COLLEGE OF MEDICINE CURRICULUM VITAE

Franklin Dexter, MD, PhD, FASA

Date of preparation: May 14, 2024

Ia. Educational history

Sc.B. Applied Mathematics-Biology with Honors, Brown University, 1985

M.S. Biomedical Engineering, Case Western Reserve University, 1988

Ph.D. Biomedical Engineering, Case Western Reserve University, 1989
Specialization in biomathematics

M.D. Case Western Reserve University, 1990
Licensure: Permanent Iowa Medical License #29564, issued 10/5/93, expires 8/1/24

Resident Physician, Department of Anesthesia, University of Iowa, 1990-1993
Certification: American Board of Anesthesiology, issued 4/28/95

Ib. Professional and academic positions held

Assistant Professor, Department of Anesthesia, University of Iowa, 1994 – 1997

Associate Professor with tenure, Department of Anesthesia, University of Iowa, 1997 – 2005

Professor with tenure, Department of Anesthesia, University of Iowa, 2005 – present
Director, Division of Management Consulting, 2001 – present
Secondary appointment in Department of Health Management and Policy, 2004 – present

Ic. Honors and awards

Academic Achievement Award in Biology and Medicine, Brown University, 1985

Rohn Truell Memorial Premium in Applied Mathematics, Brown University, 1985

Sigma Xi (Scientific Research Honor Society), 1985

Medical Scientist Training Program, Case Western Reserve University, 1985

Alpha Omega Alpha (Medical Honor Society), 1990

Association of University Anesthesiologists, 1997

Statistical consultant to FDA's Anesthesiology and Respiratory Therapy Devices Panel, 1997

Department of Nursing Quality Management Recognition Award, University of Iowa, 1998

Associate Editor of the journal *Anesthesiology*, 1999 – 2005

Advisory Board of *OR Manager*, 2000 – 2013

Paper Recognition [#57, #81, #92], American Association of Clinical Directors, 2001 – 2004

Public Interest in Anesthesia Award, American Association of Nurse Anesthetists, 2004
"… to a person or group who has made a significant contribution regarding anesthesia safety, quality of care or social and health issues in the field of anesthesia."

Editorial board member, *Health Care Management Science*, 2006 – 2022

Mary Hanna Memorial Journalism Award, American Society of PeriAnesthesia Nursing, 2006

Anesthesia Patient Safety Foundation Scientific Evaluation Committee, 2007 – 2014

Section Editor for Economics, Education, and Policy, *Anesthesia & Analgesia*, 2006 – 2015

Statistical Editor, *Anesthesia & Analgesia*, 2010 – 2015

Guest Editor (Statistics), *Canadian Journal of Anesthesia*, 2014 – present

Associate Editor, *Journal of Clinical Anesthesia*, 2017 – present

Fellow of the American Society of Anesthesiologists, 2018 – present

Carver College of Medicine Impact Scholars Award, 2020

University of Iowa Quality and Safety faculty project award, 2023

II a. Teaching – student lectures

Operations Research for Surgical Services 50-hour course

Educational research studies performed to improve the course: #148, #149, #192, #223, #246, #280, #294, and #301, below

2004 × 1	2008 × 2	2012 × 4	2016 × 4	2020 × 4
2005 × 1	2009 × 4	2013 × 5	2017 × 3	2021 × 4
2006 × 1	2010 × 3	2014 × 2	2018 × 6	2022 × 2
2007 × 2	2011 × 5	2015 × 8	2019 × 6	2023 × 4

III a. Peer-reviewed papers in operating room management, health services research, and managerial epidemiology; h-index 79 (Google Scholar, May 12, 2024)

1. Dexter F, Tinker JH. Analysis of strategies to decrease post anesthesia care unit costs. *Anesthesiology* 82:94-101, 1995
2. Dexter F, Tinker JH. Comparisons between desflurane and isoflurane or propofol on time to following commands and time to discharge. A metaanalysis. *Anesthesiology* 83:77-82, 1995
3. Dexter F, Tinker JH. The cost efficacy of hypothetically eliminating adverse anesthetic outcomes from high, but neither low nor moderate, risk surgical operations. Anesthesia & Analgesia 81:939-944, 1995
4. Dexter F, Coffin S, Tinker JH. Decreases in anesthesia-controlled time cannot permit one additional surgical operation to be scheduled during the workday. *Anesthesia & Analgesia* 81:1263-1268, 1995
5. Dexter F. Application of prediction levels to OR scheduling. *AORN Journal* 63:607-615, 1996
6. Dexter F. Application of cost-utility and quality-adjusted life years analyses to monitored anesthesia care for sedation only. *Journal of Clinical Anesthesia* 8:286-288, 1996
7. Dexter F, Pearson K, Griffiths DL, Jebson P. Surgical ICU underutilization does not significantly discourage discharge. *Health Services Management Research* 9:238-242, 1996
8. Dexter F, Rittenmeyer H. Measuring productivity of the phase I postanesthesia care unit. *Journal of PeriAnesthesia Nursing* 12:7-11, 1997
9. Dexter F, Rittenmeyer H. A statistical method for predicting postanesthesia care unit staffing needs. *AORN Journal* 65:947-957, 1997
10. Dexter F, Coffin S, Woodward J. Performance of anesthesia machines' devices that are not part of the Food and Drug Administration's daily checkout. *Journal of Clinical Monitoring* 13:171-179, 1997
11. Pecka SL, Dexter F. Anesthesia providers' interventions during cataract extraction under monitored anesthesia care. *AANA Journal* 65:357-360, 1997
12. Dexter F, Rittenmeyer H. Quantification of phase I postanesthesia nursing activities in the phase II postanesthesia care unit. *Nursing Outlook* 45:86-88, 1997

13. Dexter F, Aker J, Wright WA. Development of a measure of patient satisfaction with monitored anesthesia care: the Iowa Satisfaction with Anesthesia Scale. *Anesthesiology* 87:865-873, 1997

14. Dexter F, Lubarsky DA, Gilbert BC, Thompson C. A method to compare costs of drugs and supplies among anesthesia providers: a simple statistical method to reduce variations in cost due to variations in casemix. *Anesthesiology* 88:1350-1356, 1998

15. Macario A, Horne M, Goodman S, Dexter F, Heinen R, Brown B. The effect of a perioperative clinical pathway for knee replacement surgery on hospital costs. *Anesthesia & Analgesia* 86:978-984, 1998

16. Ludington ES, Dexter F. Statistical analysis of total labor pain using the visual analog scale and application to studies of analgesic effectiveness during childbirth. *Anesthesia & Analgesia* 87:723-727, 1998

17. Dexter F. Regional anesthesia does not significantly change surgical time versus general anesthesia - a meta-analysis of randomized studies. *Regional Anesthesia & Pain Management* 23:439-443, 1998

18. Dexter F, Macario A, Cerone SM. Hospital profitability for a surgeon's common procedures predicts the surgeon's overall profitability for the hospital. *Journal of Clinical Anesthesia* 10:457-463, 1998

19. Zhou J, Dexter F. Method to assist in the scheduling of add-on surgical cases - upper prediction bounds for surgical case durations based on the log normal distribution. *Anesthesiology* 89:1228-1232, 1998

20. Dexter F, Macario A, Dexter EU. Computer simulation of changes in nursing productivity from early tracheal extubation of coronary artery bypass graft patients. *Journal of Clinical Anesthesia* 10:593-598, 1998

21. Dexter F, Penning DH, Lubarsky DA, DeLong E, Sanderson I, Gilbert BC, Bell E, Reves JG. Use of an automated anesthesia information system to determine reference limits for vital signs during cesarean section. *Journal of Clinical Monitoring and Computing* 14:491-498, 1998

22. Dexter F, Macario A. Decrease in case duration required to complete an additional case during regularly scheduled hours in an operating room suite - a computer simulation study. *Anesthesia & Analgesia* 88:72-76, 1999

23. Dexter F, Traub RD, Qian F. Comparison of statistical methods to predict the time to complete a series of surgical cases. *Journal of Clinical Monitoring and Computing* 15:45-51, 1999

24. Dexter F, Macario A, Manberg PJ, Lubarsky DA. Computer simulation to determine how rapid anesthetic recovery protocols to decrease the time for emergence or increase the phase I post anesthesia care unit bypass rate affect staffing of an ambulatory surgery center. *Anesthesia & Analgesia* 88:1053-1063, 1999

25. Dexter F, Macario A, Traub RD. Optimal sequencing of urgent surgical cases – scheduling cases using operating room information systems. *Journal of Clinical Monitoring and Computing* 15:153-162, 1999

26. Dexter F, Macario A, Traub RD, Hopwood M, Lubarsky DA. An operating room scheduling strategy to maximize the use of operating room block time: Computer simulation of patient scheduling and survey of patients' preferences for surgical waiting time. *Anesthesia & Analgesia* 89:7-20, 1999

27. Dexter F, Macario A, Lubarsky DA, Burns DD. Statistical method to evaluate management strategies to decrease variability in operating room utilization. Application of linear statistical modeling and Monte-Carlo simulation to operating room management. *Anesthesiology* 91:262-274, 1999

28. Dexter F. Design of appointment systems for preanesthesia evaluation clinics to minimize patient waiting times: a review of computer simulation and patient survey studies. *Anesthesia & Analgesia* 89:925-931, 1999

29. Dexter F, Macario A, O'Neill L. A strategy for deciding operating room assignments for second-shift anesthetists. *Anesthesia & Analgesia* 89:920-924, 1999

30. Macario A, Glenn D, Dexter F. What can the postanesthesia care unit manager do to decrease costs in the PACU? *Journal of Perianesthesia Nursing* 14:284-293, 1999

31. Dexter F, Macario A, Traub RD. Which algorithm for scheduling add-on elective cases maximizes operating room utilization? Use of bin packing algorithms and fuzzy constraints in operating room management. *Anesthesiology* 91:1491-1500, 1999

32. Dexter F, Macario A, Qian F, Traub RD. Forecasting surgical groups' total hours of elective cases for allocation of block time. Application of time series analysis to operating room management. *Anesthesiology* 91:1501-1508, 1999

33. Macario A, Dexter F. Estimating the duration of a case when the surgeon has not recently performed the procedure at the surgical suite. *Anesthesia & Analgesia* 89:1241-1245, 1999

34. Zhou J, Dexter F, Macario A, Lubarsky DA. Relying solely on historical surgical times to estimate accurately future surgical times is unlikely to reduce the average length of time cases finish late. *Journal of Clinical Anesthesia* 11:601-605, 1999

35. Dexter F, Traub RD. Sequencing cases in operating rooms: predicting whether one surgical case will last longer than another. *Anesthesia & Analgesia* 90:975-979, 2000

36. Dexter F, Macario A, O'Neill L. Scheduling surgical cases into overflow block time - computer simulation of the effects of scheduling strategies on operating room labor costs. *Anesthesia & Analgesia* 90:980-986, 2000

37. Macario A, Dexter F. Effect of compensation and patient scheduling on operating room labor costs. *AORN Journal* 71:860-869, 2000

38. Dexter F, Macario A. What is the relative frequency of uncommon ambulatory surgery procedures in the United States with an anesthesia provider? *Anesthesia & Analgesia* 90:1343-1347, 2000

39. Dexter F, Traub RD. Statistical method for predicting when patients should be ready on the day of surgery. *Anesthesiology* 93:1107-1114, 2000

40. Epstein RH, Dexter F. Economic analysis of linking operating room scheduling and hospital material management information systems for just in time inventory control. *Anesthesia & Analgesia* 91:337-343, 2000

41. Dexter F, Macario A, Traub RD. Statistical method using operating room information system data to determine anesthetist weekend call requirements. *AANA Journal* 68:21-26, 2000

42. Dexter F, Macario A, Traub RD. Enterprise-wide patient scheduling information systems to coordinate surgical clinic and operating room scheduling can impair operating room efficiency. *Anesthesia & Analgesia* 91:617-626, 2000

43. Dexter F. A strategy to decide whether to move the last case of the day in an operating room to another empty operating room to decrease overtime labor costs. *Anesthesia & Analgesia* 91:925-928, 2000

44. Dexter F, Traub RD. Determining staffing requirements for a second shift of anesthetists by graphical analysis of data from operating room information systems. *AANA Journal* 68:31-36, 2000

45. Dexter F, Traub RD. The lack of systematic month-to-month variation over one-year periods in ambulatory surgery caseload - application to anesthesia staffing. *Anesthesia & Analgesia* 91:1426-1430, 2000

46. Dexter F, Gan TJ, Naguib M, Lubarsky DA. Cost identification analysis for succinylcholine. *Anesthesia & Analgesia* 92:693-699, 2001

47. Dexter F, Macario A. What is the optimal number of beds and occupancy to minimize nursing staffing costs in an obstetrical unit? *Canadian Journal of Anesthesia* 48:295-301, 2001

48. Dexter F, Traub RD, Lebowitz P. Scheduling a delay between different surgeons' cases in the same operating room on the same day using upper prediction bounds for case durations. *Anesthesia & Analgesia* 92:943-946, 2001

49. Dexter F, Epstein RH, Penning DH. Statistical analysis of postanesthesia care unit staffing at a surgical suite with frequent delays in admission from the operating room - a case study. *Anesthesia & Analgesia* 92:947-949, 2001

50. Dexter F, Thompson E. Relative value guide basic units in operating room scheduling to ensure compliance with anesthesia group policies for surgical procedures performed at each anesthetizing location. *AANA Journal* 69:120-123, 2001

51. Dexter F, Traub RD, Penning DH. Statistical analysis by Monte-Carlo simulation of the impact of administrative and medical delays in discharge from the post-anesthesia care unit on total patient care hours. *Anesthesia & Analgesia* 92:1222-1225, 2001

52. Dexter F, Macario A, Lubarsky DA. The impact on revenue of increasing patient volume at surgical suites with relatively high operating room utilization. *Anesthesia & Analgesia* 92:1215-1221, 2001

53. Dexter F, Epstein RH, Marsh HM. A statistical analysis of weekday operating room anesthesia group staffing costs at nine independently managed surgical suites. *Anesthesia & Analgesia* 92:1493-1498, 2001

54. Macario A, Dexter F, Traub RD. Hospital profitability per hour of operating room time can vary among surgeons. *Anesthesia & Analgesia* 93:669-675, 2001

55. Dexter F, O'Neill L. Weekend operating room on-call staffing requirements. *AORN Journal* 74:666-671, 2001

56. Dexter F, Epstein RH. Reducing family members' anxiety while waiting on the day of surgery: systematic review of studies and implications of HIPAA health information privacy rules. *Journal of Clinical Anesthesia* 13:478-481, 2001

57. Dexter F, Blake JT, Penning DH, Lubarsky DA. Calculating a potential increase in hospital margin for elective surgery by changing operating room time allocations or increasing nursing staffing to permit completion of more cases: a case study. *Anesthesia & Analgesia* 94:138-142, 2002

58. Dexter F, Blake JT, Penning DH, Sloan B, Chung P, Lubarsky DA. Use of linear programming to estimate impact of changes in a hospital's operating room time allocation on perioperative variable costs. *Anesthesiology* 96:718-724, 2002

59. Blake JT, Dexter F, Donald J. Operating room managers' use of integer programming for assigning allocated block time to surgical groups: a case study. *Anesthesia & Analgesia* 94:143-148, 2002

60. Epstein RH, Dexter F. Statistical power analysis to estimate how many months of data are required to identify operating room staffing solutions to reduce labor costs and increase productivity. *Anesthesia & Analgesia* 94:640-643, 2002

61. Dexter F, Traub RD. How to schedule elective surgical cases into specific operating rooms to maximize the efficiency of use of operating room time. *Anesthesia & Analgesia* 94:933-942, 2002

62. Dexter F, Macario A. Changing allocations of operating room time from a system based on historical utilization to one where the aim is to schedule as many surgical cases as possible. *Anesthesia & Analgesia* 94:1272-1279, 2002

63. Dexter F, Traub RD, Fleisher LA, Rock P. What sample sizes are required for pooling surgical case durations among facilities to decrease the incidence of procedures with little historical data? *Anesthesiology* 96:1230-1236, 2002

64. Dexter F, Macario A, Penning DH, Chung P. Development of an appropriate list of surgical procedures of a specified maximum anesthetic complexity to be performed at a new ambulatory surgery facility. *Anesthesia & Analgesia* 95:78-82, 2002

65. Epstein RH, Dexter F, Traub RD. Statistical power analysis to estimate how many months of data are required to identify PACU staffing to minimize delays in admission from ORs. *Journal of PeriAnesthesia Nursing* 17:84-88, 2002

66. Dexter F, Lubarsky DA, Blake JT. Sampling error can significantly affect measured hospital financial performance of surgeons and resulting operating room time allocations. *Anesthesia & Analgesia* 95:184-188, 2002

67. Epstein RH, Dexter F. Uncertainty in knowing the operating rooms in which cases were performed has little effect on operating room allocations or efficiency. *Anesthesia & Analgesia* 95:1726-1730, 2002

68. Dexter F, Epstein RH, Marsh HM. Costs and risks of weekend anesthesia staffing at 6 independently managed surgical suites. *AANA Journal* 70:377-381, 2002

69. Dexter F, Traub RD, Macario A. How to release allocated operating room time to increase efficiency: predicting which surgical service will have the most underutilized operating room time. *Anesthesia & Analgesia* 96:507-512, 2003

70. Dexter F, Epstein RH. Optimizing second shift OR staffing. *AORN Journal* 77:825-830, 2003

71. Abouleish AE, Dexter F, Epstein RH, Lubarsky DA, Whitten CW, Prough DS. Labor costs incurred by anesthesiology groups because of operating rooms not being allocated and cases not being scheduled to maximize operating room efficiency. *Anesthesia & Analgesia* 96:1109-1113, 2003

72. Dexter F, Traub RD, Macario A, Lubarsky DA. Operating room utilization alone is not an accurate metric for the allocation of operating room block time to individual surgeons with low caseloads. *Anesthesiology* 98:1243-1249, 2003

73. Dexter F, Smith TC, Tatman DJ, Macario A. Physicians' perceptions of minimum time that should be saved to move a surgical case from one operating room to another: internet-based survey of the Association of Anesthesia Clinical Directors' (AACD) members. *Journal of Clinical Anesthesia* 15:206-210, 2003

74. Dexter F, Ledolter J. Managing risk and expected financial return from selective expansion of operating room capacity. Mean-variance analysis of a hospital's portfolio of surgeons. *Anesthesia & Analgesia* 97:190-195, 2003

75. Dexter F, Wachtel RE, Yue JC. Use of discharge abstract databases to differentiate among pediatric hospitals based on operative procedures: Surgery in infants and young children in the State of Iowa. *Anesthesiology* 99:480-487, 2003

76. Dexter F, Abouleish AE, Epstein RH, Whitten CW, Lubarsky DA. Use of operating room information system data to predict the impact of reducing turnover times on staffing costs. *Anesthesia & Analgesia* 97:1119-1126, 2003

77. Abouleish AE, Dexter F, Whitten CW, Zavaleta JR, Prough DS. Quantifying net staffing costs due to longer-than-average surgical case durations. *Anesthesiology* 100:403-412, 2004

78. Dexter F, Macario A. When to release allocated operating room time to increase operating room efficiency. *Anesthesia & Analgesia* 98:758-762, 2004

79. O'Neill L, Dexter F. Market capture of inpatient perioperative services using DEA. *Health Care Management Science* 7:263-273, 2004

80. Wachtel RE, Dexter F. Differentiating among hospitals performing physiologically complex operative procedures in the elderly. *Anesthesiology* 100:1552-1561, 2004

81. Dexter F, O'Neill L. Data envelopment analysis to determine by how much hospitals can increase elective inpatient surgical workload for each specialty. *Anesthesia & Analgesia* 99:1492-1500, 2004

82. Dexter F, Lubarsky DA. Using length of stay data from a hospital to evaluate whether limiting elective surgery at the hospital is an inappropriate decision. *Journal of Clinical Anesthesia* 16:421-425, 2004

83. Dexter F, Epstein RD, Traub RD, Xiao Y. Making management decisions on the day of surgery based on operating room efficiency and patient waiting times. *Anesthesiology* 101:1444-1453, 2004

84. Dexter F, Epstein RH. Review of operational decision making before the day of surgery based on operating room efficiency. *Journal Européen des Systèmes Automatisés* 38:603-630, 2004

85. Macario A, Dexter F, Lubarsky DA. Meta-analysis of trials comparing postoperative recovery after anesthesia with sevoflurane or desflurane. *American Journal of Health-System Pharmacy* 62:63-68, 2005

86. Freytag S, Dexter F, Epstein RH, Kugler C, Schnettler R. Allocating and scheduling operating room time based on maximizing operating room efficiency at a German university hospital. *Der Chirurg* 76:71-79, 2005

87. Kanter RK, Dexter F. Criteria for identification of comprehensive pediatric hospitals and referral regions. *Journal of Pediatrics* 146:26-29, 2005

