

Key considerations in a bundled payment model (BPM) design: A musculoskeletal condition case study

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Introduction

In recent years, payment for healthcare services has moved away from fee-for-service reimbursement toward value-based payment (VBP) models, including accountable care organizations and bundled payments. The goal of VBP models is to reduce costs by improving care coordination and eliminating unnecessary services while maintaining or improving quality of care.¹ For example, in 2021 the Centers for Medicare and Medicaid Services (CMS) established a goal to have 100% of original Medicare beneficiaries and the vast majority of Medicaid beneficiaries in accountable care organization (ACO) relationships by 2030 as part of the strategic refresh by the Center for Medicare and Medicaid Innovation (CMMI).² Bundled payments are one type of VBP model, typically executed as a fixed-price agreement for a predefined episode of care that commonly contains a procedure and all related services, or all care for a specific medical condition. CMS has invested significant resources into these types of models, and they recently announced a new mandatory five-year bundled payment model called the Transforming Episode Accountability Model (TEAM), which aims to incentivize care coordination by holding selected hospitals accountable for the total cost and quality of care during and 30 days after certain surgical procedures.³

In this paper, we present a case study related to knee osteoarthritis and highlight why musculoskeletal (MSK) conditions such as low back pain, cervical neck pain, and knee or hip osteoarthritis are well suited for bundled payments. In addition, we will discuss the features that should be considered by organizations that are designing a bundled payment model (BPM).

Types of organizations entering into a BPM

A variety of organizations participate in bundled payment arrangements. In a typical bundled payment arrangement, there are two sides—organizations transferring financial risk and organizations taking financial risk. While many of the early bundled payment models were designed by payers and adopted by providers, there are other stakeholders willing to take financial risk. For example, conveners are third-party organizations (not providers or payers) that generally take on

financial risk from payers for the performance of provider participants in bundled payment programs. In exchange, the conveners have the opportunity to receive payments for achieving performance targets. Self-insured employer groups and workers' compensation insurers also participate in bundled payment models. Depending on their role, these stakeholders may or may not be directly involved in bundle design but can create a demand for entering into VBP models. For risk-bearing organizations, participation in a bundled payment arrangement can be voluntary, or it may be the only way a payer, self-insured employer group, or workers' compensation insurer is willing to pay for a set of services.

Organizational goals when entering into a BPM

ORGANIZATIONS TRANSFERRING FINANCIAL RISK

Organizations typically transferring financial risk include payers such as CMS, commercial health plans, and self-insured employer groups. Their primary goals are to lower costs and improve (or maintain) quality of care. The predictability of cost with a bundled payment model is also attractive for participants. Organizations transferring risk are typically the groups designing the bundled payment models, or these organizations may find themselves in a situation where they can select a predesigned bundled payment model for implementation.

Many health plans have designed bundled payment models and contracted directly with their network providers. As an example, one national payer has developed a prospective bundled payment for select orthopedic surgeries in multiple states. The stated goal of its program is to increase transparency and connect patients to quality care at a predictable and affordable cost.⁴

Some self-insured employer groups and providers choose to contract directly to offer value-based arrangements to employees. Large employers, including General Motors, Lowe's, Walmart, and JetBlue have partnered directly with select healthcare organizations in the country for high-cost specialty surgical procedures via bundled payment arrangements.⁵ While their primary goal is to mitigate costs, direct contracting also allows the self-insured employer group to have more control over benefit designs and offerings.

ORGANIZATIONS TAKING ON FINANCIAL RISK

Risk-bearing entities (commonly providers, conveners, or other third parties) typically enter into voluntary bundled payment models because they see them as an opportunity for increased revenue from bundled savings or additional patient volume. Ideally, bundled savings should come from increased efficiency, where organizations are able to modify the delivery of bundled services to be more efficient and effective while receiving payment similar to what would be provided for less efficient and less effective service delivery. Rendering services more efficiently (e.g., achieving good functional status with fewer physical therapy visits or moving surgery from the inpatient to outpatient setting), or improving care coordination to reduce avoidable complications such as emergency department visits, may result in financial rewards for the organization.

