking antithrombotic medication.
Miller S, Nitzki-George D, Caprini JA.

Depression/Psychiatric disease
Psychosocial Risk Factors for Postoperative Pain in Ankle and Hindfoot Reconstruction.
Mulligan RP, McCarthy KJ, Grear BJ, Richardson DR, Ishikawa SN, Murphy GA.

Infection – Active or previous at surgical site
Current concepts review: risk factors for nonunions in foot and ankle arthrodeses.
Thevendran G, Younger A, Pinney S.

Chronic Pain and Narcotic Use – Chronic
Psychosocial Risk Factors for Postoperative Pain in Ankle and Hindfoot Reconstruction.
Mulligan RP, McCarthy KJ, Grear BJ, Richardson DR, Ishikawa SN, Murphy GA.

Obesity – BMI >40
Obesity Is Associated With Increased Complications After Operative Management of End-Stage Ankle Arthritis.
Werner BC, Burrus MT, Looney AM, Park JS, Perumal V, Cooper MT.
Foot Ankle Int. 2015 Aug;36(8):863-70

Effect of Obesity on Outcomes of Forefoot Surgery.
Stewart MS, Bettin CC, Ramsey MT, Ishikawa SN, Murphy GA, Richardson DR, Tolley EA.
Foot Ankle Int. 2016 May;37(5):483-7.

Effect of Obesity on Total Ankle Arthroplasty Outcomes.
Schipper ON, Denduluri SK, Zhou Y, Haddad SL.

Rheumatoid Arthritis
Risk factors for surgical site infection and delayed wound healing after orthopedic surgery in rheumatoid arthritis patients.

Sleep Apnea – Obstructive
The effect of obstructive sleep apnea on amputation site healing.
Andrews KL, Dib M, Shives TC, Hoskin TL, Liedl DA, Boon AJ.

Tobacco Dependency
Risk factors for wound complications in patients after elective orthopedic foot and ankle surgery.
Wiewiorksi M, Barg A, Hoerterer H, Voellmy T, Henninger HB, Valderrabano V.

Ankle fusion in a high risk population: an assessment of nonunion risk factors.
Steroid use
Risk factors for incision-healing complications following total ankle arthroplasty.
Raikin SM, Kane J, Ciminiello ME.

Ulceration of the foot or ankle – prior or current
Study of risk factors and outcome of patients with diabetic foot ulcers.
Chiraniya S, Shejol D, Bhagat V, Yadav S, Moulick N.
J Assoc Physicians India. 2016 Jan;64(1):92

Diabetic heel ulcers: a major risk factor for lower extremity amputation.
Younes NA, Albsoul AM, Awad H.
Ostomy Wound Manage. 2004

Venous Stasis Disease
Risk Factors in Patients with Venous Stasis-Related Skin Lesions without Major Abnormalities on Duplex Ultrasonography.
Suehiro K, Morikage N, Yamashita O, Harada T, Samura M, Takeuchi Y, Mizoguchi T, Hamano K.

Work-related injury
Risk Factors for Open Malleolar Fractures: An Analysis of the National Trauma Data Bank (2007 to 2011).
Shibuya N, Liu GT, Davis ML, Grossman JP, Jupiter DC.
PMID: 26403573

Demographic Information that is helpful:
Alcohol Use
Revision Surgery
Heart Disease
Diabetes
Rheumatoid Arthritis
Peripheral Vascular Disease
Peripheral Neuropathy
History of DVT or PE
Co-morbidities/risk factors by orthopaedic sub-specialty

Shoulder and Elbow

Alcoholism
Analysis of peri-operative morbidity and mortality in shoulder arthroplasty patients with preexisting alcohol use disorders.

Increased Age
Over 80 Years of Age: Increased risk of prolonged hospitalization

Need for Revision of a RCR higher with higher age, co-morbidity, lower surgeon volume

Increased Age/Decreased Bone Mineral Density
Osteoporosis and shoulder osteoarthritis: incidence, risk factors, and surgical implications.

Allergies – Metal
Shoulder arthroplasty in the patient with metal hypersensitivity

Angular Deformity>15 degrees
The impact of residual angulation on patient reported functional outcome scores after non-operative treatment for humeral shaft fractures.

Collagen Vascular Disorder-Rheumatoid Arthritis, Lupus, Psoriatic Arthritis – often Immunocompromised - Ehlers-Danlos Syndrome
Open inferior capsular shift for multidirectional shoulder instability in adolescents with generalized ligamentous hyperlaxity or Ehlers-Danlos syndrome.

Medication, surgery, and physiotherapy among patients with the hypermobility type of Ehlers-Danlos syndrome.