88. Dexter F, Epstein RH, Marcon E, de Matta R. Strategies to reduce delays in admission into a postanesthesia care unit from operating rooms. *Journal of PeriAnesthesia Nursing* 20:92-102, 2005

89. Dexter F, Ledolter J, Wachtel RE. Tactical decision making for selective expansion of operating room resources incorporating financial criteria and uncertainty in subspecialties' future workloads. *Anesthesia & Analgesia* 100:1425-1432, 2005

90. Dexter F, Wachtel RE, Sohn MW, Ledolter J, Dexter EU, Macario A. Quantifying effect of a hospital's caseload for a surgical specialty on that of another hospital using market segments including procedure, payer, and locations of patients' residences. *Health Care Management Science* 8:121-131, 2005

91. Dexter F, Epstein RH, Marcon E, Ledolter J. Estimating the incidence of prolonged turnover times and delays by time of day. *Anesthesiology* 102:1242-1248, 2005

92. Wachtel RE, Dexter F, Lubarsky DA. Financial implications of a hospital's specialization in rare physiologically complex surgical procedures. *Anesthesiology* 103:161-167, 2005

93. Dexter F, Marcon E, Epstein RH, Ledolter J. Validation of statistical methods to compare cancellation rates on the day of surgery. *Anesthesia & Analgesia* 101:465-473, 2005 and erratum 114:693, 2012

94. Xiao Y, Hu P, Hao H, Ho D, Dexter F, Mackenzie CF, Seagull FJ, Dutton R. An algorithm for processing vital sign monitoring data to remotely identify operating room occupancy in real-time. *Anesthesia & Analgesia* 101:823-829, 2005

95. O'Neill L, Dexter F. Methods for understanding super-efficient data envelopment analysis results with an application to hospital inpatient surgery. *Health Care Management Science* 8:291-298, 2005

96. Dexter F, Macario A, Epstein RH, Ledolter J. Validity and usefulness of a method to monitor surgical services' average bias in scheduled case durations. *Canadian Journal of Anesthesia* 52:935-939, 2005

97. Dexter F, Ledolter J. Bayesian prediction bounds and comparisons of operating room times even for procedures with few or no historical data. *Anesthesiology* 103:1259-1267, 2005

98. Marcon E, Dexter F. Impact of surgical sequencing on post anesthesia care unit staffing. *Health Care Management Science* 9:87-98, 2006

99. Dexter F, Yue JC, Dow AJ. Predicting anesthesia times for diagnostic and interventional radiological procedures. *Anesthesia and Analgesia* 102:1491-1500, 2006

100. O'Sullivan CT, Dexter F. Assigning surgical cases with regional anesthetic blocks to anesthetists and operating rooms based on operating room efficiency. *AANA Journal* 74:213-218, 2006

101. Dexter F, Weih LS, Gustafson RK, Stegura LF, Oldenkamp MJ, Wachtel RE. Observational study of operating room times for knee and hip replacement surgery at nine US community hospitals. *Health Care Management Science* 9:325-339, 2006

102. Dexter F, Epstein RH. Holiday and weekend operating room on-call staffing requirements. *Anesthesia & Analgesia* 103:1494-1498, 2006

103. McIntosh C, Dexter F, Epstein RH. The impact of service-specific staffing, case scheduling, turnovers, and first-case starts on anesthesia group and operating room productivity: tutorial using data from an Australian hospital. *Anesthesia & Analgesia* 103:1499-1516, 2006

104. Dexter F, Wachtel RE, Epstein RH. Impact of average patient acuity on staffing of the phase I PACU. *Journal of PeriAnesthesia Nursing* 21:303-310, 2006

105. Dexter F, Davis M, Halbeis CE, Marjamaa R, Marty J, McIntosh C, Nakata Y, Thenuwara KN, Sawa T, Vigoda M. Mean operating room times differ by 50% among hospitals in different countries for laparoscopic cholecystectomy and lung lobectomy. *Journal of Anesthesia* 20:319-322, 2006

106. O'Neill L, Dexter F. Tactical increases in operating room block time based on financial data and market growth estimates from data envelopment analysis. *Anesthesia & Analgesia* 104:355-368, 2007

107. O'Sullivan CT, Dexter F, Lubarsky DA, Vigoda MM. Evidence-based management assessment of return on investment from anesthesia information management systems. *AANA Journal* 75:43-48, 2007

108. Wachtel RE, Dexter EU, Dexter F. Application of a similarity index to state discharge abstract data to identify opportunities for growth of surgical and anesthesia practices. *Anesthesia & Analgesia* 104:1157-1170, 2007

109. Dexter F, Macario A, Ledolter J. Identification of systematic under-estimation (bias) of case durations during case scheduling would not markedly reduce over-utilized operating room time. *Journal of Clinical Anesthesia* 19:198-203, 2007

110. Marcon E, Dexter F. An observational study of surgeons' sequencing of cases and its impact on postanesthesia care unit and holding area staffing requirements at hospitals. *Anesthesia & Analgesia* 105:119-126, 2007

111. Wachtel RE, Dexter F. A simple method for deciding what time patients should be ready on the day of surgery without procedure-specific data. *Anesthesia & Analgesia* 105:127-140, 2007

112. Dexter F, Willemsen-Dunlap A, Lee JD. Operating room managerial decision-making on the day of surgery with and without computer recommendations and status displays. *Anesthesia & Analgesia* 105:419-429, 2007

113. Dexter F, Lee JD, Dow AJ, Lubarsky DA. A psychological basis for anesthesiologists' operating room managerial decision-making on the day of surgery. *Anesthesia & Analgesia* 105:430-434, 2007

114. Dexter F, Xiao Y, Dow AJ, Strader MM, Ho D, Wachtel RE. Coordination of appointments for anesthesia care outside of operating rooms using an enterprise-wide scheduling system. *Anesthesia & Analgesia* 105:1701-1710, 2007

115. Wachtel RE, Dexter F. Tactical increases in operating room block time for capacity planning should not be based on utilization. *Anesthesia & Analgesia* 106:215-226, 2008

116. Dexter F, Epstein RH. Calculating institutional support that benefits both the anesthesia group and hospital. *Anesthesia & Analgesia* 106:544-553, 2008

117. Xiao Y, Dexter F, Hu P, Dutton RP. The use of distributed displays of operating room video when real-time occupancy status was available. *Anesthesia & Analgesia* 106:554-560, 2008

118. Masursky D, Dexter F, McCartney CJL, Isaacson SA, Nussmeier N. Predicting orthopedic surgeons' preferences for peripheral nerve blocks for their patients. *Anesthesia & Analgesia* 106:561-567, 2008

119. Masursky D, Dexter F, O'Leary CE, Applegeet C, Nussmeier NA. Long-term forecasting of anesthesia workload in operating rooms from changes in a hospital's local population can be inaccurate. *Anesthesia & Analgesia* 106:1223-1231, 2008

120. Dexter F, Dexter EU, Masursky D, Nussmeier NA. Systematic review of general thoracic surgery articles to identify predictors of operating room case durations. *Anesthesia & Analgesia* 106:1232-1241, 2008

121. Epstein RH, Dexter F, Piotrowski E. Automated correction of room location errors in anesthesia information management systems. *Anesthesia & Analgesia* 107:965-971, 2008

122. Dexter F, O'Neill L, Lei X, Ledolter J. Sensitivity of super-efficient data envelopment analysis results to individual decision-making units: an example of surgical workload by specialty. *Health Care Management Science* 11: 307-318, 2008

123. Masursky D, Dexter F, Nussmeier NA. Operating room nursing directors' influence on anesthesia group operating room productivity. *Anesthesia & Analgesia* 107:1989-1996, 2008

124. Dexter F, Birchansky L, Bernstein JM, Wachtel RE. Case scheduling preferences of one surgeon's cataract surgery patients. *Anesthesia & Analgesia* 108:579-582, 2009

125. Dexter F, Epstein RH, Lee JD, Ledolter J. Automatic updating of times remaining in surgical cases using Bayesian analysis of historical case duration data and instant messaging updates from anesthesia providers. *Anesthesia & Analgesia* 108:929-940, 2009

126. Epstein RH, Dexter F, Ehrenfeld JM, Sandberg WS. Implications of event entry latency on anesthesia information management system decision support systems. *Anesthesia & Analgesia* 108:941-947, 2009

127. Dexter EU, Dexter F, Masursky D, Garver MP, Nussmeier NA. Both bias and lack of knowledge influence organizational focus on first case of the day starts. *Anesthesia & Analgesia* 108:1257-1261, 2009

128. Dexter F, Epstein RH. Typical savings from each minute reduction in tardy first case of the day starts. *Anesthesia & Analgesia* 108:1262-1267, 2009

129. Wachtel RE, Dexter F, Dow AJ. Growth rates in pediatric diagnostic imaging and sedation. *Anesthesia & Analgesia* 108:1616-1621, 2009

130. Masursky D, Dexter F, Garver MP, Nussmeier NA. Incentive payments to academic anesthesiologists for late afternoon work did not influence turnover times. *Anesthesia & Analgesia* 108:1622-1626, 2009

131. Wachtel RE, Dexter F. Influence of the operating room schedule on tardiness from scheduled start times. *Anesthesia & Analgesia* 108:1889-1901, 2009

132. Wachtel RE, Dexter F. Reducing tardiness from scheduled start times by making adjustments to the operating room schedule. *Anesthesia & Analgesia* 108:1902-1909, 2009

133. Pandit JJ, Dexter F. Lack of sensitivity of staffing for 8-hour sessions to standard deviation in daily actual hours of operating room time used for surgeons with long queues. *Anesthesia & Analgesia* 108:1910-1915, 2009

134. Dexter F, Marcon E, Aker J, Epstein RH. Numbers of simultaneous turnovers calculated from anesthesia or operating room information management system data. *Anesthesia & Analgesia* 109:900-905, 2009

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III d. Extensive consultations that are external – total of 264 for 66 companies and 153 hospitals

Studies performed to improve the quality of consultations: #152, #188, #208, and #378, above.

Cardiopulmonary bypass, statistician, NIH RO1, principal investigator BJ Hindman, 1991
Fetal brain injury, statistician, NIH RO1, principal investigator DH Penning, 1995

Drug interactions, statistician, Hoffman-LaRoche, principal investigator MM Ghoneim, 1996
Preterm fetal brain injury, statistician, NIH RO3, principal investigator JD Reynolds, 1997
Vital sign data from AIMS in malpractice cases, Preferred Physicians Mutual 1997
Economic benefits of bispectral index monitoring, Aspect Medical Systems, 1998
Effect of RSR–13 on cerebral ischemia, statistical analysis, Allos Therapeutics, 1998
Cerebral ischemia, statistical analysis, NIH RO1, principal investigator DS Warner, 1993
Minimizing anesthesia staffing costs, Wayne State University, 1999
Cost identification analysis of succinylcholine, Organon, Inc., 1999
PACU staffing & delays, Department of Anaesthesia, University of Toronto, 2000
Operating room efficiency, Conemaugh Valley Memorial Medical Center, 2000
Algorithms for analyzing perioperative data, Picis, Inc., 2000
Procedures at new center, Sunnybrook and Women's Health Sciences Centre, 2000
Cost effectiveness of therapy for wound healing, funded by Augustine Medical, 2000
Development of CalculatOR™ software, Medical Data Applications, 2000
Perioperative IT plan, Sunnybrook and Women's Health Sciences Centre, 2001
Reducing the incidence of PACU hold, Duke University Medical Center, 2001
Pharmacoeconomics of transdermal delivery of a drug, Lavipharm Labs, 2001
Budgeting OR strategically, Sunnybrook and Women's Health Sciences Centre, 2001
Anesthesia group productivity, Fort Atkinson Memorial Health Services, 2001
Operating room efficiency, Providence St. Vincent Hospital, 2001
Block scheduling implementation & recurrent analyses, Park Nicollet, 2001
OR late afternoon work hours, Shawnee Mission Medical Center, 2001
OR financial & operational assessment, Jackson Memorial Hospital, 2001
Long surgical times, University of Texas Medical Branch, Galveston, 2001
Anesthesia, OR, and PACU staffing, Bay Medical Center, 2002
OR efficiency assessment, Louisiana State University Health Sciences Center, 2002
Developing OR scheduling plan for a new hospital, Sentara Health System, 2002
Operating room staffing modeling, Deloitte Consulting, 2002
Day of surgery decision-making using video technologies, University of Maryland, 2002
Weekday OR staffing, Vanderbilt University, 2002
Preanesthesia evaluation to minimize case cancellations, Deloitte Consulting, 2002
OR allocation CalculatOR™ analyses, MedCentral Health System 2002
Quarterly OR analysis using CalculatOR™, Sentara Health System, 2002
Scheduling surgery resident work-hours, Upstate Medical University, 2002
OR efficiency & anesthesiologists' productivity, Sacred Heart Medical Center, 2003
OR allocations, decision-making, and finances, Upstate Medical University, 2003
Decision-making using anesthesia information systems, University of Miami, 2003
Cost effectiveness of neuromuscular relaxants for ICU, Abbott Laboratories, 2003
CalculatOR™ analysis & scenarios, Bay Regional Medical Center, 2003
Anesthesiology financial evaluation, Tufts – New England Medical Center, 2003
Sevoflurane and desflurane meta-analysis, Abbott Laboratories, 2003
OR allocations, Verity Partners and Iowa Health System, 2003
Anesthesiology staffing, University of Massachusetts Memorial Healthcare, 2003
Incidence of surgery in US of duration longer than 1 hour, Arizant Healthcare, 2004
Anesthesia outcome for regional anesthesia, Jewish Hospital Hand Care Center, 2004
Anesthesia staffing optimization, Jackson Memorial Hospital, 2004
OR and CRNA staffing by CalculatOR™, Rapid City Regional Hospital, 2004
Custom report on decisions with OR efficiency, Boulder Community Hospital, 2004
Survey of surgical patient flow diagnostic metrics, VHA Upper Midwest, 2004
CalculatOR anesthesia stipend analysis, Boulder Valley Anesthesiology, 2004
OR allocation, Alignment Partners and Memorial Hospital of South Bend, 2004

Operational, financial, and day-of-surgery performance, UT MD Anderson, 2004
Anesthesia stipend and productivity, Trinity Mother Frances Health System, 2004
CalculatOR™ staffing, State University of New York Upstate Medical University, 2004
Outsourced OR staffing, scenario, and financial calculations, DocuSys, 2004
Anesthesia group productivity, Sarah Bush Lincoln Health System, 2004
Survey of pediatric anesthesia medical direction, Per-Sé Technologies, 2004
OR allocations, scenario creation, and PACU staffing, Reading Hospital, 2004
Modeling the cost of OR time, Oncura, 2004
Anesthesiologists' use of analgesic modalities, Endo Pharmaceuticals, 2004
Assessment of anesthesia services, Trinity Regional Health System, 2004
Operational and financial assessment, Thomas Jefferson University, 2004
Artificial intelligence for day-of-surgery decisions, Stottler Henke Associates, 2005
OR allocations, needs assessment, and financial analysis, Mount Carmel East, 2005
Strategic financial and marketing analysis, McLeod Regional Medical Center, 2005
Anesthesia staffing, Verity Partners and Johns Hopkins Health System, 2005
Anesthesia group staffing, Conemaugh Health System, 2005
OR assessment, decision-making, & financial analyses, Christiana Care, 2005
Anesthesia staffing, Verity Partners and Mississippi Baptist Health System, 2005
OR staffing, ProSTAT Anesthesia Advisors and St. Joseph's Medical Center, 2005
Monitoring operational and financial measures, Transformation of the OR, VHA, 2005
Economics of reducing prolonged turnovers, SRI/Surgical Express, 2005
Anesthesia staffing, Mt. Carmel Regional Medical Center, 2006
Service-specific staffing and operational assessment, U Texas MD Anderson, 2006
Health economics advisory panel for sugammadex, Organon 2006
Service-specific staffing and financial analyses, Mount Carmel East, 2006
OR productivity, US Air Force and Karta Technologies, Inc., 2006
Anesthesia workload, Holmes Regional Medical Center and Verity Partners, 2006
Improving surgeon preference cards, SUNY Upstate Medical University, 2006
OR operational assessment, Olmsted Medical Center, 2006
Anesthesia health system financial support, Anesthesia Services, P.A., 2006
OR allocation and add-on case scheduling, Monadnock Community Hospital, 2006
Surgeon preferences for regional, Upstate Medical Anesthesiology Group, 2007
Demographic basis for OR workload, Upstate Medical Anesthesiology Group, 2007
Operating room decision support and Advisory Board, MediViz Systems, 2007
OR financial analysis and staffing, St. Mary's Hospital, 2007
OR and PACU assessment, Saint Agnes Medical Center, 2007
Assessment of anesthesia services, Trinity Regional Health System, 2007
Economics of dantrolene and malignant hyperthermia, Procter & Gamble, 2007
Predicting case durations with CPTs, SUNY Upstate Medical University, 2007
OR staffing and blocks, Holmes Regional Medical Center and Verity Partners, 2007
Anesthesia support contract, Anesthesia Consultants of Western Colorado, 2007
Assessment of growth in workload, Saint Agnes Medical Center, 2007
Reassessment of OR operations, Thomas Jefferson University, 2007
Service-specific staffing and turnovers, Westchester Anesthesiologists, 2007
OR nurse manager salaries and promotions, SUNY Upstate Medical University, 2007
OR staffing and blocks, Arnot Ogden Medical Center and Verity Partners, 2007
Under-utilized anesthesia staffing, Waxahachie Anesthesia Consulting Services, 2007
OR efficiency and informatics principles, Karl Storz Endoscopy-America, 2007
OR and PACU staffing and information systems, Lutheran Hospital of Indiana, 2007
State database analysis for surgery, St. Mary's Hospital, 2007
Patient preferences for surgery, Fox Eye Surgery, 2007
Pharmacoeconomics of OR time from reversal of anesthesia, Organon, 2008
Case duration meta-analysis, Covidien, 2008
Counts of inpatient surgeries in US, AcelRx Pharmaceuticals, 2008
Tardiness of first case starts, SUNY Upstate, 2008

Anesthesia staffing, Lake Monroe Anesthesia Associates, 2008
Afternoon workloads, Waxahachie Anesthesia Consulting Services, 2008
Behavioral impact of incentive program, SUNY Upstate, 2008
Economics of surgical devices, Covidien, 2008
Economics of pediatric endoscopy & otolaryngology, SUNY Upstate, 2008
Coordinating anesthesia groups' services, Queen's Medical Center, 2008
Fospropofol pharmacoeconomics, Eisai, 2008
Assessment of anesthesia services, Trinity Regional Health System, 2008
Anesthesia support agreement, Anesthesia Resource Network, 2008
Anesthesia staffing, Bronson Healthcare Group, 2008
Quantifying rate and reliability of anesthetic wakeups, Baxter Healthcare, 2008
Counts of inpatient admissions in US, AcelRx Pharmaceuticals, 2009
Pharmacoeconomic decisions and anesthesia time, SUNY Upstate, 2009
Anesthesia and PACU productivity, Sarah Bush Lincoln Health System, 2009
Multiple campus surgical workload, Mercy Health Partners, 2009
Statistics education program for residents, SUNY Upstate, 2009
Strategic assessment of hospital surgery, Westchester Anesthesiologists, 2009
OR analysis training and result interpretation, Mercy Health Partners, 2009
Anesthesia staffing training, Sarah Bush Lincoln Health System, 2009
Experimental and observational studies of fresh gas flows, SUNY Upstate, 2009
Strategic role of anesthesia support agreements, Trinity Health System, 2009
Anesthesia staffing analysis and intensive course, Spectrum Health, 2009
Anesthesia staffing, Trinity Health - Saint Alphonsus Regional Medical Center, 2009
Anesthesia support & financial modeling, Froedtert Memorial Lutheran Hospital, 2009
Anesthesia staffing & costs, surgical finances, St. Joseph Mercy Oakland, 2009
Perceptions of prolonged turnovers, SUNY Upstate, 2009
Variability of extubation times, Baxter Healthcare, 2010
Anesthesia and PACU analyses, Avera McKennan Hospital, 2010
Anesthesia decision making and costs, St. Joseph Regional Medical Center, 2010
Day of surgery decision making, Anesthetix Management, 2010
OR management distance learning, Alabama Anesthesia of Huntsville, 2010
Canadian pharmacoeconomics, Baxter Healthcare, 2010
Anesthesiologists and unnecessary preoperative studies, SUNY Stony Brook, 2010
Sugammadex outcomes research, Merck, 2010
Anesthesia staffing and case duration prediction, St. Joseph Mercy – Ann Arbor, 2010
Propofol and desflurane pharmacoeconomics, Baxter Healthcare, 2010
Multihospital financial and operational analysis and benchmarking, Trinity Health, 2010
OR management statistical analyses, Dept. of Veterans Affairs, 2010
Trends in individual surgeons' workload, SUNY Upstate, 2010
Esmolol pharmacoeconomics for supraventricular tachycardia, Baxter Healthcare, 2010
European focused OR efficiency research, Merck, 2010
Anesthesia staffing, Cleveland Clinic Anesthesia Institute, 2011
Surgical operational assessment, Pennock Health Services, 2011
Operations research for surgical services teaching, University of Miami, 2011
Course and analysis for operations research in anesthesia, Medical College of Wisconsin, 2011
Anesthesia staffing and changes in OR management, Borgess Health, 2011
Operating room time cost accounting, Spacelabs Healthcare, 2011
Anesthesia staffing education (course), Cleveland Clinic Anesthesia Institute, 2011
Orthopedic operating room throughput, Massachusetts General Hospital, 2011
Anesthesia and PACU assessment, Metro Health Hospital, 2011
CRNA productivity, Asheville Anesthesia Associates, 2012
Operating room management (course), University of California, Davis, 2012
Dantrolene cost utility, Association for Accreditation of Ambulatory Surgery Facilities, 2012
Time for nerve blocks, Lehigh Valley Health Network, 2012
Esmolol systematic literature review, Baxter Healthcare, 2012