Often, risk-bearing and risk-transferring organizations involved in voluntary bundled payment models work together to enhance existing or promote new specialty referral patterns, resulting in increased patient volume to the bundled payment arrangements. For example, in some bundled payment models, participating organizations may be marketed as a preferred entity. Preferred entities may be prioritized in directories and can be included in benefit designs that offer reduced member cost sharing. One regional health plan promotes the use of its branded specialty care network and encourages its employer clients to customize their benefit designs through lower cost sharing, coverage restrictions that require care through their owned or affiliated health centers, or rewarding members for seeking services from their branded specialty network using gift cards.^{6,7}

Types of BPMs

Bundled payment models can be broadly categorized into procedure-based bundles and condition-based bundles.

A procedure-based bundle is initiated by a procedure such as surgery. The episode duration includes the time period of the surgery (the day of outpatient surgery or the duration of the surgical inpatient admission) and may include a predetermined time period prior to the date of the surgery and a time period following the surgery date. For example, 30 days prior to the date of the surgery through 90 days after the surgery date is a common episode duration for surgical episodes in order to capture spending for relevant preoperative and postoperative services. Procedure-based bundles can include all services provided during this time period (total cost of care) or a definition of "related services" may identify a narrower set of services that are included in the episode definition.

Procedure-based bundles are appealing to payers as they drive lower per procedure cost. However, payers may be concerned that the procedural episodes do not provide incentives for providers to intensify medical management that may potentially avoid procedures altogether. To address concerns about potential overutilization of elective procedures that may result from the provider opportunities presented by procedure-based bundled payments, bundled payments for episodes centered on medical conditions for which a procedure is one treatment option among others can help to address this risk. This bundle type is referred to as a condition-based bundle.

Condition-based bundles typically include a broader set of services that are considered beneficial to help managing or slowing disease progression, reducing the need for surgery, and they directly incentivize lower rates of procedures, which are typically high-cost services that contribute substantially to the episode cost for medical conditions.⁸ Within condition-based bundles, the scope of included services can vary significantly but always includes medical management and may or may not include surgical management. The time period for condition-based bundles is often longer (e.g., one year) than procedure-based bundles.

Musculoskeletal conditions provide robust opportunities for bundled payment success

MSK conditions are an emerging cause of health and financial burden in the United States, where they affect more than one in three people or approximately 127.4 million individuals.⁹ In 2016, MSK conditions were the leading contributor to healthcare spending, with an estimated direct cost of \$380.9 billion, exceeding diabetes (\$309.1 billion), cardiovascular diseases (\$255.1 billion), mental disorders (\$180.7 billion), and cancer (\$123.8 billion).¹⁰ MSK conditions also have substantial indirect costs such as lost wages and are the leading cause of disability,⁵ responsible for nearly one-third of days away from work.¹¹

Due to the disease prevalence and variation in practice patterns, patients with MSK conditions are a population where improved clinical management can result in a cost-savings opportunity for organizations transferring risk. Even when clinical guidelines exist, variation occurs due to differences in regional practice patterns as well as physician-level differences in clinical decision making. As an example, for patients with newly diagnosed cervical spine pain, multiple guidelines^{12,13,14} recommend physical therapy prior to surgery. However, a large cross-sectional study recently demonstrated that the proportion of patients with cervical spine pain who received any physical therapy ranged between 5.7% and 65.4%, depending on the surgeon.¹⁵

In addition to the fact that MSK conditions are cost drivers, bundled payment models for MSK conditions are attractive for the following reasons:

1. **Elective:** While some patients initially present to the emergency department for MSK conditions, patients are often referred back to their primary care provider or scheduled with a specialist days later for management of the MSK condition. If surgery or other procedures are performed, they are generally scheduled in advance and are not life-threatening, if delayed.
2. **Established care pathways:** There are well-established care pathways for the diagnosis, management, and treatment of common MSK conditions such as knee osteoarthritis,¹⁶ hip osteoarthritis,¹⁷ and rotator cuff tears.¹⁸ This makes it easier to design, implement, and monitor bundled payments that rely on efficient and standardized patterns of care for success. In addition, management of MSK conditions is less susceptible to factors that may substantially impact bundle pricing, such as pricing fluctuations in infusion drugs.¹⁹
3. **Narrow provider team:** The team of provider types that care for patients with MSK conditions is fairly narrow, which allows for more control over the management of the patient. The team commonly includes a facility (hospital or ambulatory surgical center), surgeon, anesthesiologist, home healthcare agency, and physical and/or occupational therapy providers. This differs from a number of other complex, high-cost conditions. For example, the cancer care pathway varies significantly by cancer type and stage and includes many different provider specialties that manage components of the patient's care (e.g., general surgeon, breast surgeon, plastic surgeon, cardiothoracic surgeon, medical oncologist, radiation oncologist, etc.).
4. **Known risk factors:** Risk factors for MSK conditions are well known²⁰ and can be accounted for in the design of the bundled payment model. Bundled payment models often require the risk-bearing entity to share financial responsibility for poor outcomes, such as avoidable hospitalizations and poor functional status outcomes. Adjusting for variations in case mix is necessary to ensure organizations are reimbursed and evaluated fairly.
5. **Multiple stages of disease:** Many MSK conditions (e.g., low back pain, knee osteoarthritis, hip osteoarthritis, etc.) are progressive in nature and the decision to seek healthcare services varies by patient and is often determined by the severity of their symptoms. There are multiple opportunities to intervene, which align closely with the stages of disease.

Examples of existing bundled payment models include the following:

- **Comprehensive Care for Joint Replacement (CJR) Model:** This is a procedure-based bundled payment model designed to improve care for Medicare patients undergoing hip and knee replacements performed in the inpatient or outpatient setting and total ankle replacements

performed in the inpatient setting. Part A and Part B services related to the CJR episode are included in the bundle. This model includes the time period of the surgery and extends 90 days after the surgery date.²¹

- The CJR Model is scheduled to end on December 31, 2024. For additional details related to TEAM, CMS's new alternative payment model that builds upon the CJR, please refer to the Milliman article "[The next generation of Medicare bundled payments: Considerations regarding TEAM.](#)"
- **Nashville-based health system:** This health system administers a condition-based bundled payment model designed to improve care for commercial members with non-injury-related shoulder pain.²² This bundle provides coverage for related medical services such as physical therapy as well as advanced imaging and includes surgery and postoperative care for patients who do not achieve desired results with medical management alone. Bundle duration can last up to nine months and varies based on individual treatment plan.
- **Division of TennCare:** TennCare, Tennessee's Medicaid program, offers a condition bundle for back and neck pain that covers all related care, such as imaging and testing, surgical and medical procedures, and medications for a period of 90 days. If the patient requires a spinal decompression or spinal fusion within 90 days, a separate procedure bundle is initiated. In this model, the two episodes are overlapping, therefore the higher-acuity bundle (e.g., the spinal decompression or spinal fusion) will be considered in the performance evaluation.²³

When considering the design for an MSK condition bundle, it is important to remember that the treatment recommendations will vary depending upon the severity of the condition and when a patient initiates care with the healthcare system. For example, the treatment guidelines for a traumatic grade 3 anterior cruciate ligament (ACL) injury for active individuals typically recommends surgery²⁴ whereas the treatment recommendations for a progressive disease such as osteoarthritis vary based upon the patient's health status, severity of symptoms, and radiographic evidence.²⁵ The remainder of this paper outlines considerations around designing a bundled payment model for a common MSK condition, knee osteoarthritis.

