G17: What is the optimal marker of glycemic control for patients undergoing major orthopedic surgery?

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Response/Recommendation:

This workgroup recommends that any or all available markers, namely HbA1c, fructosamine or blood glucose variability should be used to determine glycemic control.

Strength of recommendation: Moderate

Delegate Vote:

Rationale:

Diabetes mellitus is one of the most prevalent diseases, affecting millions of people worldwide (1). Dysregulated blood glucose levels are commonly observed in patients undergoing orthopedic surgeries (2,3). This condition has been linked to both short-term and long-term complications, such as infections, readmission and overall mortality (2,4–6). As a result, it has been recommended that all patients be screened for glycemic control before surgery (7). Currently, the American Diabetes Association has endorsed HbA1c as a reliable marker for assessing blood glucose levels before surgery. In recent years, there has been growing uncertainty regarding the ability of HbA1c to predict complications after orthopedic surgeries, as well as debate over the optimal cutoff values for this marker (8,9). At the same time, increasing research is exploring other markers, such as fructosamine, which may offer potential in reducing postoperative complications in orthopedic patients (10,11).

A systematic review and meta-analysis were conducted. After the initial and full-text screening, 67 papers were included in the final review (12–78). Currently, three main markers are used to assess glycemic status in patients undergoing major orthopedic surgeries: HbA1c, fructosamine, and glucose variability. It should be noted that the included papers vary with regard to the inclusion of these three markers for comparison, use differing cutoffs to study significance, and involve inconsistent time of marker obtainment (preoperative, intraoperative, or postoperative). Nonetheless, three primary outcomes were evaluated in these studies for major orthopedic surgeries: infections (including surgical site infection [SSI] and periprosthetic joint infection [PJI]), readmissions, and reoperations. The meta-analysis revealed that HbA1c has a strong predictive value for infection and readmission following major orthopedic surgeries but not for reoperation. However, the heterogeneity across all analyses ranged from moderate to high, which limits the interpretability of the results. A commonly used cutoff value for HbA1c is 7%; however, this threshold has recently been called into question (79–81). A subgroup analysis was conducted to evaluate the association between different HbA1c cutoff levels and infection rates following orthopedic surgery. However, the analysis revealed that the differences between the cutoff values were not statistically significant. Fructosamine was also evaluated as a predictive marker for outcomes following major orthopedic surgeries, demonstrating promising results. The most commonly used cutoff for fructosamine was 292–293 μmol/L (82,83). It exhibited significant predictive value for infections, readmissions, and reoperations. Although the heterogeneity among studies was low, the limited number of studies investigating this marker reduces the robustness of the conclusions that can be drawn from these findings. Glucose variability was evaluated and reported in studies using the coefficient of variation (CV), with

most studies stratifying CV into three tertials. A subgroup analysis was conducted to evaluate high and medium CV levels in comparison to low CV for predicting infection rates following orthopedic surgeries. Significant results were observed for high glucose variability compared to low, but not for medium glucose variability.

Comparative research aimed at identifying the optimal glycemic marker remains limited. A 2019 study by Shohat et al. on fructosamine demonstrated that it provides superior predictive value, responds more rapidly to treatment, and can identify patients with postoperative complications who have normal HbA1c levels but whose fructosamine levels exceed the established cutoff (82). Additionally, a 2017 study by Shohat et al. reported that while HbA1c levels above 7% were not able to predict or show a significant association with infection, reoperation, or readmission, fructosamine demonstrated greater predictive value (83). These results highlight the need for better-controlled comparisons between these two markers in the literature to obtain more meaningful findings.

A variety of other markers, such as single assessments of blood glucose, the HbA1c/albumin ratio, and albumin-corrected fructosamine, have been studied. Some research has demonstrated good predictive value for these markers; however, due to the limited number of studies and variations in evaluation methods, further research is required to establish their clinical relevance (11,84–86)

Conclusion

Based on current evidence, three main markers are used for assessing glycemic control in patients undergoing major orthopedic surgeries: HbA1c, fructosamine, and blood glucose variability. HbA1c is the most adopted method of assessment; however, it has been shown to be less reliable in recent investigations. Fructosamine, an emerging marker, may offer greater predictive value compared to HbA1c. Nevertheless, further research is needed to compare these two markers using more controlled and comprehensive methods to determine the optimal glycemic marker for predicting outcomes following orthopedic surgeries.