Anesthesia staffing and workflow, Tufts Medical Center, 2012
Interpreting OR time data, Arrowsight, 2012
Predictors of prolonged extubations, Merck, 2012
Staffing analysis and analytics teaching, Bronson Methodist Hospital, 2012
European operations research course, Stichting Medina Care, 2013
Operating room labor costs analysis and teaching, Geneva University Hospital, 2013
Anesthesia pharmacoeconomics and value analysis, Erica Bergstrom Partners, 2013
Unevenness in anesthesia workload among days, Thomas Jefferson University, 2013
Existing product economics and relationship with surgeon perception, Merck, 2013
Anesthesia group agreements, Dublin Anaesthesia Group, 2013
Influence of clinical attributes of anesthesia drugs on economics, Merck, 2013
Return on investment decision-making on day of surgery, PatientStream, 2013
Economics of reducing postanesthesia care unit time, Respiratory Motion, 2013
Reducing variability in anesthesiologists' workload, Thomas Jefferson University, 2013
OR productivity and governance, City of Hope National Medical Center, 2013
Decision making on day of surgery, PatientStream, 2014
OR allocation calculations, Tufts Medical Center, 2014
Iowa Satisfaction with Anesthesia Scale, University of the West Indies, 2014
Economics of medical devices, Cook, 2014
Economics of MH hotline call center, Malignant Hyperthermia Association of US, 2014
Anesthesia agreements and OR efficiency, McLaren Northern Michigan, 2014
Ophthalmology hospital staffing and case scheduling, Vital Quadro Consultancy, 2014
Chile OR management course, Pontificia Universidad Católica de Chile, 2014
Day of surgery decision making, UnityPoint Health – Trinity, 2014
Statistical analyses, Medjaden Bioscience Ltd., 2014
Anesthesia staffing and staff scheduling, Providence Health & Services-WA, 2014
OR analysis, Hospital Clínico, Red de Salud UC-CHRISTUS, 2014
Modeling and teaching on anesthesia staffing, Scott & White Memorial Hospital, 2014
Operating room management course, UnityPoint Health, 2014
Surgical services course, Providence Health & Services-WA, 2015
Operating room statistical analysis, Trinity Medical Center, 2015
Iowa Satisfaction with Anesthesia Scale study usage, Wendy VanderKooi, 2015
Sociedade Portuguesa de Anestesiologia, 2-day course, 2015
OR and PACU analyses, and course, Thomas Jefferson University Hospitals, 2015
Operating room management course, Bellinzona Regional Hospital, 2015
Operating room performance and decision-making, Christiana Care, 2016
Iowa Satisfaction with Anesthesia Scale, Ottawa Hospital Research Institute, 2016
Surgical services course, Christiana Care, 2016
Iowa Satisfaction with Anesthesia Scale, Fondation Ophtalmologique A. de Rothschild, 2016
First case starts and other OR analyses, Denver Health, 2016
Surgical services course, University of Miami, 2016
OR management course provided remotely, Thomas Jefferson University Hospitals, 2016
Pharmacoeconomics of analgesics, Concentric Analgesics, 2017
Operating room management course, Denver Health, 2017
Anesthesia statistical analysis, Stichting Medina Care, 2017
OR statistical analysis, Hospital Clínico UC-CHRISTUS, 2017
Anesthesia staffing, Bronson Healthcare Group, 2017
OR management teaching, Greenville Health System, 2017
OR and PACU analytics, Wake Forest University, 2017
Operating room and associated national data, Prashanth Iyengar, 2017
OR management teaching, planning, and analytics, University of Florida, 2017
Applicability of prior simulation studies, Mateer Harbert, 2017
Operating room analytics course and planning, University of Texas Health Sciences Center, 2018
Repeating and interpretation of differences in prior simulation studies, Mateer Harbert, 2018
First-case on time starts at endoscopy procedural suites, Henry Ford Health System, 2018

Anesthesia staffing and OR management, Borgess Medical Center, 2018
Anesthesia staffing analytics subcontracting, DL Consulting, Inc, 2018
Clinical trial design, Kenall Manufacturing, 2018
Anesthesiologist staffing and staff scheduling, UCSF Benioff Children's Hospital Oakland, 2018
OR staffing, Henry Ford Health System, 2018
Novel anesthesia machine, Dräger, 2018
OR, PACU, and financial perioperative analyses and implementation, UC Davis, 2018
Surgical services analytics course, William Beaumont Army Medical Center, 2018
Surgical services analytics courses, Womack Army Medical Center (Fort Bragg), 2018
Daily OR management decision making, Bend Anesthesiology Group, 2018
Surgical services analytics course, Fort Sam Houston, 2018
Iowa Satisfaction with Anesthesia Scale use, Peak Woo MD CPLLC, 2019
Anesthesiology resident interview analytics, SJ Med Connect (Thalamus), 2019
Anesthesia staffing, Henry Ford Allegiance Health, 2019
Statistical design and management of observational study, Kenall Manufacturing, 2019
OR statistical analysis, Hospital Clínico UC-CHRISTUS, 2019
Analysis of anesthesiologist supervision of CRNAs and billing, DL Consulting, 2019
Iowa Satisfaction with Anesthesia Scale use, Boston Medical Center, 2019
Analysis of national residency survey data, Mayo Clinic Phoenix, 2019
Operations research for surgical services course, City of Hope National Medical Center, 2019
Scientific basis for planning anesthesiologist staffing, McGuireWoods LLP, 2019
Analyses clinical trial of intraoperative bacterial transmission, Kenall Manufacturing, 2019
Operating room management and surgical site infections, SLD Technology, 2019
OR statistical analysis, Hospital Clínico UC-CHRISTUS, 2019
OR analytics for hospital campus, City of Hope National Medical Center, 2020
Surgical services analytics courses, Army Enterprise Career Program 53, 2020
Infection control experimental design, Georgia-Pacific, 2020
Analyses of OR information system data to target infection control, RDB Bioinformatics, 2020
Procedural locations courses and analytics, City of Hope National Medical Center, 2020
Multiple specialty resident interview analytics, SJ Med Connect (Thalamus), 2021
Iowa Satisfaction with Anesthesia Scale, B.C. Women’s Hospital, 2021
Operating room analytics course, University of Rochester Medical Center, 2021
Iowa Satisfaction with Anesthesia Scale, University of Washington, 2021
Iowa Satisfaction with Anesthesia Scale, University of Colorado, 2021
Operating room management principles, Apella Technology, 2021
Surveillance to prevent bacterial transmission, NIH RO1, principal investigator JR Brown, 2021
OR analytics and intensive course, City of Hope National Medical Center, 2021
Anesthesia staff scheduling, University of Rochester, 2021
Surgical site infections, 3M, 2021
Ultraviolet disinfection industrial engineering, Surfacide, 2021
Iowa Satisfaction with Anesthesia Scale translation, Federal University of Santa Catarina, 2022
Anesthesia staffing and productivity, Bayhealth Medical Center, 2022
Anesthesia pharmacoeconomics, Heron Therapeutics, 2022
Analyses of microbiological reliability data, RDB Bioinformatics, 2022
Iowa Satisfaction with Anesthesia Scale, DUALAMS, Inc., dba Airkor, 2022
Operating room cost economics, ZYSC, LLC, 2022
Operating room management and ultraviolet-C dose, Varitex, 2022
Operating room analytics course, University of Texas Health Sciences Center, 2022
Anesthesia pharmacoeconomic analyses, Harrington Discover Institute, 2022
Economics prolonged times to tracheal extubation with desflurane, Baxter Healthcare, 2022
Changes to anesthesia fresh gas flows, Henry Ford Health System, 2023
Operating room management course, Lahey Hospital, 2023
Prolonged times to tracheal extubation, Merck, Sharp & Dohme, 2023
Service-specific staffing analysis and teaching, University of Tennessee, 2023
Iowa Satisfaction with Anesthesia Scale questions, University of California San Francisco, 2023

III e. Extensive consultations for University of Iowa – total of 246

Fast-tracking coronary artery bypass graft patients, 1997
Strategy to decrease variability in OR schedule, 1997
Incentive programs to increase surgical productivity, 1997
Analysis of daily variation in OR workload, 1997
OR allocation from anesthesia billing data, 2001
Anesthesia policy and procedures manual, 2001
CalculatOR™ with OR & anesthesia data, 2001
Surgical workload throughout Iowa, 2002
Surgical length of stay impact on contribution margin, 2002
Perioperative strategic and financial analysis, 2002
Impact of reducing turnovers on anesthesia costs, 2003
Delays in PACU admission, 2003
Monitoring turnovers, cancellations, and waiting, 2004
Leasing vs. purchasing capital surgical equipment, 2004
MD & CRNA assignment and staffing on productivity, 2004
Forecasting ECT workload one week in advance, 2004
Ongoing assessment of strategic position, 2005
Prediction bounds to improve calling for patients, 2005
Costs & financial value from OR anesthesia services, 2005
Pagers to notify staff of OR management decisions, 2005
Otolaryngology strategic financial & market analysis, 2005
Variation in OR efficiency and tardiness by surgeon, 2005
Potential growth in surgical workload, 2005
Training & monitoring afternoon/ weekend decisions, 2005
Sequencing surgical cases by surgeon, 2005-2006
Efficiency of use of endodontic clinic (dental) chairs, 2005
Schedule preop AM of surgery increases efficiency, 2005
Choosing patient fasting, NPO, and arrival times, 2005
Forecasting holiday OR workload, 2006
Checklists for operating room management, 2006
Longitudinal assessment of surgical growth rate, 2006
Self-scheduling of non-OR anesthesia procedures, 2006
Automation of anesthesia staff assignment, 2006
Off-line monitoring of enterprise-wide scheduling, 2006
Forecasting OR workload the next workday, 2006
Patient-centered RN administered sedation program, 2006
Notification of patients for anesthesia, 2006
Variability in durations of ambulatory procedures, 2007
Operational and tactical monitoring, 2007
Preference cards and relationship to case durations, 2007
Expand vertically & open rooms when working late, 2007
Real-time estimation of time to end of case, 2007
Resident workload determined from billing data, 2008
Growth in diagnostic imaging with anesthesia, 2008
Anesthesia technician workload from AIMS, 2008
Predicting cancellation on day of surgery, 2008
CRNA nighttime workload, 2008
Upper prediction bounds for ORs' end of workdays, 2008
Patient arrival times to reduce space requirements, 2009
Sequencing calling for patients upon surgical arrival, 2009
Influence of case duration on patient outcome, 2009

Phase I PACU staffing with trends in acuity, 2009
Coordinated CRNA staffing and staff scheduling, 2009
Elective Saturday OR schedule, 2009
Ambulatory surgery center assessment, 2009
Pairing services for staff hiring and training, 2009
OB anesthesia staffing, 2009
CRNA starts of workday and revised shifts, 2009
Monitoring surgical clinic cases in pipeline to OR, 2009
AIMS screen simulation, 2010
Regional nerve blocks with RN monitoring, 2010
Patient satisfaction in ambulatory and tertiary surgical suites, 2010
Supervision ratios MD:CRNA influence of diversity of procedures, 2010
Impact of case duration on outcome, 2010
Systems-based practice course using blood product data, 2010
Monitoring ambulatory surgery neuropathy, 2011
Nurse anesthetists and anesthesiologists per room ratios, 2011
Preanesthesia evaluation clinic patient flow optimization, 2011
Tracking turnovers with observers, 2011
Software to recruit patients used for operating room scheduling, 2011
CRNA evaluations of anesthesiologists, 2011
Insurers' anesthesia duration and outcomes data, 2011
Resident and faculty broad management training, 2011
Anesthesia technicians and turnover times, 2011
Monitoring clinicians' performance using peer evaluations, 2011
Ambulatory surgery patients staying in hotels and coordination, 2011
Pediatric surgery OR allocations and turnover times, 2011
General surgery block time, 2012
Resources required for faculty development, 2012
Moving cases to ambulatory surgery center, 2012
Quantifying scheduling office and patient waiting, 2012
Reducing type and screen and hemoglobin checks preoperatively, 2012
Preanesthesia evaluation clinic screening, 2012
Ambulatory surgery center staffing and turnover times, 2012
Strategic analysis of building more ORs versus long workdays, 2012
Anesthesia staff scheduling, weekends and nights, 2012
Persuasiveness in hospital committees, 2012
Preoperative evaluation echocardiogram reports, 2012
OR control desk simulation training, 2012
Monitoring faculty supervision and unexpected clinical events, 2012
Regional anesthesia economics for ambulatory surgery center, 2013
Assessment of patient satisfaction with individual anesthesiologists, 2013
Behavioral modeling measurement of VS before induction, 2013
Quantitative neuromuscular monitoring influence on OR times, 2013
Predictive factors for anesthesiologist recruitment, 2013
Ambulatory surgery center long-term OR allocations, 2013
Non-operating room anesthesia scheduling, 2013
Preoperative importance of drug reconciliation errors, 2013
Faculty activity survey validation using secondary data, 2014
Causes of low anesthesiologist supervision scores by CRNAs, 2014
OR and non-OR early evening coordination and use of cues, 2014
Ongoing professional performance evaluation of CRNAs, 2014
Relative OR anesthesia labor costs, 2014
Resident education of principles in staff assignment, 2014
Predicting ICU admissions from non-OR anesthetic locations, 2014
Referral patterns to surgeon or surgical group, 2014

Longitudinal changes in assessed supervision with changes staffing ratios, 2014
Sedation nurses administration and outcome, 2014
Anesthesia technician staffing, 2014
Forecasting new hospital anesthesia staff scheduling, 2014
Obstetrical anesthesia labor costs and productivity, 2014
Choosing adult and pediatric dental patient arrival times, 2014
Scientific study and publication of interdisciplinary in situ simulations, 2015
Evaluating incentive program point systems, 2015
Numbers of breaks and handoffs and relationship to staff scheduling, 2015
Narcotic dispensing and auditing, 2015
PACU staffing and length of stay, 2015
Turnover time milestones, 2015
Comments written by faculty when evaluating residents, 2015
Evaluating patient satisfaction in pain clinic, 2015
Process of faculty intermittent procedural retraining, 2015
Evaluating faculty on multiple dimensions of performance for OPPE, 2015
Non-operating room (“satellite”) scheduling for productivity, 2015
Managing admissions when hospital occupancy > 95%, 2015
Comparing final intraoperative temperature among providers and procedures, 2015
Saturday elective schedule benchmarking, 2016
Influence of faculty teams and specialization on quality of resident and CRNA supervision, 2016
Systematic review of quantitative findings on briefing, time-out, and debriefing checklist(s), 2016
Influence of e-mail reminders of evaluations on completion, 2016
Adjustment of faculty supervision scores for leniency of individual residents, 2016
Automatic identification of red blood cell transfusions for auditing, 2016
Satisfaction of parents with anesthesia providers, 2016
National outpatient surgery center adjusted utilization, 2016
Readmission rate benchmarking and state versus national focus, 2016
Comparing clinicians’ blood management decisions, 2016
Role of the large academic medical center within a statewide alliance of hospitals, 2016
Influence of preoperative evaluation completeness and turnover times, 2016
Hospital economic impact of anemia clinic, 2017
Anesthesia information management system data quality influence on decisions, 2017
Surgical suite productivity with long workdays and flexible ORs, 2017
Hospital length of stay reduction and benchmarking, 2017
PACU length of stay and hospital census, 2017
Fresh gas flows and volatile anesthetic usage, 2017
Growth of non-physiologically complex surgery longitudinally statewide, 2017
Psychometrics of alternative question set for CRNA evaluation of anesthesiologists, 2017
State data to facilitate forecasting of hospital surgical workload, 2017
Response rates of resident evaluations of faculty, 2017
Evaluation of new faculty anesthesiologists’ performance, 2018
Pediatric surgical caseload statewide, 2018
Surgical patient travel distances and influence on growth, 2018
Staff scheduling and cost accounting software, 2018
Centers of excellence for morbidly adherent placenta, 2018
Pain clinic productivity, 2018
Improving to-follow surgeon on-time starts, 2018
Interventional pain management procedures statewide, 2018
CRNA evaluation of anesthesiologists departmentally, 2018
Changes over years in operative versus chronic pain anesthesia workload, 2018
University of Iowa productivity all anesthetizing locations, 2018
Prolonged time to tracheal extubation and anesthesia staff assignments, 2019
Reliability of faculty and CRNA rankings using daily evaluations, 2019
Ambulatory surgery center work hours nationwide, 2019

One day OR management course in multiple sessions with effective teams, 2019
Phase I post-anesthesia care unit physical bed requirements, 2019
Clinical days per year of anesthesiology residents, 2019
Evaluations of quality of faculty supervision of trainees in chronic pain clinic, 2019
Effect of neuromodulation thresholds on pain clinic caseloads, 2019
University of Iowa “room” productivity of nurse anesthetists, 2019
Managerial epidemiology of discharge time of day, 2019
Time for insurance preapproval of surgery, 2019
Control chart analysis of monitored intraoperative bacterial transmission, 2019
CRNA factors influencing job retention and recruitment, 2020
Improving case selection for transmission surveillance to reduce surgical site infections, 2020
Prolonged time to tracheal extubation and Iowa’s anesthetic choices, 2020
Adjusting operating room assignment for personal protective equipment shortage, 2020
Impact of asymptomatic COVID-19 patients on operating room management, 2020
Chronic pain telemedicine targeted by region because of COVID-19, 2020
Forecasting COVID-19 hospital wide bed and ventilator use, 2020
Airflow and risk of provider infection, 2020
Short-term forecasting of surgical ward and intensive care unit occupancy, 2020
Educating operating room management revisions caused by COVID-19, 2020
Relative anesthesia workloads by weekday after acute phase of COVID-19 pandemic, 2020
Cancellations 0-1 days before surgery with modified preoperative evaluation, 2020
Weekend caseload after acute period of COVID-19 pandemic, 2020
Sugammadex liberal use economics, 2020
Reduced variability and/or greater predictability to faculty OR work hours, 2020
Comparing unplanned absences among types of anesthesia providers, 2020
Case cancellations from COVID-19 preoperative testing, 2020
Cesarean section, orthopedic, and cardiovascular surgical site infections, 2020
Availability and ready access to lactation facilities at surgical suites statewide, 2020
Probability distributions of surgical times, 2020
Implementation rater leniency adjusted work habits scores, 2020
Anesthesia department staffing among all locations, 2020
Monitoring changes in MD: CRNA ratio over 10+ year periods, 2020
Medical student information for family leave and arranging electives, 2020
Patient Dignity Inventory and critical care, 2020
Benchmarking CRNA work hours, 2021
Faculty evaluations of supervision quality in intensive care units, 2021
Average time to PACU discharge and total PACU capacity, 2021
Pediatric surgical suite staffing, staff scheduling, and staff assignment, 2021
Time and expense of Surfacide UV-C treatment for COVID-19 and surgical site infections, 2021
Anesthesia staffing for more surgery in December, 2021
Arrival times of pediatric procedural patients at facility with many open rooms, 2021
Visibility of anesthesiologist relief coordination late in the workday, 2021
On-call points valuation, 2021
Sequencing urgent surgical cases, rewarding block time, 2021
Cesarean section durations, 2021
Patient satisfaction intensive care unit stay, 2021
Pediatric hospital individual surgeon case scheduling, 2021
Statewide obstetrical anesthesia workforce, 2021
Intermittent binary entry for evaluations when all answers at maximum, 2021
Nurse anesthetist staff scheduling by weekday with residents choosing assignments, 2021
Anesthesiologist and nurse anesthetist lunch breaks, 2021
Anesthesia leadership responsibilities for environmental sustainability, 2022
Time series analysis changes obstetric anesthesia workload, 2022
Surgical site infections after cesarean delivery, 2022
Progressive annual changes in percentage surgical cases ambulatory or overnight stay, 2022