Case study: Designing a BPM around knee osteoarthritis

BACKGROUND

Knee osteoarthritis (OA), also known as degenerative joint disease of the knee, is typically the result of wear and tear and progressive loss of articular cartilage. The intensity of the clinical symptoms and rate of progression vary by individual. Common clinical symptoms include knee pain that is gradual in onset and worse with activity, knee stiffness and swelling, pain after prolonged sitting or resting, and pain that worsens over time.²⁶

There are multiple classification systems for diagnosing knee osteoarthritis.^{27,28,29} The Kellgren and Lawrence (KL) grading system is a well-recognized approach that allows physicians to categorize knee OA severity into five grades from grade 0 (normal), to grades 1-3 (early stages), to grade 4 (advanced stage), based upon a radiograph.^{30 31} For the purpose of this paper, we'll be referring to three subsets of patients:

- Early stage, mild symptomatic: Patients with early-stage knee OA with mild symptoms. These patients typically self-manage and are less likely to seek medical care. This subset aligns closely with KL grade 1.
- Early stage, moderate symptomatic: Patients with early-stage knee OA with moderate symptoms who are seeking medical care for relief of symptoms. This subset aligns closely with KL grades 2 and 3.
- Advanced stage: Patients with advanced stage knee OA who are symptomatic and for whom nonoperative therapies were ineffective.³² This subset aligns closely with KL grade 4.

Most patients with knee OA begin in early-stage disease, where they are generally asymptomatic or relieve mild symptoms through lifestyle management. However, it is more common that patients seek treatment when the pain or disability has progressed to a point where prescription pain medications or physical therapy is indicated. For some, symptoms can be managed such that surgical care is not needed or desired. For others, knee OA progresses to a point where the symptoms cannot be sufficiently managed without surgery to replace the knee.

DESIGN CONSIDERATIONS

Assess membership:

For conditions with such a broad disease continuum, it is important to determine which patient subsets your design is intended for. Using the classification described above, there are three patient subsets for knee osteoarthritis and the case mix of the membership should be assessed.

Organizations with large proportions of patients with advanced OA and high rates of membership turnover may choose to design a condition bundle focused on lower-cost medical

management services. The goal of this bundle would be to avoid or delay higher-cost surgical care as long as possible, given it is likely that the member will not be with the organization for a long period of time and cost savings may not be realized during the typical enrollment period.

Eligibility criteria:

For each patient subset, an objective eligibility criterion must be established. For patients with advanced knee OA, treatment guidelines recommend surgical intervention to alleviate pain and disability.³² This patient subset is most appropriate for a procedure-based bundle, as there is low value in medical management.³³

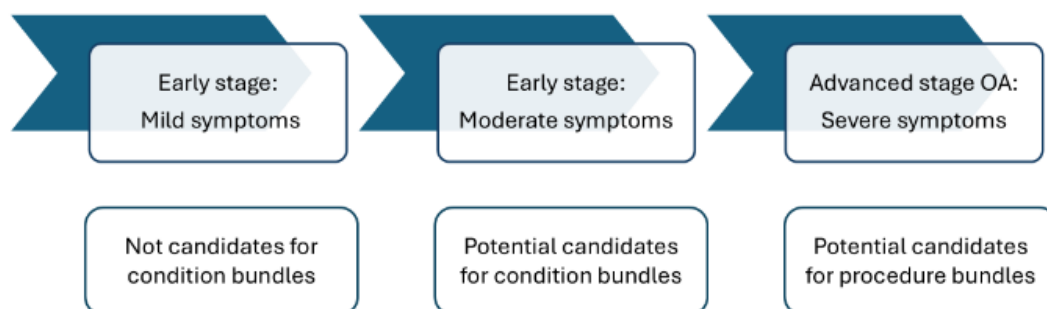
For patients with early-stage OA with moderate symptoms, treatment guidelines recommend conservative management such as physical therapy and prescribed pain medications. For these patients, condition bundles may be most appropriate, as surgery could be avoided with comprehensive medical management. If surgery is necessary, the patient should meet an established medical necessity criteria for surgery. Criteria for surgery varies and may require a minimum duration of time where the patient has been symptomatic, or proof that a trial of conservative treatment has failed to improve the symptoms. Depending on the details of the bundled payment model, the surgery may be included in the condition bundle or may result in the termination of the condition bundle and initiation of a procedure-based bundle.