References:

1. Ong KL, Stafford LK, McLaughlin SA, Boyko EJ, Vollset SE, Smith AE, et al. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021. The Lancet. 2023 Jul 15;402(10397):203–34.

2. Iorio R, Williams KM, Marcantonio AJ, Specht LM, Tilzey JF, Healy WL. Diabetes Mellitus, Hemoglobin A1C, and the Incidence of Total Joint Arthroplasty Infection. J Arthroplasty. 2012 May 1;27(5):726-729.e1.

3. Capozzi JD, Lepkowsky ER, Callari MM, Jordan ET, Koenig JA, Sirounian GH. The Prevalence of Diabetes Mellitus and Routine Hemoglobin A1c Screening in Elective Total Joint Arthroplasty Patients. J Arthroplasty. 2017 Jan 1;32(1):304–8.

4. Chrastil J, Anderson MB, Stevens V, Anand R, Peters CL, Pelt CE. Is Hemoglobin A1c or Perioperative Hyperglycemia Predictive of Periprosthetic Joint Infection or Death Following Primary Total Joint Arthroplasty? J Arthroplasty. 2015 Jul 1;30(7):1197–202.

5. Maradit Kremers H, Lewallen LW, Mabry TM, Berry DJ, Berbari EF, Osmon DR. Diabetes Mellitus, Hyperglycemia, Hemoglobin A1C and the Risk of Prosthetic Joint Infections in Total Hip and Knee Arthroplasty. J Arthroplasty. 2015 Mar 1;30(3):439–43.

6. Hogan C, Bucknell AL, King KB. The Effect of Diabetes Mellitus on Total Joint Arthroplasty Outcomes. JBJS Rev. 2016 Feb 23;4(2):e3.

7. Shohat N, Goswami K, Tarabichi M, Sterbis E, Tan TL, Parvizi J. All Patients Should Be Screened for Diabetes Before Total Joint Arthroplasty. J Arthroplasty. 2018 Jul 1;33(7):2057–61.

8. Citak M, Toussaint B, Abdelaziz H, Klebig F, Dobinsky A, Gebauer M, et al. Elevated HbA1c is not a risk factor for wound complications following total joint arthroplasty: a prospective study. Hip Int J Clin Exp Res Hip Pathol Ther. 2020 Sep;30(1_suppl):19–25.

9. Shohat N, Muhsen K, Gilat R, Rondon AJ, Chen AF, Parvizi J. Inadequate Glycemic Control Is Associated With Increased Surgical Site Infection in Total Joint Arthroplasty: A Systematic Review and Meta-Analysis. J Arthroplasty. 2018 Jul 1;33(7):2312-2321.e3.

10. Shohat N, Goswami K, Breckenridge L, Held MB, Malkani AL, Shah RP, et al. Fructosamine is a valuable marker for glycemic control and predicting adverse outcomes following total hip arthroplasty: a prospective multi-institutional investigation. Sci Rep. 2021 Jan 26;11(1):2227.

11. Cetik RM, Azboy I, Birinci M, Ozturkmen Y, Kalyenci AS, Atilla B. Predictive value of different glycemic control markers in total hip or knee arthroplasty: A prospective study. Acta Orthop Traumatol Turc. 2023 Sep;57(5):289–93.

12. Shohat N, Tarabichi M, Tan T, Goswami K, Kheir M, Malkani A, et al. 2019 John Insall Award: Fructosamine is a better glycaemic marker compared with glycated haemoglobin (HbA1C) in predicting adverse outcomes following total knee arthroplasty A PROSPECTIVE MULTICENTRE STUDY. BONE Jt J. 2019;101B(7):3–9.

13. Liu H, Zhang W, Hu Q, Liu L, Xie Z, Xu Y, et al. A nomogram for accurately predicting the surgical site infection following transforaminal lumbar interbody fusion in type 2 diabetes patients, based on glycemic variability. Int Wound J. 2023;20(4):981–94.