Modified ongoing professional practice evaluation statistics for faculty/CRNA performance, 2022
Variability among workdays in numbers of CRNA only surgical lists, 2022
Targeting anesthetizing locations for infection control, 2022
Operating room comprehensive analytics reports, 2022
Ambulatory surgery center changes in times to tracheal extubation, 2022
Evaluating department by using individual faculty evaluations, 2022
Post-anesthesia care unit times association with prolonged extubations, 2022
Strategies for vacation holiday staff scheduling, 2023
Pairwise evaluations of dermatomal levels, 2023
Increasing faculty teaching evaluation scores, 2023
Statistical design of clinical trials of postoperative cognitive dysfunction, 2023
Departmental research publication production, 2023
Faculty computational simulation projects, 2023
Examples of work habits maximum and not maximum scores, 2023
Faculty educator milestones, 2023
Epidural catheter and coagulopathy study design, 2023
Propofol boluses and prolonged times to tracheal extubation, 2023
Hypoxemia end of surgery among junior residents and supervision quality, 2023
Staff scheduling based on physiological complexity, 2023
Reductions in evaluations per week, 2023
Phase I post-anesthesia care unit staffing and length of stay, 2023
Probability distribution of ECMO cannulation times, 2023
Hoarseness and airway pressure postoperatively study design, 2023
Resident assignments, supervision quality, and work habits impact on patient outcomes, 2023
Evaluation of chronic pain fellows' procedural skills from fluoroscopy logs, 2023
Anesthesiologist officer of the day need and risk, 2023
Day of surgery chlorhexidine wipe effectiveness, 2023
Development of multiple group clinical trial of at home monitoring, 2023
Automated department patient outcome measures, 2024
Pediatric central line distances and fluoroscopy, 2024
Epidural clonidine and postoperative analgesia, 2024
Analgesia administration dosing and timing postoperatively on ward, 2024
Frequency of interventional pain procedure among patients for initial evaluation, 2024

III f. Brief consultations that are external – total of 43 for 25 companies and 11 hospitals

Burroughs Wellcome, PACU pharmacoeconomics, 1995
Aspect Medical Systems, Cost analyses in anesthesia, 1996
Beth Israel Deaconess Medical Center, OR objectives and cost reductions, 1999
Luther Hospital, Strategies in OR scheduling to decrease costs, 1999
MCP Hahnemann University, Methods of allocating OR time, 2001
US Army TATRC, OR of the Future Strategy Forum, 2001
Harlan Appalachian Regional Healthcare, Urgent case scheduling, 2002
University of Pittsburgh, Turnover time benchmarking nationwide, 2002
Virginia Mason Medical Center, OR decision making, 2003
Phase 2 Consulting, Anesthesiology productivity, 2003
Frost and Sullivan, Perioperative cost accounting, 2004
Skila, Fluid warming, 2004
Boulder Community Hospital, Anesthesia group contracting, 2004
Cline Davis & Mann, Pharmacoeconomics of a drug, 2006
Health Advances, LLC, Economics of reducing OR time, 2007
University of Maryland, OR dashboards, 2007
University of Texas MD Anderson, OR policy manual, 2007
Mercy Health System, OR consolidation calculations, 2009
MediViz, Observation of OR efficiency, 2010

Froedtert Memorial Lutheran Hospital, Simultaneous turnovers, 2012
Oak Ridge Associated Universities, Potential anesthesia products, 2012
Portuguese Foundation for Science and Technology, OR management, 2012
Oakstone Publishing, review course lecture, 2013
EmCare, Economics of reducing anesthesia times, 2013
Health Advances, LLC, Inhalational anesthetics, 2014
Guthrie Robert Packer Hospital, Operations research course, 2016
SurgeryLink, Surgical scheduling and coordination, 2016
Prashanth Iyengar, Performing operating room management analyses, 2017
ExplORer Surgical, Updating case duration predictions, 2017
Sarada Mylavarapu, Operating room and anesthesia group prioritization, 2017
Kotler Marketing Group, Surgical cancellation economics, 2017
TenX Healthcare, Optimization of patient tracking, 2017
University of Jordan, Anesthesia statistical reviewing, 2018
University of Utah, Iowa Satisfaction with Anesthesia Scale use, 2018
Ballard Rosenberg Golper & Savitt, Anesthesia staff scheduling and turnover times, 2018
UC Davis, Ambulatory surgery center operations, 2018
Joni Maga, Operating room analytics, 2019
Radeval, Anesthesiologists' expertise, 2020
Elsevier, Acquisitions opportunity, 2020
Springer Nature, publication recommendation, 2020
Jupiter Life Science Consulting, neuromuscular blockade, 2021
Rabin Medical Center, Iowa Satisfaction with Anesthesia Scale use, 2022
Elsevier, Acquisitions opportunity, 2022
CAST Technologies, Turnover times, 2022
HMP Education, Patient preparation and surgical site infections, 2023
Wiltshire Air Ambulance, Iowa Satisfaction with Anesthesia Scale, 2024

III g. Brief consultations for University of Iowa – total of 393

Risk of OR fires during monitored anesthesia care, 1997
Implementing clinical pathways in OB anesthesia, 1998
Urinary retention with epidurals after nephrectomy, 1998
Monitoring incidence of perioperative vocal cord injury, 1999
Central sterilization layout to reduce time to get supplies, 1999
Monitoring incidence of nerve block placement failures, 1999
Surgical services material management, 1999
Monitoring patients' pain during phlebotomy, 1999
Software to integrate patient tracking with clinic scheduling, 2001
Department of Anesthesia, Secondary data analysis, 2001
Assist in purchasing anesthesia information system, 2001
Teaching conscious sedation to health care providers, 2002
Impact of reducing surgical times on anesthesia group profitability, 2002
Customize scenarios for teaching OR management, 2002
Spinal surgery cost accounting and market potential, 2004
Improving methods of scheduling anesthesiologists on-line, 2004
Operating room robot scheduling, 2004
Forecasting costs of adjusting weekend CRNA staffing, 2004
Hyperbaric oxygen therapy finance and workload, 2004
Turnover times in Urology clinic, 2005
Monte-Carlo simulation for anesthesia scheduling, 2005
Measuring perioperative productivity, 2005
Forecasting future pediatric surgical workload, 2005
Holding urgent case for trauma activation, even if may not come to OR, 2005
Control charts for rapid feedback on biased OR times, 2006

Scheduling orthopedic and radiology clinic appointments, 2006
Forecasting earliest admission time to a hospital ward from PACU, 2006
Anesthesia group productivity by DEA, 2006
First case start delays by anesthesiologist & surgeon, 2006
11 PM to 7 AM anesthesia staffing, 2006
Statewide pediatric workload, 2007
Urgent case sequencing by categories, 2007
Monitoring anesthesiologists' anesthesia controlled time, 2007
Anesthesia supply and drug costing, 2007
Anesthesia equipment budgeting, 2008
Automatic staff scheduling to facilitate staff assignment, 2008
Growth in pediatric anesthetics, 2008
Monitoring anesthesiologists' outcomes, 2009
Centralized versus distributed case scheduling, 2009
Day of surgery decision making, 2009
Volatile anesthetic usage, costs, and education, 2009
PACU length of stay, 2010
Non-operative time benchmarks, 2010
Role of specialty teams, 2010
Weekend cases running checklist, 2010
Anesthesia workload trends over past decade, 2010
Resident SICU staffing and staff scheduling, 2010
Influence of annual exam scores on time to board certification, 2010
Monitoring surgeons' case duration scheduling, 2010
Statistics of AIMS data for Ongoing Professional Performance Evaluation, 2010
Productivity program based on RVU's, 2010
Lean principles turnover time reduction, 2011
Academic, private differences and reimbursement, 2011
Forecasting long term growth and numbers of first case starts, 2011
Infection monitoring and cause survey, 2011
Anesthesia group metrics tied to financial support, 2011
Entropy monitoring to reduce variability in emergence time, 2011
Economic value of comprehensive teamwork training program, 2011
Quantifying value of anesthesia ambulatory clinical pathways, 2011
Assessing resident learning in critical care, 2011
Survey design for information system implementation, 2011
Study of obstetrical nausea and vomiting, 2011
Determinants of patient satisfaction with ambulatory surgery, 2011
Staff (product) mix analyses for cost minimization, 2011
Operating room infection control monitoring, 2011
Monitoring surgical durations among facilities, 2011
Engineering studies in anesthesia departments, 2011
Economics and development of clinical trials course, 2012
Clinical utility and cost of smart alarms within operating rooms, 2012
First case start psychology and institutional focus, 2012
Anesthesia E code usage, 2012
CRNA compensation models, 2012
Implant cost contracts, 2012
Reimbursement 23 hr stay patients, 2012
Postanesthesia care unit time comparison among clinicians, 2012
Sizing of U Iowa intensive care units, 2012
Qualifications of administrators and hiring questions, 2012
Preanesthesia evaluation clinic add-on patients and cancellations, 2012
Predicting anesthesia residents' certification examination scores, 2012
Trend over time in duration of preanesthesia evaluations, 2012

OR time planning for individual surgeons, 2012
Meta-analysis of incidence for quality monitoring,
Anesthesia agreements and psychological biases, 2012
Benefits and costs of anesthesia teams, 2012
Measuring satisfaction of patients' waiting families, 2012
Ambulatory surgery center adding ORs, 2012
OIG opinions and relationship with anesthesia, 2012
Monitoring quality of preanesthesia evaluations, 2012
Monitoring patients' chronic pain from acute surgery, 2012
Cost utility of ultrasound for regional anesthesia, 2012
Correlational analyses of clinical performance, 2012
Patient safety research in outpatient surgery, 2012
Pre-incision timeouts and lean methodology, 2013
Forecasting growth in specialty-specific ambulatory surgery, 2013
Targeting single surgeons with > 8.5 hours of cases and only one OR, 2013
Psychological biases influencing clinician use of monitoring systems, 2013
Analysis of skewed ordinal thoracic data, 2013
Predicting staff scheduling, with medical absences, for nurse monitored cases, 2013
Electronic applications for notifications of holding room status, 2013
Orthopedic ambulatory surgery cost accounting, 2013
Preoperative clinic scheduling patients to individual providers, 2013
Moving cases from one facility to another and state of the art science, 2013
CRNA and faculty staff assignment, 2013
Calculating anesthesia labor cost and profit from adding an OR, 2013
Preoperative clinic ARNP staffing and staff scheduling, 2013
Monitoring perioperative workload long-term, 2013
Sedation nurse enterprise wide scheduling, 2013
TeamStepps, checklists, and preventions of intraoperative interruptions, 2013
Sedation team case scheduling, 2013
Transfusion decision-making in ORs, 2013
Reducing delays from OR to PACU, 2013
Regional anesthesia reductions in PACU time, 2013
Endoscopy clinic scheduling, 2013
Preoperative laboratory test costs, 2013
Periods of decline in rate of growth of surgical workload, 2013
Inpatient surgical bed management, 2013
Efficacy and economics of treatment of nausea in PACU, 2013
Commercial preoperative evaluation software, 2014
Leveling inpatient ward usage, 2014
Criteria for residents to be contacting supervising anesthesiologist, 2014
Implementing resident evaluation milestones, 2014
Quantifying and interpreting heterogeneity in meta-analysis, 2014
Multivariable logistic regression interpretation, 2014
Coordinating breaks for evaluations of clinical performance, 2014
Simulation to reduce surgical time for laparoscopic and robotic surgery, 2014
Risk adjusted CUSUM for resident education evaluation, 2014
Managing clinics to enhance operating room throughput, 2014
Interpretation of 80th percentile of numbers of ORs in use at times of the day, 2014
Economics of ORs working > 8 hours with long break between surgeons, 2014
Perioperative Surgical Home economics, 2014
PACU flow control, 2014
Ambulatory surgery focus on access as compared with case duration control, 2014
Moving cases among facilities with construction and impact on workload, 2014
Satisfaction assessment of all of a department's patients over a week, 2014
Economics of brief reductions in PACU time, 2014

Statistical review by anesthesiology residents, 2014
Predicting outpatient orthopedic surgical workload, 2014
Interpreting statistical evaluation of comparisons of operating room times, 2014
Comparing exceptional versus average performance of CRNAs, 2014
Meta-analysis research for institutional decision-making, 2014
Interpreting value of resident education in management, 2014
CONSORT reporting of management clinical trial, 2014
Comparing pain scores among anesthesiologists, 2014
Running 1 surgeon in 2 rooms with over-utilized time, 2014
Subspecialty teams on call at night, 2015
Factors affecting turnover time in operating rooms, 2015
Differences and ratios of operating room and procedural times, 2015
Benchmarking add-on case percentages and management response, 2015
Comparing turnover times among hospitals and services, 2015
Failure to rescue versus reduction in adverse event rates, 2015
Themes in faculty evaluation of anesthesiology residents, 2015
Staff assignments in late afternoons based on start of surgical closure, 2015
Federal and state definitions of “surgery” and “procedure,” 2015
Effect of medical devices on OR efficiency, 2015
Anesthesia provider recall system for mass casualty incidents, 2015
Quantifying departmental non-clinical activities, 2015
Endovascular add-on case scheduling, 2015
Quantification of case complexity for faculty evaluation of residents, 2015
Monitored anesthesia care conversion to general anesthesia, 2015
Evaluation of complaints of anesthesiologists, 2015
Anesthesia hospital agreement concepts, 2015
Pharmacy queue management and monitoring, 2015
Resident practice management education, 2015
CRNA knowledge of anesthesiologist activity increasing efficiency, 2015
Quantification of anesthesiologists’ patient communication skills, 2015
CUSUM analysis of resident performance data, 2015
Comparing paper to electronic anesthesia data and influence on outcome, 2015
Estimating incidences of pain among Iowa versus national patients, 2015
Narratives of adverse events and trainee supervision, 2015
Analysis of hemodynamic data trends over time among devices, 2015
Monitoring non-operative time, 2015
Case scheduling when there are many add-on cases, vascular surgery, 2015
Anesthesia machine contracts and maintenance, 2015
Evaluating resident procedural competence, 2015
Forecasting annual increases in anesthesia workload, 2015
Dental injury incidence, seasonal variation, and training, 2015
Ambulatory surgery center monitoring workload, cases, etc., 2016
EPIC anesthesia information system for research data, 2016
Evaluation of effectiveness of preoperative anemia clinic, 2016
Endpoints anesthesia provider ambulatory surgery performance, 2016
Patient arrival and fasting times incorporating movement of cases, 2016
Distribution of case physiological complexity among residents, 2016
Definitions of starting cases together, 2016
Bed discharge planning and committee decision making, 2016
Influence of changing surgeon block time on case duration prediction, 2016
Data quality and analytics for ongoing professional practice evaluation, 2016
Statistical analysis of needle-stick injury data, 2016
Systems-based practice initiatives to increase patient satisfaction, 2016
Anesthesiology workload nationally and relationship with hiring, 2016
Influence of diversity on intraoperative pathway development, 2016

Enterprise-wide analytics software, 2016
Describing importance of turnover time reduction, 2016
Relationship of board certification and trauma center outcome, 2016
Qualitative analysis and systematic literature review for adverse events, 2016
Pharmacoeconomics and anesthesia drug use, 2016
Variability hospital census, 2016
Scientific studies of patient complaints of anesthesiologists, 2016
Quantifying uniqueness of University of Iowa through diversity measures, 2016
Minutes of hypotension measured with gaps and noninvasive BP, 2016
Numbers of nurses at preoperative clinic and calling patients, 2016
Comparisons of 95th percentiles of anesthesia durations, 2016
Categories for urgent case waiting and sequencing, 2017
Economics of neurological clinical trial designs, 2017
Obtaining information from PubMed automatically, 2017
Preoperative information obtained from patient, 2017
Time remaining in single OR series of on-going cases, 2017
Time motion studies for economics of brief procedures, 2017
Designing turnover time reduction studies, 2017
Phone preoperative interviews, 2017
Benchmarking ASA RVG units among departments, 2017
Hospital cost accounting for Perioperative Surgical Home, 2017
Predictive error in estimating case durations, 2017
Endpoints for preoperative clinic effectiveness, 2017
CRNA 2nd shift staffing and staff scheduling, 2017
Inspired CO_2 monitoring for replacement of carbon dioxide absorbent, 2017
Confidentiality versus anonymity of evaluations, 2017
Faculty and resident perceptions of provided feedback, 2017
Economic rationale for reductions in length of stay and bundled payment, 2017
Joint arthroplasty state alliance of hospitals, 2017
Nurse anesthetists' specialization, 2017
Handoffs and communication, 2017
Professionalism education, 2017
Using statewide hospital data for evaluating peripartum RBC transfusion, 2017
Anesthesia staff scheduling mathematics, 2017
Cost per minute of anesthesia time, 2017
Economics of 1 surgeon in 2 ORs, 2017
Benchmarking percentage of cases with arterial line, 2017
Benchmarking CRNAs per OR and anesthesiologists per OR, 2018
Feedback by e-mail to clinicians for reduction in drug costs, 2018
Modeling relationship between surgical duration and wound infection, 2018
Measuring changes over time in our surgical patients' acute pain after discharge, 2018
Relative Value Guide to Relative Value Unit conversion, 2018
Semi-real time status board displays for anesthesia assignments, 2018
Geolocation of anesthesia providers using mobile applications, 2018
Pediatric anesthesia cancellation rates, 2018
Arrival and ready time of pediatric surgical patients, 2018
Influence of anesthesiologist: CRNA supervisory ratio on non-operative time, 2018
Obstetrical transfusion statewide for planning referral centers, 2018
OR and PACU temperature monitoring, 2018
Surgeon clinics on weekends, 2018
Phase I PACU length of stay benchmarking, 2018
Robotic surgery, length of stay, 2018
Increasing predictability versus reducing variability of clinical OR schedules, 2018
Workforce planning and surgical staffing, OR allocations versus staff assignment, 2018
Resident perceptions of feedback, 2019

Numbers of anesthesia technicians, 2019
Reducing non-operative time to do more cases, 2019
Hyperbaric bupivacaine supply disruption and anesthetic effects, 2019
Survey to determine relative use of different acute pain procedures, 2019
Benchmarking cancellation rates among ambulatory surgery cases, 2019
Principles of anesthesia productivity and staffing calculations, 2019
Lean analyses for non-operative times in surgical suites, 2019
Post-residency match survey comparing concerns men and women, 2019
Evaluation of faculty coordinator supervising PACU resident, 2019
Discrepancies in expected CRNA productivity, 2019
Calculating maximum possible anesthesia department productivity, 2019
Achieving high response rate among anesthesia providers, 2019
Anesthesia technician staffing and staff scheduling calculations, 2019
Surgical trays and central sterilization planning, 2019
Combining ambulatory and inpatient ORs at new surgical suite, 2019
Productivity changes with 1 surgeon scheduled into 2 ORs, 2019
Monitoring of queues of add-on cases, 2019
National anesthesia productivity reports, 2019
Registered nurses for preoperative phone calls, 2019
Intraoperative temperature monitoring for payments, 2019
Patients estimating percentage reductions in pain scores, 2019
Prior research sick leave anesthesia, 2020
Predicting caseload 1 week ahead, 2020
Anesthesia department support, 2020
Economics of solo CRNA care versus group practice, 2020
Adding gap between two surgeons the day before surgery, 2020
Surgeons' perceptions of anesthesia team activity, 2020
Intradepartmental management drug shortages with COVID-19, 2020
Anesthesia after COVID-19, 2020
Overbooking diagnostic imaging, 2020
Anesthesia delays and potential to schedule another case or reduce staffing, 2020
Sugammadex high dose, lower dose, 2020
Guidelines and standards for responsibility during PACU emergency, 2020
Nurse administered sedation dosing, 2020
Cardiothoracic surgery surgical site infections and operating rooms, 2020
Predicting unexpected intensive care unit admission, 2020
Supervision scores and respectful behavior in operating room, 2020
Noise in operating rooms, 2020
Science of trust in operating room management, 2021
Retrospective analyses using problem lists, 2021
Medical student evaluations reliably, 2021
Small procedures performed before patient enters operating room, 2021
Bernoulli CUSUM of CRNA work habit evaluations, 2021
Cardiac surgery anesthesia and surgical times, 2021
Intravenous catheter research studies, 2021
Chronic pain clinic quality and workflow defects, 2021
Reducing obstetrical hemorrhage quality improvement, 2021
Anesthesia department's hospital metrics, 2021
Faculty breaks to trainees and critical anesthesia periods, 2021
Lack of effect of anesthesiologist and anesthesia provider on operating room times, 2021
Chronic pain clinic facility location determination, 2021
Measuring group faculty productivity, 2021
Pediatric MRI case scheduling, 2021
Interpretation of faculty evaluation CUSUM daily analysis, 2021
Design of obstetrical clinical trial using postoperative analgesia consumption as endpoint, 2021