Patients in the early stages of disease with mild symptoms typically self-manage by weight loss or modified physical activity. These self-managed patients may not require additional treatments (e.g., physical therapy, prescribed pain medications) and therefore will not meet the condition bundle eligibility criteria.

Figure 1 below outlines the suggested bundle type for the various stages of knee OA.

Other eligibility criteria may include age, insurance coverage, clinical risk, presentation (e.g., elective, urgent, emergent), and primary diagnoses (e.g., osteoarthritis).

FIGURE 1: DISEASE PROGRESSION OF KNEE OSTEOARTHRITIS



Role of utilization management:

For both procedure and condition bundle designs, the role of utilization management to enforce the eligibility criteria and manage individual services is going to heavily influence the success of the model. Maintaining guardrails related to coverage limitations (e.g., maximum of 20 physical therapy visits) or the medical necessity for surgery is encouraged. For example, if medical necessity requirements were waived and the decision to proceed with surgery is made directly by the surgeon (who is part of the organization accepting [and benefiting] from the risk-taking arrangement), that surgeon is thus able to influence the volume of surgeries rendered. This may result in unintended increased total bundle volume overall, which is not what the payer usually wants.

Role of risk adjustment:

Even with a well-defined bundled payment model, including objective eligibility criteria and strong utilization management, it is important to evaluate organization performance fairly (e.g., cost and/or quality targets). Risk adjustment is the process of statistically accounting for differences in patient demographics, comorbidities, geographic location, and socioeconomic status that influence healthcare outcomes.³⁴ Without adequate risk adjustment, it will be unclear whether differences in outcomes are related to the patient case mix or practice changes due to the bundled payment model.

Other elements of design such as prospective versus retrospective methodologies and administrative capabilities should also be considered. For more information on these topics please see the Milliman article "[What are bundled payments and how can they be used by healthcare organizations?](#)"

Monitoring and reporting:

Regardless of the bundled payment type, it is important to have a routine monitoring process to ensure that desired goals are being met. The healthcare landscape can change quickly, thereby influencing provider practice patterns. Having reports and processes to monitor utilization, trends in cost of care, updates to clinical practices, and changes in diagnosis and procedure codes that may impact the bundle definition are critical, especially if a fixed payment has been negotiated. For example, if reimbursement for a procedure bundle was based upon historical inpatient facility rates and surgeries shift to the ambulatory surgical setting, being aware of the change in site of service is essential.

Closing thoughts

Bundled payment models are not all the same. Selecting an MSK condition for either a condition or procedure bundled payment model is a good option, as these conditions are driving costs and there is sufficient variation in provider practice patterns to see a meaningful change in cost and quality targets. Creating a bundle design that encompasses both early stage and advanced stages of a disease will increase the number of patients enrolled in a value-based arrangement and may result in favorable outcomes. With an increasing shift toward value-based reimbursement, employers, payers, providers, and third-party organizations must work together to understand the landscape of their markets to create a win-win situation for all stakeholders.