14. Anderson BM, Wise BT, Joshi M, Castillo R, O'Toole RV, Richards JE. Admission Hyperglycemia Is a Risk Factor for Deep Surgical-Site Infection in Orthopaedic Trauma Patients. J Orthop Trauma. 2021;35(12):e451–7.

15. Shohat N, Goswami K, Tarabichi M, Sterbis E, Tan TL, Parvizi J. All Patients Should Be Screened for Diabetes Before Total Joint Arthroplasty. J Arthroplasty. 2018;33(7):2057–61.

16. Kallio PJ, Nolan J, Olsen AC, Breakwell S, Topp R, Pagel PS. Anesthesia preoperative clinic referral for elevated Hba1c reduces complication rate in diabetic patients undergoing total joint arthroplasty. Anesth Pain Med [Internet]. 2015;5(3). Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84937064587&doi=10.5812%2faapm.5%283%292015.24376&partnerID=40&md5=a58d71fde70a32b40f4a74c339fecbb8

17. Domek N, Dux K, Pinzur M, Weaver F, Rogers T. Association Between Hemoglobin A1c and Surgical Morbidity in Elective Foot and Ankle Surgery. J Foot Ankle Surg. 2016;55(5):939–43.

18. Cancienne JM, Brockmeier SF, Werner BC. Association of Perioperative Glycemic Control With Deep Postoperative Infection After Shoulder Arthroplasty in Patients With Diabetes. J Am Acad Orthop Surg. 2018;26(11):e238–45.

19. Takahashi S, Suzuki A, Toyoda H, Terai H, Dohzono S, Yamada K, et al. Characteristics of diabetes associated with poor improvements in clinical outcomes after lumbar spine surgery. Spine Phila Pa 1976. 2013;38(6):516–22.

20. Mazoch M, Barnes C, Cooper K. Complications in diabetic patients undergoing revision total joint arthroplasty. Curr Orthop Pract. 2016;27(3):296–302.

21. Wang WH, Hsieh TC, Wu WT, Lee RP, Wang JH, Yeh KT. Correlation between the Control of Blood Glucose Level and HbA1C and the Incidence of Surgical Site Infection after Emergent Surgery for the Lower Limb Fracture among Type II DM Patients Aged More Than 50 Years Old. J Clin Med. 2022;11(19).

22. Leung LHB, Chan WKV, Fu H, Cheung MH, Cheung A, Luk MH, et al. Determining the risk factors for hyperglycemia and glucose variability after total knee arthroplasty with continuous glucose monitoring: An observational cohort study. J Orthop Trauma Rehabil. 2024;31(1):28–33.

23. Tarabichi M, Shohat N, Kheir MM, Adelani M, Brigati D, Kearns SM, et al. Determining the Threshold for HbA1c as a Predictor for Adverse Outcomes After Total Joint Arthroplasty: A Multicenter, Retrospective Study. J Arthroplasty. 2017;32(9S):S263-S267.e1.

24. Kremers H, Schleck C, Lewallen E, Larson D, Van Wijnen A, Lewallen D. Diabetes Mellitus and Hyperglycemia and the Risk of Aseptic Loosening in Total Joint Arthroplasty. J ARTHROPLASTY. 2017;32(9):S251–3.

25. Iorio R, Williams KM, Marcantonio AJ, Specht LM, Tilzey JF, Healy WL. Diabetes mellitus, hemoglobin A1C, and the incidence of total joint arthroplasty infection. J Arthroplasty. 2012;27(5):726-9.e1.

26. Maradit Kremers H, Lewallen LW, Mabry TM, Berry DJ, Berbari EF, Osmon DR. Diabetes Mellitus, Hyperglycemia, Hemoglobin A1C and the Risk of Prosthetic Joint Infections in Total Hip and Knee Arthroplasty. J Arthroplasty. 2015;30(3):439–43.

27. Hwang JS, Kim SJ, Bamne AB, Na YG, Kim TK. Do glycemic markers predict occurrence of complications after total knee arthroplasty in patients with diabetes? Clin Orthop Relat Res. 2015;473(5):1726–31.

28. Kieruzel N, Sethi S, Nair V, Wolf JM, Strelzow JA. Do preoperative glucose levels predict risk of complications in orthopaedic surgery? Eur J Orthop Surg Traumatol. 2024;34(6):2941–7.