Catastrophic Thinking (ruminating about irrational worst-case outcomes)
Psychological Distress Is Associated with Greater Perceived Disability and Pain in Patients Presenting to a Shoulder Clinic.  

**Chronic Colonization**  
Propionibacterium acnes: an agent of prosthetic joint infection and colonization.  

The Incidence of Propionibacterium acnes in Shoulder Arthroscopy.  

**Depression**  
The influence of a history of clinical depression on peri-operative outcomes in elective total shoulder arthroplasty: a ten-year national analysis.  

Causes of poor postoperative improvement after reverse total shoulder arthroplasty.  

Anxiety and depression predict poor outcomes in arthroscopic subacromial decompression.  

**Diabetes**  
Diabetes as a risk factor for poorer early postoperative outcomes after shoulder arthroplasty.  
http://doi.org/10.1016/j.jse.2014.01.046.  

Diabetes is independent risk factor for TEA: Comparison of peri-operative complications after total elbow arthroplasty in patients with and without diabetes.  
http://doi.org/10.1016/j.jse.2014.06.045.  

The influence of diabetes mellitus on clinical and structural outcomes after arthroscopic rotator cuff repair.  

Diabetes mellitus increases the risk of rotator cuff tear repair surgery: A population-based cohort study.  

Predictors of shoulder pain and shoulder disability after one year in diabetic outpatients.  
Diabetes mellitus impairs tendon-bone healing after rotator cuff repair.

The influence of diabetes mellitus on clinical and structural outcomes after arthroscopic rotator cuff repair.

Increased risk in arthroplasty among acute fracture patients
Factors predicting complication rates after primary shoulder arthroplasty.

Hepatitis C
Is Hepatitis C Infection Associated With a Higher Risk of Complications After Total Shoulder Arthroplasty?

Systemic Inflammatory Disease
The shoulder girdle in ankylosing spondylitis.

An analysis of factors affecting the long-term results of total shoulder arthroplasty in inflammatory arthritis.

Metabolic Syndrome
Metabolic syndrome and shoulder arthroplasty: epidemiology and peri-operative outcomes.

Neurological Disorders –Chronic – Parkinson, prior CVA, Polio, Peripheral Neuropathy, Epilepsy
Epilepsy
Early Postoperative Complications After Shoulder Arthroplasty in Patients With Epilepsy.

Parkinsons
Shoulder arthroplasty in patients with Parkinson’s disease is associated with increased complications.

Obesity
Obesity higher risk for need for HHR revision
Risk factors for revision surgery after humeral head replacement: 1,431 shoulders over 3 decades.

Obesity – morbid (BMI > 45)
Outcomes of primary reverse shoulder arthroplasty in patients with morbid obesity.
(No effect)
Super obesity (body mass index &gt;50 kg/m2) and complications after Total shoulder arthroplasty: an incremental effect of increasing body mass index. (Causative Effect) Werner BC, Burrus MT, Browne JA, Brockmeier SF. Journal of Shoulder and Elbow Surgery, 2015 Dec;24(12): 1868-75. doi:10.1016/j.jse.2015.05.046. Epub 2015 Jul 17.


Osteoporosis


Race


Renal Failure
Magnetic resonance imaging classification of haemodialysis-related amyloidosis of the shoulder: risk factors and arthroscopic treatment.

Upper extremity complications in patients with chronic renal failure receiving haemodialysis.

Tumoral calcinosis of the shoulder.

Chronic Skin Disorders/Lymphedema
The Influence of Arm Swelling Duration on Shoulder Pathology in Breast Cancer Patients with Lymphedema.

Lymphedema after breast cancer: incidence, risk factors, and effect on upper body function.

C-Reactive Protein (CRP)
Increased CRP/Sed Rate
Shoulder adhesive capsulitis in the early freezing phase: correlations between blood exams and Constant Score.

Socioeconomic status
Heterogeneity in health status and the influence of patient characteristics across patients seeking musculoskeletal orthopaedic care – a cross-sectional study.

Medications – Statin
Effect of Statins (Beneficial)
Simvastatin reduces fibrosis and protects against muscle weakness after massive rotator cuff tear.


Effect of Fluoroquinolones
**Bench Press/Lifting**
Distal clavicular osteolysis in adults: association with bench pressing intensity.

**Depression/Psychiatric Disorders**
The influence of psychiatric comorbidity on peri-operative outcomes after shoulder arthroplasty.

Cost of RSA correlated with Co-morbidity burden
Preparing for the bundled-payment initiative: the cost and clinical outcomes of reverse shoulder arthroplasty for the surgical treatment of advanced rotator cuff deficiency at an average 4-year follow-up.

**Psychological Distress/Pain Catastrophizing, Anxiety, Depression**
Psychological distress negatively affects self-assessment of shoulder function in patients with rotator cuff tears.