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ENDNOTES

1. Harrill, W.C. & Melon, D.E. (2021). A Field Guide to U.S. Healthcare Reform: The Evolution to Value-Based Healthcare. *Laryngoscope Investig Oto.*;6(3):590-599. doi:10.1002/lio2.575.
2. CMS. Innovation Center Strategy Refresh. Retrieved December 16, 2024, from <https://www.cms.gov/priorities/innovation/strategic-direction-whitepaper>.
3. CMS. Transforming Episode Accountability Model (TEAM). Retrieved December 16, 2024, from <https://www.cms.gov/priorities/innovation/innovation-models/team-model>.
4. Cigna. Cigna Drives More Affordable Orthopedic Care With Bundled Payment Program in Connecticut. Retrieved December 16, 2024, from <https://newsroom.cigna.com/surgical-treatment-and-support-program>.
5. Populytics (March 15, 2022). Why Companies Like GM and Walmart Opt for Direct Health Care Contracting. Retrieved December 16, 2024, from <https://www.populytics.com/en/knowledge-center/blog/why-companies-like-gm-and-walmart-are-opting-for-direct-health-care-contracting>.
6. Blue Cross Blue Shield. Blue Distinction Specialty Care. Retrieved December 16, 2024, from <https://www.bcbs.com/about-us/programs-initiatives/blue-distinction-specialty-care/index>.
7. Blue Cross Blue Shield Blue Care Network of Michigan. Blue Distinction Specialty Care. Retrieved December 16, 2024, from <https://www.bcbsm.com/employers/network-choices/blue-distinction-specialty/>.
8. Bazell, C., Alston, M., Pelizzari, P., & Sweatman, B.A. (March 27, 2023). What Are Bundled Payments and How Can They Be Used by Healthcare Organizations? Milliman. Retrieved December 16, 2024, from <https://www.milliman.com/en/insight/what-are-bundled-payments-and-how-can-they-be-used-by-healthcare-organizations>.
9. Nguyen, A.T., Aris, I.M., Snyder, B.D. et al. (2024). Musculoskeletal Health: An Ecological Study Assessing Disease Burden and Research Funding. *The Lancet Regional Health – Americas*;29:100661. doi:10.1016/j.lana.2023.100661.
10. Dieleman, J.L., Cao, J., Chapin, A. et al. (2020). U.S. Healthcare Spending by Payer and Health Condition, 1996-2016. *JAMA*;323(9):863. doi:10.1001/jama.2020.0734.
11. U.S. Bureau of Labor Statistics. Occupational Injuries and Illnesses Resulting in Musculoskeletal Disorders (MSDs). Retrieved December 16, 2024, from <https://www.bls.gov/iif/factsheets/msds.htm>.
12. Hsu, J.R., Mir, H., Wally, M.K., & Seymour, R.B. (2019). Orthopaedic Trauma Association Musculoskeletal Pain Task Force: Clinical Practice Guidelines for Pain Management in Acute Musculoskeletal Injury. *J Orthop Trauma*;33(5):e158-e182. doi:10.1097/BOT.0000000000001430.
13. Childress, M.A. & Becker, B.A. (May 1, 2016). Nonoperative Management of Cervical Radiculopathy. *Am Fam Physician*;93(9):746-54.
14. Blanpied, P.R., Gross, A.R., Elliott, J.M. et al. (2017). Neck Pain: Revision 2017: Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health From the Orthopaedic Section of the American Physical Therapy Association. *Journal of Orthopaedic & Sports Physical Therapy*;47(7):A1-A83. doi:10.2519/jospt.2017.0302.
15. Song, Z., Kannan, S., Gambrel, R.J. et al. (2022). Physician Practice Pattern Variations in Common Clinical Scenarios Within Five U.S. Metropolitan Areas. *JAMA Health Forum*;3(1):e214698. doi:10.1001/jamahealthforum.2021.4698.
16. Sharma, L. (2021). Osteoarthritis of the Knee. Solomon, C.G., ed. *N Engl J Med*;384(1):51-59. doi:10.1056/NEJMcp1903768.
17. Aresti, N., Kassam, J., Nicholas, N., & Achan, P. (July 6, 2016). Hip Osteoarthritis. *BMJ*:i3405. doi:10.1136/bmj.i3405.
18. Sambandam, S.N. (2015). Rotator Cuff Tears: An Evidence-Based Approach. *WJO*;6(11):902. doi:10.5312/wjo.v6.i11.902.