CRNA:anesthesiologist and Resident:anesthesiologist ratios by time of day, 2021
Wrong side surgery studies, 2021
First case start benchmark data, 2021
Hemodynamic data recording in Epic, 2021
Assigning departmental points for effort, 2021
Interpretation of statistically significantly low odds ratios of supervision scores, 2021
Implementation infection control processes, 2021
Assessing validity of trainee simulation scoring, 2021
Fellow physician evaluation of faculty, 2021
Patient centered outcome observations for ECMO patients, 2021
Patient centered outcome observations after spine surgery, 2021
Hospital surgical infection control with ultraviolet disinfection industrial engineering, 2021
Outcomes and economics of anesthesia practitioners for GI procedural sedation, 2021
Operating room control desk displays and their communication value, 2022
Resident selection of daily case assignments, 2022
Faculty anesthesiologists working late frequency post-pandemic, 2022
Retrospective cohort study autologous red blood cell transfusion in cardiac surgery, 2022
Physician quality reporting, 2022
Resident basic echocardiography training survey, 2022
Obstetric workload at CRNA only Iowa hospitals, 2022
Quality monitoring using electronic health record data, 2022
Ongoing professional practice evaluation abbreviated reporting formats, 2022
Interpreting nurse anesthetist work habit evaluations, 2022
Surgeon block time quantification, 2022
Faculty promotion reporting format, 2022
Obesity and ambulatory surgery, 2022
Reporting resident evaluations of faculty, 2022
American Society of Anesthesiologists' Physical Status assignment and feedback, 2022
Studies of operating room team culture and outcomes, 2022
Risk Stratification Index for University of Iowa patients, 2022
Sample size pain regional anesthesia clinical trial, 2022
Hypotension in phase I PACU, 2022
Summary of anesthesia productivity quantification, 2022
Anesthesiologists giving breaks, 2022
Emotional exhaustion and relief decisions, 2022
Algorithms for random-effect meta-analyses of relative risk, 2023
Sample size for two group proportion comparisons with imprecise prior knowledge, 2023
Ongoing professional practice evaluation automation, 2023
Interpretation of supervision evaluation scores, 2023
Sample size studies evaluating peripheral neuropathy, 2023
Cesarean deliveries among hospitals in Iowa, 2023
Ambulatory surgery center randomized clinical trial design, 2023
Changes over decade in incidence prolonged times to tracheal extubation, 2023
Personnel at surgical time out, 2023
Trainee evaluations of faculty rationale and summary, 2023
Sample size design for clinical trial of interscalene block, 2023
Interpretation faculty evaluation comments, 2023
Ultraviolet-C disinfection scheduling and use in operating rooms, 2023
Statistical analyses of lidocaine concentrations, 2023
Amisulpride study design, 2023
Supervision scale attributes being evaluated, 2023
Propensity score analysis of hypotension, 2023
Measuring postoperative pulmonary adverse events, 2023
Evaluation of the quality of intraoperative teaching, 2023
Total oral morphine equivalents as primary endpoint for randomized trial, 2023

Ongoing professional practice evaluation and annual faculty evaluations, 2023
Reporting in situ simulation results experiences, 2023
Standardized differences for proportions, 2023
CUSUM monitoring of faculty, 2023
Resident evaluation completion, 2023
Principles of work habits evaluation, 2023
Budgeting cost of interim analysis of randomized trial, 2023
Absence of invitation to evaluate supervision after each operating room workday, 2023
Interpretation of resident comments about quality of supervision, 2023
Faculty anesthesiologist and CRNA interactions per year, 2023
CRNA evaluation of faculty anesthesiologists, 2023
Resident teaching evaluations reports to individual faculty, 2023
Physical construction phase I PACU, 2023
Associations between patient race and initial treatment recommendations, 2023
Equity and work hours with relief of anesthesiologists, 2023
ACGME clinician educator milestones and evaluation anesthesiologists' supervision quality, 2023
ICU faculty supervision scores, 2023
Frequency of ongoing professional practice evaluations, 2023
Clinician educator milestone implementation analytics, 2023
Interpretation of small sample size faculty evaluations, 2023
Analysis of ratios of two procedural duration distributions, 2023
Interpretation of odds ratio of supervision scores, 2023
Increasing supervision scores, 2024
Supervision scores with low response rates, 2024
Critical care research program planning, 2024
Cerebral oximetry sample size design, 2024
Rocuronium and sugammadex use monitoring, 2024
Including social factors and insurance when modeling readmission, 2024
Initial design of corneal abrasion retrospective chart review, 2024
ECMO outcome prediction, 2024
Pediatric hospital infection prevention, 2024
Frequency of measurements affecting maximum observed, 2024
Quality improvement study design to decrease low frequency adverse event, 2024
First case start analyses, 2024
Abbreviated ongoing professional practice evaluation report, 2024
Automation to increase anesthesiologists' productivity when moving among facilities, 2024
Didactic teaching evaluation, 2024

III h. Invited lectures – total of 193

Boston Children's Hospital, Harvard University, 1995, "Cerebral oxygenation during hypothermic cardiopulmonary bypass"
University of Washington, 1996, "Cost analyses in anesthesia" and "How can we safely decrease costs of anesthesia? A review of scientific studies."
Columbia University, 1996, "How can we safely decrease costs of anesthesia?" and "Cerebral oxygenation during profoundly hypothermic cardiopulmonary bypass"
American Society of Extracorporeal Technology, 1996, "Cost savings from eliminating adverse outcomes from high-, but neither low- nor moderate- risk, surgical operations"
Duke University, 1996, "How can we safely decrease costs of anesthesia? A review of scientific studies" and "Cerebral oxygenation during profoundly hypothermic cardiopulmonary bypass"
University of Nebraska, 1997, "Cerebral oxygenation during hypothermic CPB" and "Cost analysis for anesthesia"
Stanford University, 1997, "The Iowa Satisfaction with Anesthesia Scale" and "Cost research at the University of Iowa"

Children's Hospital of the University of Pennsylvania, 1997, "Cerebral oxygenation during cardiopulmonary bypass" and "How can we safely decrease costs of anesthesia?"
University of Alabama at Birmingham, 1997, "Perioperative health services research"
Henry Ford Health System, 1997, "Costs saving in anesthesia" and "Operating room operations research"
Iowa PeriAnesthesia Nursing Update, 1998, American Society of PeriAnesthesia Nursing Iowa Chapter, "PACU economics"
Case Western Reserve University, 1998, "Cerebral oxygenation during hypothermic cardiopulmonary bypass"
Cleveland Clinic Foundation, 1998, "Statistical analysis of surgical services information systems to optimize operating room utilization"
Association of Anesthesia Clinical Directors, 1998, "Analysis of scheduling strategies to maximize operating room utilization"
University of Iowa, Applied Mathematical and Computational Sciences, 1998, "Computer simulation to determine how new anesthetic drugs and monitors can impact staffing."
Washington University, 1999, "How should patients be scheduled to maximize operating room utilization?"
Stanford Perioperative Management Conference, 1999, "New strategies for maximizing anesthesia department reimbursement"
Association of Anesthesia Clinical Directors, 1999, "Operating room scheduling strategies to maximize operating room utilization"
Presbyterian Healthcare Services, Albuquerque, NM, 1999, "OR Management"
New Mexico Society of Anesthesiologists, 1999, "Can new anesthetic drugs and monitors for ambulatory surgery decrease costs?"
Organon, Inc., symposium at PostGraduate Assembly in Anesthesia, 1999, "Regaining control of the OR"
Stanford University, 1999, "Future research in OR management"
Association of Anesthesia Clinical Directors, 2000, "Patient scheduling to minimize operating room costs"
OR Business Management Conference, 2000, "Operating room scheduling algorithms"
Society for Ambulatory Anesthesia, 2000, "Cost containment advantages of various operating room scheduling paradigms"
Iowa Association of Nurse Anesthetists, 2000, "Principles in purchasing operating room information systems"
Southern Medical Association, 2000, "Efficient operating room scheduling – why patient scheduling matters financially"
Society for Technology in Anesthesia, 2001, "Why you should buy an operating room information system & analyze the stored data in it"
Fuqua School of Business, Duke University, 2001, "OR in the OR: management science in the surgical suite"
American Association of Clinical Directors, 2001, "Operating room scheduling – what system is right for your surgical suite?"
Johns Hopkins, Department of Anesthesiology and Critical Care Medicine, 2001, "Progress in OR management"
Frontiers in Quantitative Biosciences Seminar, University of Iowa, 2001, "Biomathematics applied to operating room management"
Jefferson Medical College, 2001, "Operating room management decision making: one by one"
Philadelphia Society of Anesthesiologists, 2001, "Progress in the economics of perioperative practice"
University of Iowa, Department of Pathology, 2001, "Advances in Planning Staffing for Medical & Surgical Procedures (e.g., phlebotomy)"
Iowa Society of Anesthesiologists, 2001, "How to staff a surgical suite to maximize OR efficiency and the anesthesia group's profitability"
CompuRecord™ Users Group Meeting Invited Speaker, 2001, "Using anesthesia information system data for assessing anesthesia & OR nursing staffing productivity"

American Society of Anesthesiologist's Refresher Course, 2001, "Cost implications of various operating room scheduling strategies"
Operating Room of the Future Strategy Forum member, 2001, Telemedicine and Advanced Technology Research Center, U.S. Army Medical Research and Materiel Command
PostGraduate Assembly in Anesthesia, 2001, "Getting the most [financially] out of your information system"
University of Miami, Department of Anesthesiology, 2002, "Advances in the science of operating room management"
American Association of Clinical Directors, 2002, "Allocating OR time and scheduling cases at surgical suites that have open hours" and "…with fixed hours"
Vanderbilt University, Department of Anesthesiology, 2002, "Allocating OR time and scheduling cases to maximize OR efficiency"
VHA Upper Midwest, Joint Meeting of Materials Managers and OR Leaders, 2002, "New techniques in OR allocation and staffing"
American Society of Anesthesiologist's Refresher Course, 2002, "Allocating operating room time & scheduling surgical cases at US hospitals"
Society for Technology in Anesthesia, 2002, "The value of using electronic anesthesia information systems for operating room management"
Cornell University, Department of Policy Analysis and Management, 2002, "Operating room utilization"
State University of New York at Stony Brook, Department of Anesthesiology, 2003, "Understanding hospital and anesthesia group decision-making"
Upstate Medical University, Department of Anesthesiology, 2003, "OR management decision-making to maximize OR efficiency"
Mayo Clinic Refresher Symposium on Anesthesia and Perioperative Medicine, 2003, "How (really) to allocate OR time and schedule cases to maximize OR efficiency"
American Association of Clinical Directors, 2003, "Combining OR information system and hospital financial data for strategic decision-making"
University of Iowa, Department of Pediatrics, 2003, "Where infants, young children, and the very old undergo operative procedures in the State of Iowa"
Florida Society of Anesthesiologists' Annual Meeting, 2003, "How to use the data we collect to increase anesthesia group productivity"
VHA, Efficient medication use program: targeting medication costs in the perioperative environment, 2003, "Why focus on the perioperative environment?"
Beth Israel Deaconess Medical Center, Department of Anesthesia, 2003, "Linking economics of anesthesia and surgery with OR efficiency for good decision making"
Queen's University, Ontario, Department of Anaesthesiology, 2003, "Decision-making based on OR efficiency" and "Anesthetic drug costs"
American Society of Anesthesiologist's Refresher Course, 2003, "Allocating operating room time & scheduling surgical cases to maximize OR efficiency"
American Society of Anesthesiologist's Clinical Forum on Practice Management, 2003
Catholic University of Leuven, Belgium, 18th International Winter Anesthesiology Symposium, 2004, "Maximizing OR efficiency to reduce anesthesia costs"
Society for Technology in Anesthesia, 2004, "OR workflow and productivity: myths and goals"
American Association of Clinical Directors, 2004, "OR allocation and case scheduling" and "Strategic decision-making"
World Congress of Anaesthesia, Paris, 2004, "Valuing healthcare – quantifying costs and quality"
OR Business Manager Conference, 2004, "Modeling and personalities - Excel versus politics in strategic decision making" and "OR efficiency for staffing"
California Society of Anesthesiologists, 2004, Organizing "Practice management workshop," and teaching "OR allocation, case scheduling, and anesthesia staffing"
Ambulatory Surgery Centers conference, 2004, "Increasing profitability at ambulatory surgery centers"
Medical College of Georgia, 2004, "Making OR management decisions based on OR efficiency"

PanArab Conference of Anesthesia, Beirut, 2004, “OR staffing to increase OR efficiency” and “Perioperative tactical decision making for capacity expansion”
Saint Louis University, 2004, “Anesthesia drug costs”
VHA, CEO Workgroup – OR Task Force, 2004, “OR operational efficiency”
VHA Michigan OR Roundtable, 2004, “Increasing reimbursement relative to costs by selectively expanding surgical capacity”
American Association of Clinical Directors, 2005, “Allocation using OR efficiency for operational decisions” and “Allocation using contribution margin for tactical decisions”
Louisiana Association of Nurse Anesthetists, 2005, “Decision making on the day of surgery” and “CRNA Afternoon Staffing”
California Society of Anesthesiologists, 2005, “Management decisions using automated anesthesia record keepers”
Euroanaesthesia Congress, Vienna, 2005, “Scheduling surgical lists with anesthesia information management systems”
Children’s Hospital Boston, 2005, “Summary of science of operating room management”
Stanford University, 2005, “Why and how OR management decisions can be made systematically based on OR efficiency”
Johns Hopkins University, 2005, “Anesthesia pharmacoeconomics”
VHA, Transformation of the OR, 2005, “Increasing flow of surgical patients to improve financial performance”
Brigham & Women’s Hospital, Harvard, 2005, "Economics of reducing turnover times in the USA" and “Service-specific staffing and decision-making based on OR efficiency"
Child Health Corporation of America, Operating Room Directors Forum, 2005, “Determinants of staffing” and “Making good tactical (1 yr) financial decisions”
University of Texas MD Anderson, 2006, “Operating room scheduling and decision making on the day of surgery”
IFAC Symposium on Innovative Engineering Techniques in Healthcare Delivery, Saint-Etienne, France, 2006, “OR efficiency for staffing and scheduling before and on the day of surgery”
University of Miami School of Business, 2006, “How to make patient flow decisions in hospitals based on ordered priorities” and “Economics of reducing turnover times”
University Hospital of Basel, Switzerland, 26th Myron B. Laver International Postgraduate Course, 2006, “Tactical OR planning should not be based on utilization when resources are limited” and “Tactical OR planning: if it is incentive driven, use highly targeted incentives”
Detroit Receiving Hospital, Wayne State University, 2006, “Economics of turnover time reduction” and “Running ORs on afternoons, evenings, and weekends”
University of North Texas, 2006, “Healthcare cost reduction from small reductions in time”
American College of Surgeons, 2006, “The economics of operating room efficiency”
VHA Northeast Perioperative Network, 2007, “Making decisions on the day of surgery to increase OR efficiency” and “Matching staffing to workload to increase OR efficiency”
Asociación de Anestesia Analgesia y Reanimación de Buenos Aires, 2007, “Making management decisions on the day of surgery to increase OR efficiency” and “Matching staffing to workload and scheduling cases to increase OR efficiency”
Society for Ambulatory Anesthesia, 2007, “Is ambulatory surgery really cheaper”
International Anesthesia Research Society Panel on OR management, 2007, “Science of turnover times - the brief summary”
Association of University Anesthesiologists, 2007, “Entrepreneurial strength as a goal of an academic department – Operational consulting”
International Conference on Industrial Engineering and Systems Management, Beijing, 2007, One day workshop on OR management analysis
Massachusetts General Hospital, 2007, “Running the OR desk: an interactive session”
American Society of Anesthesiologists, 2007, “Do patients care about satisfaction with anesthesia or perioperative experience?” and “Does reducing PACU time reduce costs?
EURO Working Group on OR Applied to Health Services, Saint-Etienne, France, 2007, “Making tactical (budget/financial) decisions for outpatient and inpatient surgery”

University of Cincinnati, Innovations in Healthcare Delivery 2007, “Targeted increases in patient flow – Lessons from operating room management”
Society for Technology in Anesthesia, 2008, “Improving productivity using anesthesia information management systems”
Syracuse University, College of Engineering, 2008, “Engineering (anesthesia & surgical) healthcare delivery”
Stanford University, School of Business, Operations, Information & Technology, 2008, “Empirical analyses to quantify reductions in cost from reducing non-value added time in ORs”
Society for Pediatric Anesthesia, 2008, “Turnover times for pediatric anesthesia”
Kansas State University, Industrial & Manufacturing Systems Engineering, 2008, “IE in healthcare: Lessons from studies of reducing setup/cleanup times in ORs”
University of Medicine and Dentistry of New Jersey, Anesthesiology, 2008, “Systems-based practice” and “Learning principles of OR management from studies of turnover times”
North Carolina State University, Industrial & Systems Engineering, 2008, “Multilevel statistical modeling and empirical rescheduling of jobs of stochastic durations to study strategies that could have reduced mean tardiness from due dates while satisfying unknown constraints”
International Conference on Productivity and Quality Research, University of Oulu, Finland, 2008, “Lessons from operating room management about when and how reducing setup and cleanup times can increase productivity” and “Seminar on OR Productivity”
Queen's University, Department of Mathematics and Statistics, 2008, “Statistical analyses of operating room turnover times”
Georgia Society of Anesthesiologists, 2008, “Principles of anesthesia institutional support” and “Economics of turnover time reduction”
Upstate Medical University, 2008, “Evidence-based management of turnover times”
Wisconsin Society of Anesthesiologists, 2008, “Why understanding turnover times matters” and “Running the OR desk to increase efficiency”
Mayo Clinic Conference on Systems Engineering and Operations Research, 2008, “Empirical assessment of strategies to reduce patient and surgeon waiting from scheduled start times”
Society for Education in Anesthesia, 2008, “Research in education: getting published”
Medical College of Wisconsin, 2008, “Understanding OR management of turnovers” and “Understanding OR management on the day of surgery”
Texas Tech University, 2008, “Learning about OR efficiency from turnover times”
Cleveland Clinic, 2009, “Turnover times” and “Decision making on the day of surgery”
Veterans Administration, National Surgical Flow Meeting, 2009, “Talk on turnover times to understand some end points to monitor”
University of Pittsburgh, 2009, “Measuring, assessing and monitoring OR effectiveness - focus on turnovers”
Fields Institute for Research in Mathematical Sciences, Toronto, 2009, “Big open (IE) problems in operating room management”
New York University, 2009, “Economics of turnover time reduction”
Beth Israel Deaconess, 2009, “Anesthesia drug costs” and “Understanding surgical growth opportunities through turnover times”
Oregon Health & Science University, 2009, “Problem based learning discussion: Planning OR time for orthopedic surgery at a 12 OR hospital” and “We can learn a lot from a turnover – progress in OR economics”
International Anesthesia Research Society, 2010, “What I have learned from performing departmental consultations”
International Conference on Systems Analysis Tools for Health Care Delivery, 2010, “Frequent lack of value of reducing non-value added time between surgical cases”
Roswell Park Cancer Institute, 2010, “Impact of turnover time reduction on operating room efficiency and profit”
University of Virginia, 2010, “Turnover times and first case starts” and “Anesthesia pharmacoeconomics”
Toronto Western Hospital, 2010, “Influence of time on anesthesia pharmacoeconomics”

Veterans Affairs Anesthesia Chiefs Meeting, 2010, “OR Efficiency, turnover times, first case starts, and cancellations” and “OR management statistical analyses for VA hospitals”
Networks in Anaesthesiology, Athens, 2011, “Best practices in OR efficiency”
University of Southern California, Industrial and Systems Engineering, 2011, “Value of small changes in operating room workflow”
University of Miami, 2011, “Old knowledge and new advances in anesthesia pharmacoeconomics: Working 'like it’s 1999'”
Georgia Institute of Technology Industrial and Systems Engineering, 2011, “Impact of anesthesia groups on OR efficiency” and “Turnover times and newsvendor problem in OR management”
International Anesthesia Research Society, 2011, “Decisions at control desk to facilitate OR work flow”
Mayo Clinic Health Care Operations Research/Systems Engineering Symposium, 2011, “Active learning: Decision-making on the day of surgery”
Wayne State University Industrial and Systems Engineering, 2011, “IE for operating room management: Sensitivity of benefit of lean methods to preceding staffing decisions and psychological biases” and “Allocating operating room time”
International Society for Anaesthetic Pharmacology, 2011, “Economic challenges to the application of pharmacogenetics in anesthesia”
American Society of Anesthesiologists’ Practice Management Conference, 2012, “Operating room staffing”
Society for Health Systems (Institute of Industrial Engineers), 2012, “Lessons from turnover times – The importance of domain specific scientific knowledge”
Georgia Institute of Technology, 2012, “Newsvendor, behavior, and the importance of anesthesia agreements (contracts)”
Albert Einstein College of Medicine, Montefiore Medical Center, 2012, “Operating room scheduling”
University of Miami, 2012, “Turnover times – BIG scientific progress since 2006”
Vanderbilt University, 2012, “Analyzing management data, a run-through of five papers”
SAMSI, Statistical and Applied Mathematical Sciences Institute, 2012, “Anesthesia operations research projects (questions)”
University of Geneva, 2013, “OR capacity planning based on monthly forecasts of workload”
City of Hope National Medical Center, 2013, “Decision-making 0 to 2 working days before surgery to reduce over-utilized time”
University of California, Irvine, 2014, “Anesthesia drug costs – A model for choosing wisely” and “Operations management of the Preoperative Assessment Clinic”
Northwestern University, 2014, “Turnover times as model for understanding how to increase efficiency of use of operating room time”
Anesthesia Patient Safety Foundation, 2014, “Preoperative evaluation findings from the 2014 study”
Weill Cornell Medical College, 2014, “Clinical and observational studies related to management of anesthesia preoperative evaluation clinics”
EmCare's Annual North Division Leadership Conference, 2014, “The economics of reducing turnover time”
Society for Technology in Anesthesia, 2015, “Using technologies to help clinicians comply with best evidence/ best practices”
Stony Brook University, 2015, “Brief reductions in turnover times and late first case starts”
International Anesthesia Research Society, 2015, “Communication tools for the decision maker”
Iowa Society of Anesthesiologists, 2015, “Basic principles in making decisions on the day of surgery” and “Running the preoperative evaluation clinic”
EmCare’s Annual Leadership Conference, 2015, “Making managerial decisions on the day of surgery”
Anesthesia Quality Institute Anesthesia Data Conference, 2015, “*Anesthesia & Analgesia* Statistical reviews of large observational data studies”
The Hospital for Sick Children, University of Toronto, 2015, “The (operating room management) science of (non-surgical) time reductions”