29. Chen D, Liu S, Liu P, Song W. Effect of Elevated Blood Glucose on Postoperative Complications Among Diabetic Patients After Surgical Treatment of Torsional Ankle Fracture. Foot Ankle Int. 2024;45(8):839–44.

30. Citak M, Toussaint B, Abdelaziz H, Klebig F, Dobinsky A, Gebauer M, et al. Elevated HbA1c is not a risk factor for wound complications following total joint arthroplasty: a prospective study. HIP Int. 2020;30(1_SUPPL):19–25.

31. Cox CT, Sierra S, Egan A, McKee D, MacKay BJ. Elevated Hemoglobin A1c and the Risk of Postoperative Complications in Elective Hand and Upper Extremity Surgery. Cureus. 2023;15(11):e48373.

32. Stryker LS, Abdel MP, Morrey ME, Morrow MM, Kor DJ, Morrey BF. Elevated postoperative blood glucose and preoperative hemoglobin a1c are associated with increased wound complications following total joint arthroplasty. J Bone Jt Surg Ser A. 2013;95(9):808–14.

33. Shohat N, Goswami K, Breckenridge L, Held MB, Malkani AL, Shah RP, et al. Fructosamine is a valuable marker for glycemic control and predicting adverse outcomes following total hip arthroplasty: a prospective multi-institutional investigation. Sci Rep. 2021;11(1):2227.

34. Harris AH, Bowe TR, Gupta S, Ellerbe LS, Giori NJ. Hemoglobin A1C as a marker for surgical risk in diabetic patients undergoing total joint arthroplasty. J Arthroplasty. 2013;28(8 Suppl):25–9.

35. Greene ST, McGee TL, Kot TC, Nehete PV, Bhanat EL, Bergin PF. Hemoglobin A1c as a Predictor of Surgical Site Infection in Patients With Orthopaedic Trauma. J Am Acad Orthop Surg Glob Res Rev. 2023;7(11).

36. Hikata T, Iwanami A, Hosogane N, Watanabe K, Ishii K, Nakamura M, et al. High preoperative hemoglobin A1c is a risk factor for surgical site infection after posterior thoracic and lumbar spinal instrumentation surgery. J Orthop Sci. 2014;19(2):223–8.

37. Wier J, Liu KC, Richardson MK, Gettleman BS, Kistler NM, Heckmann ND, et al. Higher Blood Glucose Levels on the Day of Surgery Are Associated with an Increased Risk of Periprosthetic Joint Infection after Total Hip Arthroplasty. J Bone Jt Surg. 2024;106(4):276–87.

38. Lin YC, Lin YH, Chou JH, Lo YT, Chang CH, Lee SH, et al. Higher reinfection rate after two-stage revision arthroplasty in patients with refractory diabetes mellitus: a retrospective analysis with a minimum ten-year follow up. BMC Musculoskelet Disord. 2022;23(1):990.

39. Singh PR, Singh S, Gupta A, Khan MP, Singh V, Singh GP. Impact of HbA1c level on perioperative hemodynamics, recovery room stay and postoperative discharge time in diabetic patients undergoing total hip arthroplasty. J Arthrosc Jt Surg. 2021;8(4):360–5.

40. Hwang JU, Son DW, Kang KT, Lee SH, Lee JS, Song GS, et al. Importance of Hemoglobin A1c Levels for the Detection of Post-Surgical Infection Following Single-Level Lumbar Posterior Fusion in Patients with Diabetes. Korean J Neurotrauma. 2019;15(2):150–8.

41. Wang S, Xu C, Tan T, Goswami K, Cooper A, Parvizi J. Increased Postoperative Glucose Variability Is Associated With Adverse Outcome Following Two-Stage Exchange Arthroplasty for Periprosthetic Joint Infection. J ARTHROPLASTY. 2020;35(5):1368–73.

42. Shohat N, Restrepo C, Allierezaie A, Tarabichi M, Goel R, Parvizi J. Increased Postoperative Glucose Variability Is Associated with Adverse Outcomes Following Total Joint Arthroplasty. J Bone Jt Surg Am. 2018;100(13):1110–7.