19. Liao, J.M. & Navathe, A.S. (2022). The Path Ahead for Bundled Payments. *JAMA*;328(16):1592. doi:10.1001/jama.2022.18191.
20. Guan, S.Y., Zheng, J.X., Sam, N.B., Xu, S., Shuai, Z., & Pan, F. (2023). Global Burden and Risk Factors of Musculoskeletal Disorders Among Adolescents and Young Adults in 204 Countries and Territories, 1990-2019. *Autoimmun Rev*;22(8):103361. doi:10.1016/j.autrev.2023.103361.
21. CMS. Comprehensive Care for Joint Replacement Model. Retrieved December 16, 2024, from <https://www.cms.gov/priorities/innovation/innovation-models/CJR>.
22. Vanderbilt Health. MyOrthoHealth – Shoulder Pain. Retrieved December 16, 2024, from <https://www.vanderbilthealth.com/solutions/myorthohealth-shoulder-pain>.
23. TennCare. Searchable Episodes Table. Retrieved December 16, 2024, from <https://www.tn.gov/tenncare/health-care-innovation/episodes-of-care/searchable-episodes-table.html>.
24. American Academy of Orthopaedic Surgeons (August 22, 2022). Management of Anterior Cruciate Ligament Injuries: Evidence-Based Clinical Practice Guideline. Retrieved December 16, 2024, from <https://www.aaos.org/globalassets/quality-and-practice-resources/anterior-cruciate-ligament-injuries/acpcpg.pdf>.
25. American Academy of Orthopaedic Surgeons (August 31, 2021). Management of Osteoarthritis of the Knee (Non-Arthroplasty): Evidence-Based Clinical Practice Guideline. Retrieved December 16, 2024, from <https://www.aaos.org/globalassets/quality-and-practice-resources/osteoarthritis-of-the-knee/oak3cpg.pdf>.
26. Hsu, H. & Siwiec, R.M. (June 26, 2023). Knee Osteoarthritis. *StatPearls*. Retrieved December 16, 2024, from <http://www.ncbi.nlm.nih.gov/books/NBK507884/>.
27. Ratzlaff, C., Ashbeck, E.L., Guermazi, A., Roemer, F.W., Duryea, J., & Kwok, C.K. (2018). A Quantitative Metric for Knee Osteoarthritis: Reference Values of Joint Space Loss. *Osteoarthritis and Cartilage*;26(9):1215-1224. doi:10.1016/j.joca.2018.05.014.
28. Luyten, F.P., Bierma-Zeinstra, S., Dell'Accio, F. et al. (2018). Toward Classification Criteria for Early Osteoarthritis of the Knee. *Seminars in Arthritis and Rheumatism*;47(4):457-463. doi:10.1016/j.semarthrit.2017.08.006.
29. Peat, G. (2006). Clinical Classification Criteria for Knee Osteoarthritis: Performance in the General Population and Primary Care. *Annals of the Rheumatic Diseases*;65(10):1363-1367. doi:10.1136/ard.2006.051482.
30. Cueva, J.H., Castillo, D., Espinós-Morató, H., Durán, D., Díaz, P., & Lakshminarayanan, V. (2022). Detection and Classification of Knee Osteoarthritis. *Diagnostics*;12(10):2362. doi:10.3390/diagnostics12102362.
31. Kohn, M.D., Sassoon, A.A., & Fernando, N.D. (2016). Classifications in Brief: Kellgren Lawrence Classification of Osteoarthritis. *Clinical Orthopaedics & Related Research*;474(8):1886-1893. doi:10.1007/s11999-016-4732-4.
32. Hannon, C.P., Goodman, S.M., Austin, M.S., et al. (2023). 2023 American College of Rheumatology and American Association of Hip and Knee Surgeons Clinical Practice Guideline for the Optimal Timing of Elective Hip or Knee Arthroplasty for Patients With Symptomatic Moderate-to-Severe Osteoarthritis or Advanced Symptomatic Osteonecrosis With Secondary Arthritis for Whom Nonoperative Therapy Is Ineffective. *Arthritis Care & Research*;75(11):2227-2238. doi:10.1002/acr.25175.
33. Lim, W.B. & Al-Dadah, O. (2022). Conservative Treatment of Knee Osteoarthritis: A Review of the Literature. *WJO*;13(3):212-229. doi:10.5312/wjo.v13.i3.212.
34. Lane-Fall, M.B. & Neuman, M.D. (2013). Outcomes Measures and Risk Adjustment. *International Anesthesiology Clinics*;51(4):10-21. doi:10.1097/AIA.0b013e3182a70a52.