Mayo Clinic Delivery Science Summit, 2015, "How can we design educational programs to advance health systems engineering?"
Sociedade Portuguesa de Anestesiologia, Lisbon, 2015, "OR costs: Anesthesiologists as part of the solution"
American Society of Anesthesiologists, 2015, "Psychometrics 101: Why the aspiring educator scientist needs to understand its role"
Johns Hopkins, Department of Civil Engineering, 2016, "Labor cost accounting for small differences in operating room time such as from lean methods"
23rd Annual Course in Anesthesia, Fundación Universitaria Sanitas, Bogotá, 2016, "Decision-making on the day of surgery"
Christiana Care Health System Value Institute, 2016, "Labor cost accounting for small differences in operating room time such as from lean methods"
University of Utah, 2016, "It takes a course for trust and benefit in the top lessons learned from OR Management research" and "Using local hospital OR data to make good turnover time decisions"
Clemson University, 2016, "Using technology to help anesthesiologists with managerial decisions"
American Society of Anesthesiologists, 2016, "Improving first-case of the day on-time starts CAN increase operating room efficiency"
41st Annual Northwestern Vascular Symposium, 2016, "Improving operating room efficiency"
New York Postgraduate Assembly in Anesthesiology, Anesthesia Patient Safety Foundation, 2016, "Wasteful cognitive biases for turnover time and anesthesia time reduction"
University of Missouri - Kansas City, 2017, "Anesthesia drug costs – implications for day to day decision-making"
University of Rochester, 2017, "Influence of faculty anesthesiologists' specialization on quality of resident supervision" and "Operational decision-making on the day of surgery"
University of Pittsburgh, 2017, "Evaluating quality of anesthesiologists' supervision"
Sociedade de Anestesiologia do Estado de São Paulo COPA 2017, "Perioperative evaluation clinics – patient perspective and impact," "Perioperative evaluation clinic – scheduling the clinic," and "Supervising anesthesia residents"
Massachusetts General Hospital, 2017, "Decision-making on the day of surgery"
International Anesthesia Research Society, 2017, "Implementing operating room management improvement"
Harvard Anesthesiology Update, 2017, "5 myths about OR efficiency: case durations, turnover times, OR allocations" and "… faster durations, block times, diversity of practice"
University of California, Irvine, 2017, "Reducing turnover times to increase OR efficiency and finish an extra case"
American Society of Anesthesiologists, 2017, "Improving first-case of the day on-time starts CAN increase operating room efficiency"
Henry Ford Health System, 2017, "Readmissions as endpoint for Perioperative Surgical Home" and "Exercises for decision-making on the day of surgery"
University of Florida, 2018, "Managing the anesthesia preoperative evaluation clinic"
University of Kansas Health System, 2018, "Decision-making on the day of surgery" and "Economics of reducing turnover times"
Society for Pediatric Anesthesia, 2018, "Economics of anesthetics: how to reduce costs in the operating room"
Iowa Hospital Association, 2018, "Forecasting and understanding changes in surgical caseloads"
American Society of Anesthesiologists, 2018, "Improving first-case of the day on-time starts CAN increase operating room efficiency"
American Society of Anesthesiologists, 2020, "Nuts and bolts of OR management: myths and importance of course to learn the science"
Latin American Confederation of Societies of Anesthesiologists, 2020, "Daily OR management for elective surgery during COVID-19 pandemic"
University of California Davis, 2020, "Managing the anesthesia preoperative evaluation clinic"
Pre-Health Shadowing, 2021, "What I do and how I got there"

University of Virginia, 2021, "Operating room case scheduling and staff assignment the day before surgery"
North American Center for Continuing Medical Education, 2021, "The effect of improving basic preventive measures in the perioperative arena on *Staphylococcus aureus* transmission and surgical site infections"
D4Z Healthcare Summit, 2021, "Monitoring the patient environment: Staphylococcus aureus transmission and surgical site infections"
University of Iowa Pre-Health Conference, 2022, "Quantitative biosciences panel," organizer and presenter
3M Healthcare Academy, 2022, "Innovative approach to reduce surgical site infections: anesthesia departments' role!"
3M Healthcare Academy, 2022, "Innovative approaches to reduce surgical site infections and anesthesia department roles"
Lahey Hospital, Department of Anesthesiology, 2022, "Decision-making on the day before and the day of surgery"
European Health Management Association and Lean Health Portugal, 2023, "Benefits of more accurate case duration predictions"
USC Keck School of Medicine Anesthesiology, 2024, "Increasing OR efficiency by reducing turnover, anesthesia, and surgical times"

IVa. Editorial responsibilities

Studies performed to improve the reporting of statistical data and methods in anesthesia journals: #208, #228, #418, #419, and #420, above. Associated Editorials including analyses are #599, #607, and #618.

Associate Editor, *Journal of Clinical Anesthesia*

Editor, Statistics, *Canadian Journal of Anesthesia*

Editorial board member, *Perioperative Care & Operating Room Management*

Editorial board member, *International Journal of Healthcare Technology and Management*

Manuscripts reviewed or handled as editor (total 8032)

2001	37	2006	118	2011	794	2016	449	2021	210
2002	34	2007	176	2012	858	2017	142	2022	213
2003	40	2008	257	2013	901	2018	163	2023	241
2004	36	2009	225	2014	1105	2019	137	2024	96 (so far)
2005	36	2010	410	2015	1055	2020	198		

100% reviews completed within 1 week from 2015 through 2023

122 journals for which I reviewed articles in 2019 through 2023

A&A Practice
Advances in Clinical and Experimental Medicine
AIMS Medical Science
American Journal of Infection Control
Anesthesia & Analgesia
Anesthesiology
Anesthesiology Research and Practice
Annals of Medicine and Surgery
Annals of Palliative Medicine
Annals of Surgery
AORN Journal
Applied Clinical Informatics

Atmospheric Environment
Bioengineering
BioMed Research International
BMC Anesthesiology
BMC Health Services Research
BMC Musculoskeletal Disorders
BMJ Open
BMJ Quality & Safety
Brazilian Journal of Anesthesiology
British Journal of Anaesthesia
Canadian Journal of Anesthesia
Computer Methods and Programs in Biomedicine
Computers & Industrial Engineering
Computers & Operations Research
Cureus
Digital Health
Disaster Medicine and Public Health Preparedness
Discover Health Systems
Epidemiology & Infection
F1000
Flexible Services and Manufacturing Journal
Frontiers in Public Health
Future Science OA
Healthcare
Health Care Management Review
Health Care Management Science
Health Policy
Health Policy and Technology
Health Science Reports
Health Services Insights
Health Services Research Journal
Health Systems
IEEE Transactions of Medical Robotics and Bionics
IEEE Transactions on Automation Science and Engineering
INFORMS Journal on Applied Analytics
INFORMS Transactions on Education
Institute for Operations Research and Management Science Journal on Computing
Intensive Care Medicine
International Journal for Quality in Health Care
International Journal of Computer Aided Engineering and Technology
International Journal of General Medicine
International Journal of Healthcare Technology and Management
International Journal of Health Planning and Management
International Journal of Information Technology & Decision Making
International Journal of Nursing and Health Care Research
International Journal of Nursing Studies
International Journal of Obstetric Anesthesia
International Journal of Occupational Safety and Ergonomics
International Journal of Operations and Production Management
International Journal of Production Research
International Journal of Surgery
JAMA (the Journal of the American Medical Association)
JAMA Network Open
JMIR Dermatology
Journal of the American Statistical Association

Journal of Biomedical Informatics
Journal of Clinical Anesthesia
Journal of Clinical Medicine
Journal of Clinical Monitoring and Computing
Journal of Clinical Nursing
Journal of Comparative Effectiveness Research
Journal of the Egyptian Public Health Association
Journal of Evidence-Based Medicine
Journal of Healthcare Engineering
Journal of Hospital Management and Health Policy
Journal of Investigative Surgery
Journal of Medical Artificial Intelligence
Journal of Medical Education and Curricular Development
Journal of Medical Systems
Journal of Nursing Management
Journal of Operations Management
Journal of PeriAnesthesia Nursing
Journal of Personalized Medicine
Journal of Rural Health
Journal of the Operational Research Society
Life
Malawi Medical Journal
Management Science
Manufacturing and Service Operations Management
Mathematical Population Sciences
Mathematical Problems in Engineering
Medical Science Monitor
Methods of Information in Medicine
Military Medical Research
Minerva Psychiatry
Nursing Open
Open Access Surgery
Operations Research for Health Care
Pain Medicine
Pain Practice
Pain Research and Management
Pediatric Anesthesia
Peer J
Perioperative Care & Operating Room Management
PLOS Global Public Health
PLOS ONE
Production and Operations Management
Regional Anesthesia & Pain Medicine
Reproductive, Female and Child Health
Research Ideas and Outcomes
Reviews in Cardiovascular Medicine
SAGE Open Medicine
Scientifica
Social Science & Medicine – Population Health
The Joint Commission Journal on Quality and Patient Safety
The Journal of Pain
The Lancet Microbe
The Surgical Journal
Transfusion Medicine
Women’s Health

IVb. Collegiate, university, and national committees and activities

Undergraduate Curriculum Committee, Biology and Medicine, Brown University, 1982 – 1985
Faculty Council, School of Medicine, Case Western Reserve University, 1985 – 1988
Chairman Alpha Omega Alpha Fall Lecture Committee, Case Western Reserve University, 1990
Respiratory Therapy Subcommittee, University of Iowa Hospitals and Clinics, 1992 – 1993
Department of Anesthesia Quality Assurance Committee, University of Iowa, 1994 – 1996
Department of Anesthesia Research Advisory Committee, University of Iowa, 1996 – 1997
Process Improvement Grant program evaluation committee, 1999
University of Iowa Hospitals and Clinics
Research Committee, College of Medicine, University of Iowa, 1997 – 2000
Consultant to Anesthesiology and Respiratory Therapy Devices Panel, 1997 – 2000
Medical Devices Advisory Committee, Food and Drug Administration
Treasurer, Health Applications Section, 2001 – 2002
Institute for Operations Research and the Management Sciences (INFORMS)
Medication Errors committee, Anesthesia Patient Safety Foundation, 2010
Ad Hoc Committee on Anesthesiology Value, American Society of Anesthesiologists, 2010-2011
Patient and Peer Surveys Workgroup, American Board of Anesthesiology, 2011
Systematic Research Group, European Society of Critical Care Medicine, 2018-2020
Professional Development Committee, INFORMS, 2019-2021
Department of Anesthesia Consulting Group (Promotions), University of Iowa, 2018 - present
Department of Anesthesia, Strategic Planning Committee on Developing Research, 2019-2021
Research Review Committee, Department of Anesthesia, University of Iowa, 2021 - present

V. Other Comments:

Wife's name: Elisabeth U. Dexter
Wife's occupation: General thoracic surgeon

Date of Birth: August 4, 1964
Citizenship: United States of America

Mobile phone: +1 (319) 621-6360

Email: Franklin-Dexter@UIowa.edu

Website: https://FranklinDexter.net

ORCID: https://orcid.org/0000-0001-5897-2484

Google scholar: https://scholar.google.com/citations?user=AA8ulM0AAAAJ

Web of Science ResearcherID: V-1495-2019

Scopus Author ID: 7102688236

My NCBI: https://www.ncbi.nlm.nih.gov/myncbi/franklin.dexter.1/bibliography/public/

LinkedIn: https://www.linkedin.com/in/franklindexter

Twitter (X): https://twitter.com/FranklinDexter

NIH Biosketch Contributions to Science, each paper listed once or in successive sentences

1. Surgical case scheduling, case duration prediction, post-anesthesia care unit staffing, etc.

- Over 30 years, my research has provided new knowledge regarding determinants of post-anesthesia care unit (PACU) costs, optimal staffing to increase PACU productivity, and strategies to increase PACU throughput. Tracking all PACU costs, drugs and supplies were found to be small expenses compared to labor costs (#1). Using simulation, we showed that PACU labor costs are more closely related to the OR schedule than to PACU length of stay (#1). Methods were developed to measure phase I PACU nurse productivity (#8), and phase I care of patients in the phase II unit (#12). Calculations were developed to quantify the impact of administrative and medical delays on total PACU time to discharge and on PACU nurse labor costs (#51). These methods have since been applied in dozens of economic analyses for devices and drugs. Statistical methods were developed and validated for the expected (mean) time remaining in the PACU, conditional on the time so far, for use in clinical trials and observational studies of interventions applied >30 minutes after patient arrival (#323). The mechanism was discerned for the creation of log-normal distributions for the times until patients are ready for phase I PACU discharge (#376). Anesthetic drugs commonly used to achieve phase I PACU bypass were reviewed (#376). Simulations were developed for valuation of phase I PACU bypass as achieved with anesthesia drugs and monitors (#24). Statistical methods were developed and tested for accuracy to determine PACU nurse staffing and staff scheduling plans that minimize the frequency of delays from ORs into the phase I PACU (#49). Simulations were performed to determine appropriate months of data to use with these methods (#65). (To provide context, formulating the problem of choosing PACU staffing with an objective to minimize the proportion of days with delays from the ORs into the PACU was new, and these simulations for power analyses were performed 23 years ago). Subsequently, the PACU staffing models were improved to include differences among patients and facilities in patient acuity (#104); click here. I organized a comprehensive review with international investigators, showing that when optimal PACU staffing is applied, the economic effects of other interventions on PACU productivity could be studied reproducibly (#88). For example, we showed that real-time forecasting of expected PACU occupancy from cases soon to finish and real-time managerial alerts cannot reduce delays from ORs into the PACU (#189). In addition, revising case sequencing of each surgeon's list of cases can reduce PACU nurse labor costs for surgical suites with ORs having the same mean hours of cases (#98). However, from study of dozens of hospitals, most surgical suites have substantial standard deviation among ORs in workload (#110). The variation in workload among ORs is so large that case sequencing is an ineffective strategy to reduce PACU staffing (#110). That work was completed in 2007. Nine years later, I was asked to consider disaster planning (e.g., large reductions in PACU capacity from a pandemic with many PACU beds being used as ICU overflow). Discrete-event simulation showed that under such conditions sequencing surgical cases substantively reduces the peak PACU nursing requirements for the OR patients (#267). Simulations were performed promptly when the COVID-19 pandemic began (#311). The same benefit of case sequencing is obtained when patients will deliberately have initial recovery in the OR until they are no longer coughing (e.g., 15 minutes) (#311). A matheuristic (i.e., hybridization of mathematical programming with metaheuristics) was developed to minimize cancellations for large surgical suites (#346).

- Allocated time is the hours into which cases are scheduled, also called service-specific staffing. Structural equation modeling and Monte-Carlo simulation showed that most of the variability in the hours that OR staff worked was caused by variability in the hours of elective cases scheduled among weekdays (#27). Studying the scheduling of add-on cases with online and offline bin packing, the addition of a fuzzy constraint to the allocated time is no different than increasing allocated hours (#31). Therefore, we performed time series modeling of workload, the total hours of cases, including calculation of upper prediction bounds of the workload (#32). Seasonal variation did not need to be added to these models (#45). We then performed the first study, worldwide, of a health system's incremental OR and anesthesia labor cost from OR time not having been allocated based on maximizing the efficiency of use of OR time (#53). We repeated

that US analysis for a German hospital (#86). We performed statistical power analyses to determine how many months of historical data should best be used for allocating OR time (#60). We showed how to calculate OR allocations that maximize the efficiency of use of OR time constrained by the previous budgetary decision by an OR committee for a specified numbers of first case starts (#62). We wrote comprehensive reviews (#84 engineering, #103 anesthesia, and #388 with calculation examples) about how to allocate OR time, with software posted online that I have maintained for 19 years: click here. I developed an alternative approach for services with single ORs, an approach so simple that it can be implemented with a few columns of formulas in Excel or Google Sheets (#133). These models assume that OR time is allocated based on the forecasted workload (i.e., hours of OR time to care for the patients), not vice-versa. We showed validity of the assumption in a managerial epidemiology study using data from all 121 hospitals in Iowa (except the 2 VA hospitals), comparing anesthesiology versus surgical meetings as natural experiments (#269). We likewise showed validity studying all 712 facilities in Florida performing major therapeutic procedures over 10 years, comparing commercially versus Medicare insured cases in December as another natural experiment (#348). We adapted the mathematics to permit sequential adjustments to planned allocated time as more information about workload is available, closer to the day of surgery (#163). We showed that anesthesia residents' specialty rotations cannot reliably be assigned when their residents' monthly schedules are not based on these OR allocations (#146). We showed also that when the rotations are not based on the allocated time, the resulting resident staff assignments can considerably reduce nurse anesthetists' productivity (#327). We showed that allocating OR time based on maximizing the expected efficiency of use of OR time and then applying corresponding case scheduling benefits anesthesia departments by decreasing the hours that anesthesiologists and nurse anesthetists work late (#219), thereby reducing labor costs. From the probability distributions of the workload, upper prediction limits can be calculated accurately for the probability that exceeding the allocated times and for anesthetists to work late (#385). Furthermore, anesthesia departments provide greater net patient benefit from a societal perspective by assuring sufficient allocated OR time for surgeons than by reducing postoperative pain (#193). In another managerial epidemiology study, with all 3546 combinations of surgical facility and surgeons in Iowa over 2 years, except for the VA hospitals, growth in the numbers of cases was due principally to the surgeons performing only a few cases per week during the first year (i.e., growth depends on using this mathematics to provide sufficient allocated OR time by surgical service, it is not an issue of surgeon-specific block time) (#251). This result was not limited to the rural state of Iowa, being as the same finding was observed when studying all surgery in Florida (#343). Effective surgical governance committees assure low caseload surgeons have access to OR time.

- The most common error in OR management data are overlapping cases among listed ORs, meaning that 2 cases are recorded as having been in the same OR at the same time. We determined that these so-called "room errors" have negligible effects on OR allocations calculated based on maximizing the efficiency of use of OR time (#67). However, because these errors in listed ORs can affect other decisions (e.g., investment in strategies to reduce turnover times), we studied how to use vital sign signals to monitor OR occupancy (#94). When physiological signals are used, human data entry is not necessary. We showed that the resulting displays are used for different decisions by OR nurses and anesthesiologists (#117). By applying use of vital signs to monitor OR occupancy throughout a surgical suite, OR room errors were essentially eliminated, decreasing from 4.1% to 0.1% (#121).