43. Ashkenazi I, Morgan S, Graif N, Shaked O, Shohat N, Khoury A, et al. Increased postoperative glycemic variability is associated with increased mortality in diabetic patients undergoing hip arthroplasty for hip fracture. Arch Orthop Trauma Surg. 2023;143(5):2773–9.

44. Reddy B, Babu P. INFLUENCE OF HbA1c IN TOTAL KNEE ARTHROPLASTY WOUND HEALING. J Evol Med Dent Sci-JEMDS. 2017;6(46):3561–4.

45. Chrastil J, Anderson M, Stevens V, Anand R, Peters C, Pelt C. Is Hemoglobin A1c or Perioperative Hyperglycemia Predictive of Periprosthetic Joint Infection or Death Following Primary Total Joint Arthroplasty? J ARTHROPLASTY. 2015;30(7):1197–202.

46. Cancienne J, Werner B, Browne J. Is There a Threshold Value of Hemoglobin A1c That Predicts Risk of Infection Following Primary Total Hip Arthroplasty? J ARTHROPLASTY. 2017;32(9):S236–40.

47. Cancienne JM, Werner BC, Browne JA. Is There an Association Between Hemoglobin A1C and Deep Postoperative Infection After TKA? Clin Orthop. 2017;475(6):1642–9.

48. Zhuang T, Feng AY, Shapiro LM, Hu SS, Gardner M, Kamal RN. Is Uncontrolled Diabetes Mellitus Associated with Incidence of Complications After Posterior Instrumented Lumbar Fusion? A National Claims Database Analysis. Clin Orthop Relat Res. 2021;479(12):2726–33.

49. Thörling J, Ljungqvist O, Sköldenberg O, Hammarqvist F. No association between preoperative impaired glucose control and postoperative adverse events following hip fracture surgery - A single-centre observational cohort study. Clin Nutr. 2021;40(3):1348–54.

50. Cancienne JM, Miller MD, Browne JA, Werner BC. Not All Patients With Diabetes Have the Same Risks: Perioperative Glycemic Control Is Associated With Postoperative Infection Following Knee Arthroscopy. Arthroscopy. 2018;34(5):1561–9.

51. Statz JM, Wagner ER, Sperling JW, Cofield RH. Outcomes of shoulder arthroplasty in diabetic patients as assessed by peri-operative A1C. Int Orthop. 2018;42(8):1923–34.

52. Kheir MM, Anderson CG, Chiu YF, Carli A. Perioperative Glycemic Variability Influences Infection Rates Differently Following Revision Hip and Knee Arthroplasty. J Arthroplasty [Internet]. 2024;((Kheir M.M., mikemkheir@gmail.com) Department of Orthopaedic Surgery, University of Michigan, Ann Arbor, MI, United States(Anderson C.G.) Department of Orthopaedic Surgery, Virginia Commonwealth University, Richmond, VA, United States(Chiu Y.-F.; Carli A.). Available from: https://www.embase.com/search/results?subaction=viewrecord&id=L645454640&from=export

53. Cancienne JM, Werner BC, Chen DQ, Hassanzadeh H, Shimer AL. Perioperative hemoglobin A1c as a predictor of deep infection following single-level lumbar decompression in patients with diabetes. Spine J. 2017;17(8):1100–5.

54. Reátegui D, Sanchez-Etayo G, Núñez E, Tió M, Popescu D, Núñez M, et al. Perioperative hyperglycaemia and incidence of post-operative complications in patients undergoing total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2015;23(7):2026–31.

55. Mraovic B, Suh D, Jacovides C, Parvizi J. Perioperative hyperglycemia and postoperative infection after lower limb arthroplasty. J Diabetes Sci Technol. 2011;5(2):412–8.

56. Yigit S, Akar M. Periprosthetic infection risks and predictive value of HbA1c/albumin ratio for total joint arthroplasty in patients with diabetes mellitus. Eur Rev Med Pharmacol Sci. 2023;27(5):1869–74.

57. Upadhyaya S, Lopez WY, Goh BC, Chen AF, Blucher JA, Beck A, et al. Post-operative hyperglycemia and its association with surgical site infection after instrumented spinal fusion. Clin Neurol Neurosurg. 2020;197:106100.