**Smoking**
The effect of smoking on rotator cuff and glenoid labrum surgery: a systematic review.

The impact of preoperative smoking habits on the results of rotator cuff repair.

Smoking Predisposes to Rotator Cuff Pathology and Shoulder Dysfunction: A Systematic Review.

**Tobacco Dependency/Opioid Use**
Preoperative opioid use and outcomes after reverse shoulder arthroplasty.

**Wound Healing**
History of previous wound healing problems or plastic reconstruction of wound
Surgical treatment of severe or moderate axillary burn scar contracture with transverse island scapular flap and expanded transverse island scapular flap in adult and pediatric patients--A clinical experience of 15 cases.

**Workers’ Compensation Patients**
Workers Compensation patients poorer outcomes after RCR
Workers' Compensation claims and outcomes after reverse shoulder arthroplasty.

Anatomic total shoulder arthroplasty for patients receiving workers' compensation.

ASES vs. European Shoulder Society Outcomes data
No agreement on co-morbidity factors in their literature.
Co-morbidities/risk factors by orthopaedic sub-specialty

Sports Medicine
Rotator Cuff

**Alcohol**
Association between alcohol consumption and rotator cuff tear.

**Emotional Health**- education level, employment, pain tolerance, patient perception of normalcy
What factors are predictors of emotional health in patients with full thickness RCT?
Barlow JD, Bishop, JY, et al, *MOON Shoulder Group*, JSES, 2016 Jun 6,

**ACL**
**Obesity/Tobacco Dependence/Chondrosis**
Prediction of patient-reported outcome after single bundle anterior cruciate ligament reconstruction

**Diabetes**
Outcomes of ACL reconstruction in patients with diabetes

**Tobacco Dependency**
The Effect of Smoking on ACL Reconstruction: A Systematic Review
Novikov Da, et al, /The Physician and Sportsmedicine 2016 Jul 25. Epub - smoking associated with significantly worse outcomes

**Microfracture**
**Tobacco Dependency**
Effects of knee compartment, concomitant surgery and smoking on medium term outcomes of microfracture
Co-morbidities/risk factors by orthopaedic sub-specialty

Spine

**Anticoagulant use / Coagulation profile / Bleeding disorders / Hemophilia**

**Bacterial Colonization** - Chronic Pre-op


**Cardiovascular Disease**


**Chronic Pain**

**Depression / Psychiatric Disorders / Emotional Health**


**Diabetes / Insulin Dependence**


Dialysis

Fragility

Hemoglobin Levels


Increased Age


Liver Disease / Hepatitis C / Alcoholism

Malnutrition
Prealbumin as a serum biomarker of impaired perioperative nutritional status and risk for surgical site infection after spine surgery.

The influence of perioperative risk factors and therapeutic interventions on infection rates after spine surgery: a systematic review.


Narcotic Use – Chronic - Opioid Abuse, Continuous
Opioid Misuse is Associated With Increased Morbidity and Mortality After Elective Orthopaedic Surgery.

Obesity – (BMI > 35)


Osteoporosis - Severe - BMD >3.5
Incidence and risk factors for the progression of proximal junctional kyphosis in degenerative lumbar scoliosis following long instrumented posterior spinal fusion.

Instrumentation-related complications of multilevel fusions for adult spinal deformity patients over age 65: surgical considerations and treatment options in patients with poor bone quality.

Osteoporosis in Cervical Spine Surgery.

Risk factors for revision surgery following primary adult spinal deformity surgery in patients 65 years and older.


Parkinson’s Disease
Spinal surgery in patients with Parkinson’s disease: construct failure and progressive deformity.

Impact of Parkinson’s disease on perioperative complications and hospital cost in multilevel spine fusion: A population-based analysis.
**Socioeconomic Factors**
Medicaid Status Is Associated With Higher Complication Rates After Spine Surgery.

**Steroid or Immunosuppressive Medication Usage**
Is There an Association of Epidural Corticosteroid Injection With Postoperative Surgical Site Infection After Surgery for Lumbar Degenerative Spine Disease?


**Systemic Inflammatory Disease - Ankylosing Spondylitis**
Spinal Fracture in Patients With Ankylosing Spondylitis: Cohort Definition, Distribution of Injuries, and Hospital Outcomes.

**Systemic Inflammatory Disease - Rheumatoid Arthritis (No increased risk with lumbar laminectomy)**
Iatrogenic disability and narcotics addiction after lumbar fusion in a worker’s compensation claimant.

**Tobacco Dependency - Smoking**

Construct Type and Risk Factors for Pseudarthrosis at the Cervicothoracic Junction.

**Worker’s Compensation**
Iatrogenic disability and narcotics addiction after lumbar fusion in a worker’s compensation claimant.