- Multiple OR management decisions made on the day of surgery and/or a few days before the day of surgery depend on predicting case durations. We performed the first study of the value of perfect (retrospective) knowledge of case durations in 2000, twice making decisions to move cases from one OR to another, once using the mean of historical OR times and then using the actual time known only afterwards (#43). There was negligible incremental value from reduction in overutilized time by having perfect knowledge of case duration (#43). The same result was obtained for the decision of the OR into which to schedule one additional (e.g., add-on) case (#83). People who do not know the science falsely misinterpret anesthesiologists working late as being caused by case duration prediction when it is caused by the allocation of OR time having

been calculated poorly months beforehand. The value of case duration prediction is mostly for estimation of the longest time cases may take. We first showed how to use nonparametric methods to calculate prediction intervals for the longest time (90% chance) that cases may take (#5). Such techniques perform well for use when predicting the time for ultraviolet disinfection of an operating room before the next case (#340). However, for surgical times, narrower intervals can be obtained while maintaining 90% coverage by using the two-parameter log-normal, frequentist model (#19). Upper prediction bounds for case durations are useful not only to fill holes (gaps) in OR schedules but also to plan brief gaps between successive surgeons in the same OR on the same day (#48). Adding such time gaps between surgeons is very useful to reduce the mean tardiness of starts of the to-follow surgeon; the gap need not be longer when the to-follow surgeon is of a different specialty than the preceding surgeon (#271). The variability in case durations among cases of the same procedure contributes more to tardiness of starts of to-follow surgeons than does variability in travel time from clinics of the to-follow surgeon (#306). Comparing the longest times cases may take between cases in two ORs is useful for coordinating equipment or personnel. Showing that logarithmic transformation of the case durations makes this the Behrens-Fisher problem permitted implementation in software of accurate estimated probabilities (#35). However, these methods were limited by the fact that when modeling the time to complete a series of cases in an OR, often at least one case consists of a rare combination of surgeon and procedure (#23). Regardless of what robust statistical method was used, there was negligible improvement in the accuracy of for case duration prediction when pooling procedures among all surgeons who had performed a procedure(s) when the scheduling surgeon had not scheduled the procedure before (#33). The same finding was obtained when using the methods for predicting the times from the start of surgical closure until operating room exit (i.e., even for closure times, classify by procedure and surgeon combination) (#351). There was negligible reduction in the waiting times of to-follow surgeons simply by increasing sample sizes of historical cases ostensibly to improve the estimate of the mean case duration (#34). There also was substantial effect of the cases with few historical data on the mathematical algorithms to reduce surgeon tardiness (#350). A study of four large teaching hospitals showed that when a surgical procedure(s) was rare at one hospital (e.g., performed once per year), it usually also was rare at the other hospitals (#63). (To provide context, this was the first application of ecological statistical methods [e.g., study of rare species of birds] to OR management, a statistical strategy we have since used many times in the subsequent 23 years.) Not only are most surgical procedures rare at large teaching hospitals, that also applies nationwide at ambulatory surgery centers (#38). That study, published in 2000, was the first managerial epidemiology study in anesthesia. Many more procedures are rare when classified using ICD-10-PCS, because laterality is included; we developed an algorithm to adjust for laterality (#272). Rare procedures account for more than half all inpatient surgery statewide in Texas (#240), and more than 2/3rd of all hospital costs for inpatient surgery (#243). The implications for policymaking are profound (e.g., no potential for price transparency for common procedures to reduce national perioperative healthcare costs meaningfully) (#243). Rare procedures have no greater proportional variability in OR times than common types of procedures (#141). However, the proportional variability is important because it differs among procedures and, when controlling for procedure, varies among services, and when controlling for service varies among hospitals (#141). One statistical consequence is that comparisons of case durations among groups with analysis of variance needs to use generalized pivotal methods (#161). Another statistical consequence is that for logistic regression studies of perioperative morbidity, when case duration and/or procedure are included as independent variables, both need to be included (#162). A policy implication of most surgical procedures being rare and that proportional variabilities in OR times vary among hospitals and services is that even though hospitals have markedly different case durations (#105), it is not possible for insurers to provide price transparency for patients' anesthesia costs (#178). Whereas the hospital and surgical facility can estimate the proportional variability in OR and anesthesia times, insurers have incomplete data and so cannot do so accurately (#178). There is another challenge in case duration prediction, and that is bias in estimates of case durations (e.g., persistent underestimation, #96). Adjusting systematically for this bias markedly reduces the tardiness of starts experienced by patients and surgeons (#131 and #132). We then combined

understanding of rare procedures, proportional variability in case durations, and bias in estimated durations to create a Bayesian method to estimate prediction bounds of OR times for all future surgical cases, even for cases with few or no historical data by procedure (#97). The addition of patient specific data to these estimated case durations generally would result in little substantive improvement in accuracy (#120). The methodology also is accurate for interventional radiology and diagnostic imaging procedures (#99). Substituting successive years of OR information system data into the Bayesian method provided further evidence of the benefit to reducing the tardiness of start times of to-follow surgeons by planning a brief gap between successive surgeons in the same OR on the same day (#270). The methodology shows too that there is lack of value to checking each surgical case's estimated duration automatically when surgeons schedule the case in order to reduce overutilized OR time (#109); instead, just apply the Bayesian method using whatever estimate of OR time is provided. The calculations also can be used to estimate the time remaining in late running cases (#125). A striking finding both mathematically and then verified empirically, when checked, is that there is a near constant mean time remaining in surgical cases exceeding their estimated duration (#125). This means that if the thoracoscopic lung lobectomy was estimated to have 3 hour OR time, and after 3 hours the surgeons have not started to close and the estimated time remaining is 1 hour, then 30 minutes later if they are still operating the estimated time remaining is approximately 1 hour – yes, that is correct. Electronic OR information system whiteboards in surgical suites lack face validity when these statistical methods are not used for estimating the times remaining in cases (#185). Good add-on case scheduling decisions to reduce overutilized time cannot be made without accurate estimation of the mean times remaining in ongoing cases (#185). Estimates of times remaining in cases are even more accurate when the initial estimated OR time is updated from information at the intraoperative time out (#142). Estimates of the time remaining in cases are supplemented substantially by including information about when milestones are satisfied (e.g., surgeon starting to close), because of properties of the log-normal distribution (#357). Estimation of the time remaining in cases is especially useful when turnover times are very long between cases (e.g., cleaning after patient of unknown COVID-19 status) (#304), because cases or teams can most easily be moved among ORs. The estimates of case duration from the Bayesian method are insensitive to the parameter measuring value of a surgeon or scheduler's estimated duration quantified in terms of equivalent numbers of historical cases (#183). That finding meant that I could write automatic software to estimate the other parameters of the Bayesian method and that personnel at OR control desks can use to obtain upper prediction bounds and estimates for the times remaining in cases; click here. Similar methods also are highly accurate for estimating the briefest lengths of surgical times, useful for assigning cases to anesthesia providers who are lactating and will need to receive break for breastmilk pumping (#319). By calculating simultaneously for multiple adjacent operating rooms, we estimated the best that anesthesia departments can achieve at assuring supervising anesthesiologists can leave for breastmilk pumping (#329). The results apply equally to anesthesiologists giving lengthy (e.g., lunch) breaks to one room while a trainee is in another room. Similar calculations can be applied for staff scheduling when considering how many extra nurse anesthetists should be scheduled to have personnel for all lunch breaks and morning breaks, when applicable (#347).

- Optimal OR case scheduling based on maximizing the expected efficiency of use of OR time matches regular practice (both 2000 and 2024), but organizations often make the case scheduling decisions with poorly calculated OR allocations (#61). By far the most important process for case scheduling to increase OR efficiency is the process of service-specific staffing (#61), described above. More accurate, unbiased predictions of OR times (e.g., using machine learning) will not increase labor productivity with the same staff scheduling unless the allocated OR times are adjusted simultaneously (#354). Under multiple conditions, more accurate predictions will, in fact, reduce anesthesia labor productivity if allocated times are not being adjusted based on minimizing the inefficiency of use of OR time, because increased accuracy of case duration prediction is achieved by increasing the variability in scheduled durations (#354). That is why there is lack of validity of absolute percentage errors in estimated operating room case durations as a measure of operating room performance (#384). Provided the service-specific staffing maximizes the

expected efficiency of use of OR time, then, as long as: 1) a case is not scheduled into overutilized time when less overutilized time can be achieved in another OR and 2) cases are considered in descending sequence of scheduled durations, the differences in overutilized time and productivity among different case scheduling policies are small (#218). We applied these principles to the scheduling of urgent surgical cases (#25) and to cases with regional nerve blocks (#100). Counter-intuitively, the efficiency of use of OR time is not increased by coordination of OR case scheduling with surgical clinic scheduling (#42). Case scheduling can still increase OR productivity substantively (by >10%), by meeting patients' preferences that when one surgeon in a practice can do surgery sooner, the patient is provided the option to switch surgeons (#257). Regarding decision-making on the day of surgery or a few days before surgery, we surveyed OR physician directors to learn how much overutilized time should be reduced to warrant moving a case from one OR to another (#73). We measured the frequency of constraints for add-on case scheduling and showed that operations research studies should control for surgeon availability (#220). Rarely were equipment or specialty-specific anesthesiologists a constraint (#220). We determined conceptually and practically how (#69) and when (#78) to release allocated OR time to maximize the efficiency of use of OR time. Services that routinely fill their allocated OR time while still having more cases to schedule generally should not have more OR time allocated because such are the services with have high cancellation rates within a few days of surgery (#173). Analysts can determine each organization's deviation from optimal decision-making by using OR information system data to populate scenarios for review over 1-2 hours, instead of the much more expensive on-site observation (#152).

- A progressive set of studies over 30 years has improved understanding of the impact of changes in anesthesia times, turnover times, and surgical times on costs and productivity. Reductions in anesthesia-controlled times even to implausibly brief durations are too small to reliably perform another case daily other than for the shortest of surgical procedures because mean anesthesia times are smaller than the standard deviations of surgical times (#4). Impractically large reductions in anesthesia times are needed even to reliably perform a brief add-on case that otherwise would wait until the next day, because mean anesthesia-controlled times are smaller than the mean absolute predictive errors in case durations (#22). We later developed a technique to quantify the incremental savings in labor cost from small reductions in turnover time, while treating OR staff rationally as a stepped cost (#76). We extended the technique to the valuation of small reductions in surgical time (#77). I showed usefulness of these tools for choosing when to employ lean methods in surgical suites (#101). A key conclusion was most hospitals and ambulatory surgery centers nationwide in the USA cannot benefit from reductions in anesthesia times, turnover times, or small reductions in surgical time, because their ORs have fewer than 8-hours of cases daily (#213). Workdays nationwide are especially brief at facilities performing pediatric ambulatory surgery (#283), such that the labor cost is fixed and there already is the capacity for growth regardless of the anesthesia times, turnover times, or surgical times. This same approach of counting OR-days with fewer versus more than 8-hours is valid also for valuing on-time first case of the day starts (#128). Based on study of the associations between the tardiness of first case starts and overutilized time, the appropriate threshold is indeed an 8-hour OR day (#288). We developed and showed usefulness of a statistical method to estimate the time of the day with the most prolonged turnovers (#91). We then applied the statistical method to learn what surgeons mean when they discuss turnover times (#151). Although it was commonly said that surgeons' perceptions of turnover times referred to periods from skin closure of the preceding patient to incision of the next patient, in reality surgeons' perceptions of turnover time were not related to actual times but instead to the quality of perioperative teams (#151). The time of day with the most prolonged turnovers shows when to have more personnel available to assist with turnovers (#134). This is useful when combined with the statistical method for estimating the net benefit of hiring additional anesthesia technicians or housekeepers to reduce turnover times (#134). Anesthesia information management system data can be used to measure the maximum numbers of ORs that anesthesiologists can supervise simultaneously without causing delays or being absent at critical periods of anesthetics (#165). These series of studies show that the cost of the resulting anesthesia delays differs markedly among ORs and facilities; the costs are zero at most

organizations, but are substantial at others, depending on the duration of the workday. These studies show too that, because activities to reduce non-operative times are much more common than urgent patient-care events, artificial intelligence and monitoring technologies based on increasing the safety of intraoperative care have little to no potential to influence anesthesia or OR productivity (#392).

- In 1999, my colleagues and I showed how to calculate statistically reliable OR block time for most surgeons, the value of which is that block time predicts when surgeons will have surgical cases. We first surveyed patients and parents of pediatric patients to learn targets for weeks of waiting for surgery (#26). Then, we showed that although one can calculate the most OR block time that a surgeon would always fill and reliably overrun (#26), appropriate block time cannot be estimated accurately based on adjusted or raw utilization (#72). A limitation of that work was that these studies were based on parameter values from one hospital, the University of Iowa. Two decades later, we have what would have seemed unimaginable, data from all 121 non-VA hospitals in Iowa (#249). The assumptions held statewide among the hospitals (#249). Subsequently, we obtained a comparable data use agreement with the State of Florida and found the same result (#330): more than half of surgeons statewide (64%) perform only 1 or 2 cases on days with at least 1 case, whether an urban or rural area. Pediatric hospitals are the same too (#339). Consequently, confirmed across hundreds of hospitals of different types, block time forecasting based on individual surgeon's adjusted or raw utilization is comparable to making decisions based on a random number generator (#330). These mathematical principles should be applied when comparing block time between female and male surgeons at large facilities to assure there has not been bias applied by gender (#345). Unadjusted differences between female and male surgeons in blocks per week were large but accounted for fully by the large differences statewide between female and male surgeons in quarterly caseloads (#364). Analyses of correlations among surgeons' workloads are so low that planning (appropriately calculated) block time for each surgeon independently is suitable (#168). Studying a 12-hospital health system, we learned also that there is no benefit to calculating surgeons' block time simultaneously, versus separately, among the hospitals (#170). However, a surgeon's OR block time is not used in isolation from the remaining allocated OR time of his or her service (#36). We developed the mathematics for coordination of the OR block time and the allocated OR time calculated based on maximizing the efficiency of use of OR time (#36). We combined these methods with financial analyses in a comprehensive review showing too that budgetary decisions by surgeon should be based on this mathematics, not adjusted or raw utilizations (#115).

- The operational objective for the time of patient arrivals on the day of surgery is to balance the costs of dissatisfied patients and families, waiting for hours, versus the OR and surgical team waiting for the patient (#39). Conceptually, lower prediction bounds can be used for the durations of the preceding case(s) in the OR, and these bounds have accurate coverage (#39). However, a nonparametric alternative based on the combination of service and day of the week incorporates the probabilities of preceding cases getting cancelled and/or cases getting moved among ORs (#111). Implementation is straightforward because no protected health information is used (#138); click here. Choosing optimal patient arrival times is the principal operations research decision for ambulatory pediatric surgery (#138). For a regional anesthesia team working with nursing to determine how early first-case of the day start patients arrive, sample size requirements are so large that using published values based on our Monte-Carlo simulations is appropriate (#328).

- Experienced clinicians do not make OR management decisions on the day of surgery that increase OR efficiency; without recommendations, their decisions for moving cases and scheduling add-on cases are worse than random chance (#112). We were both the first to recognize that this was so and to study why. Most clinicians make OR management decisions appropriate for a surgical resident, anesthesia resident, or OR nurse working in a single OR (#113). They then sub-optimally apply this heuristic to decisions involving multiple ORs (#113). The hospital where this was identified had many ORs with long workdays and over-utilized OR time. This same cognitive bias was being applied at a different hospital that had essentially no overutilized time (e.g., decisions affecting first case starts and the moving of cases had no effect

on the hours worked by OR nursing or anesthesia providers) (#179). We developed appropriate control chart daily monitoring to provide departmental feedback to mitigate this cognitive bias (#145). I have managed the notifications daily for 14 years. A different cognitive bias explained why patients often are given fasting and arrival times that are vastly too early (#114), and why organizations place such great emphasis on timely first case starts (#127). However, the false belief that starting 5-minutes late necessarily means finishing the workday 5-minutes late, or longer, also is caused by lack of knowledge of the science of maximizing the efficiency of use of OR time (#127). Sadly, inaccurately estimated allocated OR times (i.e., the hours into which cases are scheduled is too small for the workload causing overutilized time and anesthesiologists working late) are due to one or more additional cognitive biases, extensively studied by others and that we reviewed systematically (#144). For example, when I provide in classes the mean and standard deviation of the workload of an orthopedics service, most participants choose allocated times that are too close to the mean, neglecting the standard deviation, causing excess overutilized time and unnecessary hours of OR teams working late (#144). A consequence of decision-making being made based on heuristics, and often a lack of scientific knowledge, is that small teams (e.g., OR committee) without all members having training in OR management science make poor quality decisions reliably >5:1 versus teams with knowledgeable members (#188). In addition, for analysts to be most successful at communicating OR management science, they best use e-mail (i.e., written asynchronous communication) with individual group members (#208).

- A knowledgeable OR management team only comes from training and ongoing feedback critiquing decisions. To meet this need, I have taught my 35 hour analytics course 71 times; click here for the cases and lectures. The curriculum is the minimum material necessary for anesthesiology residents to participate meaningfully in systems-based practice projects, such as OR management (#149). Bibliometric study over 28 years from 1996 through 2023 showed progressively more authors per year publishing research in operating room management, but with the unchanging characteristic that nearly all were by authors with few or no earlier publications in the field (#375). A consequence has been an increase over time in the need for the educational program in the science of operating room management (#375). Course participants review statistics beforehand (#148). They do that work ahead because individual learning with computer assistance has comparable efficacy to other teaching methods (#148). Likewise, course vocabulary is learned beforehand, because participants need this knowledge to find relevant articles for problem solving (#192). Practitioners' trust in the findings and in the use of analytics does not come from the many examples of hospitals use of the OR management in the course, but rather from the equations in appendices (#223). Therefore, before the class time, course participants read review articles, selected to include such formulas. After the first 12 hours of the course, discussion content focuses on skills to critically evaluate limitations of the methods taught. Therefore, we hypothesized and confirmed that trust in the analytical content is achieved by the 12-hour point of the course (#246). Because the statistics learned ahead for the course meets the requirements for anesthesia residents' BASIC examination, we expected and showed too that resident physicians obtain value from an abbreviated 1-day version of the course (#280). Most of the full 35-hour course, as well as the 1-day version, is spent with teams solving OR management analytic problems (i.e., word problems). The skills obtained in the course successfully match those of participants' jobs afterwards (#294). We learned from the course that having leaders value analytics is insufficient for successful team decision-making (#294). Instead, all team members need to know the OR management science (#294). Physicians (e.g., anesthesiologists and surgeons) who have taken the course generally have jobs that can use the content many years later (#301).

- The non-random assignment of surgical cases to ORs and the variability in case durations have important consequences for studying and preventing surgical site infections and pathogen transmission. Using National Healthcare Safety Network data from 338 non-federal hospitals in California, we showed the futility of cluster designs for clinical trials of OR capital equipment mitigation of perioperative infections (#293). Infection control specialists sometimes produce control charts for infections for each OR and by doing so examine which ORs have greater incidences of infection (#297). Such conclusions are unreliable statistically; instead, patient-

matched cohort designs should be used (#297). The counts of surgical site infections per year are so unequal among ORs that the Gini index is at least as large as that for the inequality of household disposable income in the USA (#325). The same applied among all anesthetizing locations (e.g., including cardiac catheterization and interventional radiology) (#367). The implication is that net cost savings from interventions to reduce surgical site infection depends on preferentially targeting interventions to reduce contamination to those few ORs with the most infections (#325); the fact that not done commonly highlights the importance of the results. Such targeting especially influences appropriate trials to be done by each hospital when choosing how many ultraviolet disinfection units it needs for terminal cleaning of the ORs (#337). Surveillance of pathogen transmission in ORs to provide feedback on applications of methods to reduce infection (e.g., hand hygiene) can be done with fewer samples (i.e., lower cost and faster) by systematically selecting pairs of cases matched by surgical specialty and based on estimated case duration (#299). We performed time series analysis of progressive changes in *Staphylococcus aureus* transmission at a surgical suite (#307). We then applied the statistical model to develop a sequential testing protocol for interventions to improve intraoperative infection control (#307); click here. We modeled the total intraoperative time for sampling (swabs) to measure transmission (#313). Sampling can be done by anesthesia technicians or OR nurses already present during cases (#313). Because approximately two-thirds of all hospital patients who receive an intravenous antibiotic also undergo an anesthetic, greater use of these infection control measures in the anesthesia operating room workspace has the potential to substantively reduce overall rates of all hospital infections (#360). We used simultaneous statistical equation modeling with several clinical trials' pooled data to learn that this sampling combined with a multifaceted bundle prevents surgical site infection better than single interventions (risk ratio 0.32) (#359). We then used temporal and spatial origination and destination information for different ESKAPE pathogens to show that all five categories of infection control approaches need to be applied to prevent intraoperative transmission (#377). We modeled the costs of infection control supplies using American Society of Anesthesiologists' Relative Value Guide units, containing both time and complexity of the surgical procedure (#353). We showed that surface disinfection wipes alone can be sufficient to achieve low bacterial contamination of anesthesia machines (#374). That is important because ≥100 colony forming units were detected on 44% of >5000 sampled machines, differed negligibly between start of the workday after terminal cleaning versus end of the workday, and had relative risk 6.9 (99% confidence interval 5.2 to 9.1) of ESKAPE pathogens (#379). We applied these principles to OR management in ambulatory surgery centers during the acute COVID-19 pandemic among patients testing negative for SARS-CoV-2 (#305).