58. Kheir MM, Tan TL, Kheir M, Maltenfort MG, Chen AF. Postoperative Blood Glucose Levels Predict Infection After Total Joint Arthroplasty. J Bone Jt Surg Am. 2018;100(16):1423–31.

59. Canseco JA, Chang M, Karamian BA, Nicholson K, Patel PD, Shenoy K, et al. Postoperative Glycemic Variability as a Predictor of Adverse Outcomes Following Lumbar Fusion. Spine Phila Pa 1976. 2022;47(7):E304–11.

60. Cetik RM, Azboy I, Birinci M, Ozturkmen Y, Kalyenci AS, Atilla B. Predictive value of different glycemic control markers in total hip or knee arthroplasty: A prospective study. Acta Orthop Traumatol Turc. 2023;57(5):289–93.

61. Godshaw B, Ojard C, Adams T, Chimento G, Mohammed A, Waddell B. Preoperative Glycemic Control Predicts Perioperative Serum Glucose Levels in Patients Undergoing Total Joint Arthroplasty. J ARTHROPLASTY. 2018;33(7):S76–80.

62. Lim S, Yeh HH, Macki M, Mansour T, Schultz L, Telemi E, et al. Preoperative HbA1c > 8% Is Associated With Poor Outcomes in Lumbar Spine Surgery: A Michigan Spine Surgery Improvement Collaborative Study. Neurosurgery. 2021;89(5):819–26.

63. Jämsen E, Nevalainen P, Kalliovalkama J, Moilanen T. Preoperative hyperglycemia predicts infected total knee replacement. Eur J Intern Med. 2010;21(3):196–201.

64. Sigurdardottir M, Sigurdsson MI, Olafsson Y, Sverrisdottir SH, Gunnarsdottir I, Sigurdsson EL, et al. Prevalence of modifiable risk factors in primary elective arthroplasty and their association with infections. Acta Orthop. 2023;94:38–44.

65. Han HS, Kang SB. Relations between long-term glycemic control and postoperative wound and infectious complications after total knee arthroplasty in type 2 diabetics. Clin Orthop Surg. 2013;5(2):118–23.

66. Lamloum SM, Mobasher LA, Karar AH, Basiony L, Abdallah TH, Al-Saleh AI, et al. Relationship between postoperative infectious complications and glycemic control for diabetic patients in an orthopedic hospital in Kuwait. Med Princ Pr. 2009;18(6):447–52.

67. Richards JE, Kauffmann RM, Zuckerman SL, Obremskey WT, May AK. Relationship of hyperglycemia and surgical-site infection in orthopaedic surgery. J Bone Jt Surg Am. 2012;94(13):1181–6.

68. Zhang B, Liu Z, Liu S, Liu B, Li M, Li W, et al. Retrospective Study from a Single Center to Identify Risk Factors Associated with Reinfection in Patients Undergoing 2-Stage Revision Surgery for Periprosthetic Joint Infection. Med Sci Monit [Internet]. 2022;28((Zhang B.; Liu Z.; Liu S.; Liu B.; Li M.; Li W.; Han Y., yongtaihan@foxmail.com) Department of Osteonecrosis and Hip Surgery, Third Hospital of Hebei Medical University, Hebei, Shijiazhuang, China). Available from: https://www.embase.com/search/results?subaction=viewrecord&id=L2018874138&from=export

69. Suh YM, Fisher M, Hu D, Lin FC, Wukich D, Tennant J, et al. Serum Fructosamine as an Indicator of Perioperative Complications in Patients Undergoing Foot and Ankle Surgery. Foot Ankle Orthop. 2024;9(3):24730114241263093.

70. Shohat N, Tarabichi M, Tischler EH, Jabbour S, Parvizi J. Serum Fructosamine: A Simple and Inexpensive Test for Assessing Preoperative Glycemic Control. J Bone Jt Surg Am. 2017;99(22):1900–7.

71. Goh GS, Shohat N, Abdelaal MS, Small I, Thomas T, Ciesielka KA, et al. Serum Glucose Variability Increases the Risk of Complications Following Aseptic Revision Hip and Knee Arthroplasty. J Bone Jt Surg. 2022;104(18):1614–20.

72. Adams AL, Paxton EW, Wang JQ, Johnson ES, Bayliss EA, Ferrara A, et al. Surgical outcomes of total knee replacement according to diabetes status and glycemic control, 2001 to 2009. J Bone Jt Surg Am. 2013;95(6):481–7.

73. Cancienne JM, Deasey MJ, Kew ME, Werner BC. The Association of Perioperative Glycemic Control With Adverse Outcomes Within 6 Months After Arthroscopic Rotator Cuff Repair. Arthroscopy. 2019;35(6):1771–8.

74. Cancienne J, Werner B, Hassanzadeh H, Singla A, Shen F, Shimer A. The Association of Perioperative Glycemic Control with Deep Postoperative Infection After Anterior Cervical Discectomy and Fusion in Patients with Diabetes. WORLD Neurosurg. 2017;102:13–7.

75. Kirkland LL, Kashiwagi DT, Burton MC, Cha S, Varkey P. The charlson comorbidity index score as a predictor of 30-day mortality after hip fracture surgery. Am J Med Qual. 2011;26(6):461–7.

76. Rocks M, Zhao A, Liu I, Agarwal A, Harris A, Gu A, et al. The Creation of Data-Driven Preoperative Hemoglobin A1c and Same-Day Glucose Strata to Stratify Complication Risk Following Total Hip Arthroplasty. J ARTHROPLASTY. 2024;39(4):1013–8.

77. Marchant M, Viens N, Cook C, Vail T, Bolognesi M. The Impact of Glycemic Control and Diabetes Mellitus on Perioperative Outcomes After Total Joint Arthroplasty. J BONE Jt Surg-Am Vol. 2009;91A(7):1621–9.

78. Shen D, Sun S, Mu Z, Yuefu D. The Maximum Threshold Value for HbA1c in Diabetic Patients Undergoing Elective Total Knee Arthroplasty. J Coll Physicians Surg Pak. 2024;34(9):1073–8.

79. Adams AL, Paxton EW, Wang JQ, Johnson ES, Bayliss EA, Ferrara A, et al. Surgical Outcomes of Total Knee Replacement According to Diabetes Status and Glycemic Control, 2001 to 2009. JBJS. 2013 Mar 20;95(6):481.

80. Cancienne JM, Werner BC, Browne JA. Is There a Threshold Value of Hemoglobin A1c That Predicts Risk of Infection Following Primary Total Hip Arthroplasty? J Arthroplasty. 2017 Sep 1;32(9, Supplement):S236–40.

81. Tarabichi M, Shohat N, Kheir MM, Adelani M, Brigati D, Kearns SM, et al. Determining the Threshold for HbA1c as a Predictor for Adverse Outcomes After Total Joint Arthroplasty: A Multicenter, Retrospective Study. J Arthroplasty. 2017 Sep 1;32(9, Supplement):S263-S267.e1.

82. Shohat N, Tarabichi M, Tan TL, Goswami K, Kheir M, Malkani AL, et al. 2019 John Insall Award: Fructosamine is a better glycaemic marker compared with glycated haemoglobin (HbA1C) in predicting adverse outcomes following total knee arthroplasty: a prospective multicentre study. Bone Jt J. 2019 Jul;101-B(7_Supple_C):3–9.

83. Shohat N, Tarabichi M, Tischler EH, Jabbour S, Parvizi J. Serum Fructosamine: A Simple and Inexpensive Test for Assessing Preoperative Glycemic Control. J Bone Joint Surg Am. 2017 Nov 15;99(22):1900–7.

84. Richards JE, Kauffmann RM, Zuckerman SL, Obremskey WT, May AK. Relationship of Hyperglycemia and Surgical-Site Infection in Orthopaedic Surgery. JBJS. 2012 Jul 3;94(13):1181.

85. Yiğit Ş, Akar MS. Periprosthetic infection risks and predictive value of HbA1c/albumin ratio for total joint arthroplasty in patients with diabetes mellitus. Eur Rev Med Pharmacol Sci. 2023 Mar;27(5):1869–74.

86. Zhang B, Liu Z, Liu S, Liu B, Li M, Li W, et al. Retrospective Study from a Single Center to Identify Risk Factors Associated with Reinfection in Patients Undergoing 2-Stage Revision Surgery for Periprosthetic Joint Infection. Med Sci Monit. 2022 Jun 13;28:0–0.