2. Development of science of the management of anesthesia departments

- The costs of anesthetic drugs and techniques include their effect on OR time. Initial meta-analyses for differences in anesthesia times were performed in the time scale (e.g., minutes differences from using desflurane [#2], sevoflurane [#85], or regional anesthesia [#17]). Reanalysis of survey data explained predictors for surgeons discouraging use of regional anesthesia even reducing OR time (#118). The probability distributions of times from end of surgery to tracheal extubation are right skewed (e.g., Weibull) (#137). From that important statistical result, we showed how to quantify differences in the variability of extubation time among drugs (#137). Student's t-test and classic analysis of variance should not be used to make comparisons of time when groups include propofol; instead, generalized pivotal methods can be used (#160). Such computational methods can be used to calculate point estimates and confidence intervals for ratios of the standard deviations of extubation times, or exceedance probabilities themselves, meaning the incidences of prolonged (≥ 15 minute) time to tracheal extubation (#365). These statistical methods were applied to meta-analysis of isoflurane versus desflurane (#143 and #373). There was a 95% reduction in prolonged extubations with the use of desflurane at one hospital (#143), and 78% among many hospitals (#373). Our observer study showed validity and reliability of using prolonged time to extubation as an endpoint of workflow, quantifying the effect of variability on clinical production (#166). Because other activities in the OR have ceased by 15 minutes after surgical end, prolonged times to extubation are bottlenecks to throughput (#166). Prolonged times

to extubation cause greater mean times from end of surgery to OR exit in multiple patient cohorts (#191). Prolonged times to extubation are associated with cases in ORs having longer workdays (i.e., the extra OR time can validly be treated as a variable cost in economic studies) (#190). Collectively, the incidence of prolonged extubations is a good endpoint for anesthesia pharmacology studies quantifying the rate of patient recovery from general anesthesia (#372). The incidences of prolonged times to tracheal extubation generally are not caused by heterogeneity among anesthesia providers and anesthesiologists within organizations (#217). They are, in part, a collective consequence of several decisions for environmental benefit, specifically using sevoflurane instead of desflurane, air instead of nitrous oxide, and low fresh gas flows, while being faced with large variability in closure time (#389). Prolonged times to extubation were observed only among anesthesia providers who had worked with a neurosurgeon <5 times ever (#292). Among multiple surgeons and procedures, there was 16% greater odds of prolonged extubation when the anesthesia provider had worked with the surgeon <5 times over the past 36 months, and even greater when the provider was a trainee (#368). A Japanese hospital achieved a >6-fold lesser incidence of prolonged times to tracheal extubation than the University of Iowa (#333). Japanese hospitals also have comparably faster times of patient discharges to surgical wards (#268).

- Drug costs can be compared reliably among anesthesia providers while adjusting for cases' acuity and duration using American Society of Anesthesiologists' Relative Value Guide units (#14). Total excess fresh gas flows are accounted for by the cumulative effect of many anesthesia providers' running greater than 2 liters per minute rather than just a few providers who use very large flows (#157). Departmental programs to achieve lower fresh gas flows are successful when they include frequent and long-term individualized feedback to individuals (#221), not brief periods of feedback on departmental performance (#387). Anesthesia provider behavior to reduce costs is reliably influenced by e-mail reports sent after cases are completed (#209). The environmental cost (impact) of desflurane and sevoflurane can be mitigated markedly by anesthetic gas capture in operating rooms and procedure rooms with anesthesia machines (#371).

- The principal way to reduce anesthesia drug costs and anesthesia-controlled times is to use monitored anesthesia care, whenever clinically appropriate. Approximately 29% of all anesthetics nationwide are monitored anesthesia care (#156). Cost utility analyses show value of monitored anesthesia care to reduce anesthesia costs (#6). However, drugs used during monitored anesthesia care for the same procedures vary substantially among anesthesia providers, variability not explained by patient comorbidities (#11). We developed the Iowa Satisfaction with Anesthesia Scale for monitored anesthesia care (#13). Using multicenter data, we showed how to pool the satisfaction scale's results among centers (#159). We developed suitable clinical trial designs and necessary sample sizes for multicenter clinical trials (#159). We learned when the scale can be administered, either by telephone (#159) or upon patient discharge from the phase II post-anesthesia care unit (#308). I assisted with the development of the French version of the scale (#487).

- My studies of anesthesia preoperative evaluation have focused on the management of the clinics and the associated preoperative processes. These processes are valuable because when preanesthesia evaluation is not completed before the day of surgery, the consequences include longer turnover times and increased tardy first-case of the day starts on the day of surgery (#245). Simulations of preoperative clinics showed that, compared to an unscheduled "drop in" approach, scheduling patients reduces their overall mean waiting time (#28). This applies even if patients routinely arrive earlier or later than their originally scheduled time, because scheduling evens out the numbers of patients per hour throughout the workday (#28). Nurse practitioners' keystroke logs showed that some practitioners work more quickly in clinic than others (#177). Nevertheless, the overall mean patient waiting time was less when each available practitioner next saw the clinic patient who had waited the longest (#177). Another way to reduce patients' clinic waiting is to estimate appointment durations more accurately. Appointment times can be estimated better from the count of drugs in the patient's electronic health record medication list than from multiple other suitable variables (#164). Clinics' success at ordering only appropriate preoperative tests can be

monitored reliably and validly by monitoring the percentage of patients meeting that criterion (#150). Clinic performance also can be quantified by OR cancellation rates (#93). Computer simulation studies showed that chi-square and Fisher exact tests are highly inaccurate, and instead control-chart methods for proportions should be used (#93). There is lack of value in mitigating the impact of cancellations on the ORs by, daily, sequencing surgeons' lists of cases based on the cases' probabilities of cancellation (#147). There also need not be concern about case cancellations causing greater variability in OR workload or overutilized OR time on the days when the cases eventually are performed (#187). Rather, the importance of case cancellations is the effect on OR time; thus, we expanded the statistical methods for cancellations to be based on estimated case durations (#186). OR case cancellations' impacts based on time differed from those estimated per case when compared among services (#186). Further applying these tools, there were no differences in cancellation rates among the 21 surgical facilities of a national health system between their facilities having nearly all elective surgery patients seen in preoperative clinics versus facilities that instead used nurse call centers (#195). Studying why counter-intuitive, we learned that the majority of the total cancelled OR time at hospitals is due to patients who are inpatient preoperatively (#195). Seeing the inpatients preoperatively several hours sooner does not reduce those cancellations because the cause of cancellations often are changes in patients' conditions (#203). That is just like for the patients who are outpatient preoperatively (#265). However, among patients who are inpatient preoperatively, preventing cancellations does not appear valuable from societal or hospital perspective in that often they do not undergo the originally planned procedure (#203). That is different than for surgical patients who are outpatient preoperatively (#187). Those patients usually do eventually undergo their scheduled surgical procedure, even when their case is cancelled once (#187).

- My colleagues and I developed algorithms for optimizing anesthesiologist and nurse anesthetist staffing for afternoons, weekends, and holidays, and have maintained and progressively updated for 24 years; click here. The mathematics for permanent handoffs of cases from one anesthesiologist or nurse anesthetist to another has excellent performance based on there being negligible incremental value of perfect knowledge of case durations (#29). Knowing when to offer brief breaks or make handovers of anesthesia practitioners depends on judging when anesthesia documentation will be complete, and we showed that can be estimated for displays from the minutes after surgical incision (#171). We figured out how to estimate appropriate numbers of regularly scheduled anesthetists working long shifts in afternoons while incorporating seasonal variation in afternoon workload (#44). The method works well both with OR information system data and anesthesia billing data (#70). The method is important because hospitals with growth both have more first case starts and more cases running in the late afternoon, proportionately (i.e., groups hiring to cover more rooms at the start of the day have greater need for algorithmic choice of afternoon staffing) (#332). To reduce permanent handovers, except for single cases >8 hours, we showed that the best method is that, the day before, the anesthesia practitioners who are on call the next day are assigned for their call day to the briefest ORs (#276). Then, on the day of surgery, once they have finished their own cases, then they take over other ORs when new cases start (#276). We estimated upper prediction bounds of the work hours of the anesthesiologists on call (#135). Despite substantial growth in caseload, an anesthesia department following this mathematics and aiming for a 20% incidence of anesthesiologists having to work late when not on call achieved this objective, long-term over 6.5-years, within a few percent (e.g., 2%) (#319). From comparing such results to surveyed personal perceptions, we also showed value of providing this information to clinicians (#135). We developed mathematics for accurate anesthetist weekend staffing (#41). Such methods are principally important for staffing of add-on cases, because, nationally, there are negligible percentages of elective cases that are performed on weekends (#229). Appropriate weekend staffing is especially important for on-call coverage of anesthesia for diagnostic imaging, because the procedure name does not functionally reveal urgency, unlike for surgical procedures (#212). We added to the mathematics for weekend staffing to include coverage from home, based on minimizing expected total labor costs (#55). We calculated these optimal weekend staffing plans for 6 hospitals of a US health network and found that their hospitals' risks of inadequate coverage exceeded the criterion that the managers reported was the

maximum acceptable (#68). From study of all 121 non-VA hospitals in Iowa, individual hospitals' caseloads on weekends and holidays increased proportionately to their increases over years in caseloads during regular workdays (#264). Weekend call coverage not only involves counts of anesthesiologists and nurse anesthetists, but also their clinical specialization (#230). Nationwide, there is as much diversity of procedures performed during weekends versus weekdays during regular work hours, such that anesthesia groups that use specialty teams during regular workdays should schedule such teams on weekends (#230). A corollary hypothesis would then be that there would be disproportionately more calls to the malignant hyperthermia hotline on weekends than expected nationally from the distribution of cases among weekdays, and when examined that was so (#206). We tested different methods to estimate appropriate geolocations that are sufficiently close to hospitals for specialty anesthesia coverage from home (#286). Anesthesia groups can reasonably use select options and criteria in Google maps for consideration of individual addresses (#286). For choosing holiday staffing, we developed a statistical method and showed its validity (#102). Once use, then departments can also apply the mathematical and psychological studies of staff scheduling for those holidays (#369). We also developed modeling for obstetrical anesthesia staffing (#47), including coverage of labor analgesia (#210). We showed validity to treating obstetrical anesthesia workload as being separate from other inpatient surgery in an analysis of 6 years of data from all 73 labor and delivery units in the State of Iowa (#349). Long-term capacity planning for obstetrics can reliably be based on time series with batch size of 1-year periods, but not based on week-to-week variability in cesarean delivery caseloads (#352). Although patients residing in counties without labor and delivery care disproportionately go to large tertiary (level III) hospitals bypassing closer hospitals, there are multiple factors dominating beyond geography such that annual increases in total obstetric anesthesia activity at major programs can be based solely on time series analyses of their own data (#356).

- Anesthesia support agreements are a substantial proportion of US groups' revenues. Progressive anesthesia group consolidation within US counties has not resulted in greater private insurance payments to groups (#207). In contrast, hospital support to anesthesia groups has increased progressively (e.g., in California 2002 through 2014 median payments increased >250%) (#285). We figured out how to calculate the marginal labor costs from OR time not having been allocated based on maximizing the expected efficiency of use of OR time (#71); click here. Then, we applied the methods to the study of several large teaching hospitals (#71). Then, we showed how to apply those budgetary results to anesthesia-hospital agreements (#116). The mathematics was unexpectedly complicated because there are two support formulations that are rational economically (#116). The incentives can, equivalently, be aligned using the hospital-perioperative medical director agreement (#211). Productivity of anesthesiologists working in the late afternoons will be less when collectively some are supervising trainees and others nurse anesthetists, a difference that is inflated by decision-making to relieve anesthesiologists based on equity (#340). Anesthesiologists' clinical productivity cannot validly be assessed using the overall anesthetizing sites supervised to anesthesiologist ratio (#326). Rather, it is the managerial decisions made to increase group and OR productivity that should be evaluated annually as part of these important agreements (#326). In contrast, textual analysis of award letters of OR nursing directors, and regression analyses of their national compensation data, both showed that nationwide there are lack of incentives for nursing leadership to increase OR productivity (#123). There similarly was lack of effect of payments to anesthesiologists for late afternoon work on their turnover times and on their perceptions of working later in the day (#130).

- Academic anesthesia departments seek to recruit and to achieve high clinical productivity of their anesthesiologists and nurse anesthetists. Anesthesia residents' coverage of cases has been remarkably stable over decades, with unchanged percentages starting cases during regular workdays (#303). Staff scheduling of anesthesiologists needs to include coverage of holding area and control desk because most pages to supervising anesthesiologists come from these locations (#175). Coverage of the PACU also needs to be included because most hypoxemic episodes occur after the anesthesia provider has left the patient (#198). In academic departments, anesthesiologists' total time needed for hospital and group management is comparable to total time commitments to education and/or to research (#214). When department chairs annual

performance evaluations include items related to environmental sustainability, they more often also include activities to promote sustainability (#383). A development program for junior faculty with accountability had low productivity of publications during the two years but substantive production of educational and patient care systems- based management projects (#182). However, long-term, over a decade, the program's predictive marginal effect was substantive, ≈1.7 more publications per year per faculty (#378). When medical students apply for anesthesia residency, the geographic factor markedly increasing probability of each interview resulting in a match is the student being from the same state as the program (#321). Anesthesiology residents similarly considered locations where they or their family had previously lived when choosing location options for their first anesthesiology job (#216). This information can be used to considerably reduce interviews with negligible probability of match or job (#331). Examining the influence of nurse anesthetist training programs on recruitment, community hospitals with rotations benefited in recruitment by the trainee temporarily living in that town (#169). We setup an educational tool for graduating anesthesiology residents and nurse anesthetist students to know of hospitals and ambulatory surgery centers statewide (in Iowa) with designated lactation facilities (#335). A suitable strategy for many women, especially if lacking convenient dedicated lactation space, is the use of a wearable breast pump (#382). The vast majority (88%) of anesthesiologists using a wearable pump did so in clinical settings, including operating rooms (#382). Regarding retention, among CRNAs nationwide, approximately half (53%) annually either change positions or consider leaving their primary position (#334). We measured unscheduled absences among a cohort of anesthesia practitioners and showed that the overall incidence can be estimated accurately for each practitioner with 1 year of data (#274). There was an overall day of the week effect of absences to be incorporated into staff scheduling (#317). Heterogeneity in the rates of unscheduled absences among practitioner types also should be included (#317). There is a linear association between the incidence of unscheduled absences and the community rate of COVID-19, sufficiently large to warrant inclusion when anesthesia departments do their staff scheduling (#355).

- In the USA, to maintain hospital clinical privileges, all anesthesiologists and nurse anesthetists must have a formal assessment of their clinical competency at least annually. This process is "ongoing professional practice evaluation," OPPE. Anesthesiologists' clinical performance cannot reliably be differentiated based on intraoperative physiological or process metrics (#202, #238, and #252). However, having all anesthesia residents evaluate all anesthesiologists using a balanced design, there was reliability and validity in measuring the quality of anesthesiologists' clinical supervision (#180). Evaluations of individual anesthesiologists are important because residents' global evaluations of supervision departmentally underestimate the true, daily performance of anesthesiologists (#199). Supervision scores encompass several of the clinical core competencies including professionalism (#237). The minimum level of acceptable performance was determined by surveying separate populations of anesthesia residents and nurse anesthetists being supervised daily (#181). Bernoulli CUSUM daily monitoring was established for early detection of such inadequate supervision scores (#197). Hospital subspecialty rotations with low supervision scores were associated with resident physicians reporting more episodes of patient harm and worse safety culture (#200). Textual analyses of written comments when supervision scores were low showed how anesthesiologists can improve their quality of supervision (#227). With feedback, the quality of supervision increased (#205). High quality supervision represents a quantifiable independent contribution to anesthesiologists' value beyond clinical productivity (e.g., relative value guide units) (#205). Anesthesiologists' supervision scores are not affected by the acuity of cases during the day, time together, cases together, etc. (#196). Anesthesiologists who specialize do not have higher supervision scores than anesthesiologists who are generalists (#232). The sole important covariates for supervision scores are the individual raters themselves (#196). Requests for daily evaluation should be made to raters both scheduled to work with the anesthesiologist and with joint workload verified using electronic health record data (#342). Evaluation less often does not substantively reduce numbers of evaluations to be completed by each rater, because in anesthesia departments there are so many combinations of raters and ratees (#380). Anesthesiologists' supervision scores are

estimated more precisely by using mixed effects logistic regression controlling for leniency of the rater (e.g., anesthesia residents) (#241). This approach for the evaluation of professionals in daily practice is novel statistically (#241). When applied, anesthesiologists can reliably be ranked into below average, above average, or average quality of supervision categories (#290). There is reliability and validity for a slightly modified version of the supervision scale when used in the chronic pain medicine division (#312). There also is reliability and validity when nurse anesthetists evaluate anesthesiologists' quality of supervision (#201). Finally, random effects meta-analysis of percentage incidences of maximum scores is a suitable statistical approach to analyze these daily supervision scores of individual anesthesiologists to evaluate the overall quality of clinical supervision provided to the trainees overall by the department over a year (#366).

- Work habits are a valid basis for assessing anesthesia providers' daily clinical performance (#222). There is validity in anesthesiologists daily evaluating nurse anesthetists' work habits (#248). A separate population of anesthesiologists was used to determine minimum acceptable work habits scores of nurse anesthetists (#233). Just like supervision scores are affected negligibly by covariates other than the rater, work habit evaluations' significant covariates are limited to the raters (#386). Just like anesthesiologists with higher quality of supervision have briefer surgeon- and procedure-adjusted operating room times, so do nurse anesthetists with greater work habits, and vice-versa (#390). Anesthesiologists' evaluations of nurse anesthetists' work habits should be adjusted for leniency of the raters (#235). Studying mechanism, leniency of anesthesiologists' ratings of nurse anesthetists were not associated pairwise with their leniency when evaluating didactic lectures by physicians (i.e., estimated leniency is not assessing the personality of the rater) (#318). Most loss of information originated from raters who provided all ratees with the largest possible score for all items and from raters who never provide ratings with the maximum score (#342). Therefore, feedback should be to raters who consistently rate all ratees the same (#342). Nurse anesthetists created a composite measure of supervision and work habits for evaluation of anesthesiologists when working together in collaborative practice (#277). When daily evaluation scores were unusual for each rater, explanation was requested for evaluation completion (#281). Approximately ¼ of the nurse anesthetists wanted greater anesthesiologist participation in direct patient care and ¼ wanted less (#281).

- Anesthesia department management logically includes chronic pain clinics. Thus, just like my colleagues and I applied managerial epidemiology to study the distribution of surgical cases among facilities and departments, we have done the same for interventional pain medicine. The distribution of different types of interventional pain procedures among hospitals and affiliated practices neither matches hospital size nor procedure counts (#278). Neither surrogate is an accurate basis to judge the diversity of the types of performed interventional pain procedures (#278). Practice and hospital websites also are misleading, with negligible correlation between counts of different procedures listed and numbers of different types of procedures commonly performed (#316). Thus, departments providing comprehensive interventional pain services and aiming for growth need to provide the quantitative data showing their unique care (#316). Practitioners at some hospitals consistently perform more procedures by performing multiple blocks per patient, with more blocks than shown to be efficacious (#284). Departments can use the statistical methods to show that their care matches the available evidence (#284). National survey showed that interventional pain procedures are performed by pain medicine physicians at fewer than half the US critical access hospitals that provide such care (#282). Similarly, among all interventional pain procedures performed in Florida 2010 through 2016, 46% were performed by physicians without American Board of Medical Specialties pain medicine certification (#295). In addition, most (78%) physicians performing spinal cord stimulation procedures in Florida performed fewer than 2 per month (#338). Combining hospital and state databases, we showed appropriate strategies for OR case scheduling for these low caseload proceduralists to maximize the efficiency of use of OR time while maintaining productivity of the proceduralists (#302).

- My colleagues and I have performed several studies of factors affecting growth of non-operating room anesthesia workload. Needs assessment for anesthesiology showed substantive risk that substitute technologies would negatively influence caseloads (#154) (e.g., safer sedative drugs

administered by registered nurses without anesthesiologist or nurse anesthetist involvement). Growth in pediatric sedation administered by registered nurses with anesthesiologists supervising did not reduce use of general anesthesia (#129). Growth in an anesthesiologist and nurse anesthetist supervised sedation nurse program was accomplished with their use of propofol and dexmedetomidine (#226). In the USA, anesthesiologist availability and costs limit vaginal birth after cesarean section (#139).

- Audits of type and screen and red blood cell transfusion also are integral to anesthesia departments. We developed frequentist and Bayesian mathematical methods for automated decision-making of whether to type and screen each patient (#167) and to audit each red blood cell transfusion (#259). Changes over time in the incidence of red blood cell transfusion can be used as a valid surrogate for changes in the numbers of units being transfused by a department and nationally for different categories of procedures (#236).
- Another subspecialty of anesthesiology is palliative care. Multiple interpretable machine learning methods show marked inaccuracy in predicting from clinical data which of the critical care patients alert and without delirium who are suffering severe dignity related distress. Therefore, all such patients in the intensive care unit for at least two days should be tested (e.g., with the Patient Dignity Inventory) (#361). Multiple logistic regression, classification models, and machine learning methods all have accuracy <65% of predicting which of these patients will remain in the intensive care unit, alert and without delirium (#362). Therefore, care models for the assessment and treatment of these patients generally should include a palliative care consultation team. The caseloads are approximately 20% of intensive care unit patients, each of whom would be assessed just once (#370). Because family members cannot accurately or reliably assess the extent to which these critical care patients experience symptom-related distress, treatment should not be delayed by the absence of family members (#381). Managerial epidemiological study shows that follow-up assessment of the patients who are alert and without delirium needs to be done prospectively, retrospective observational study being inaccurate and impractical (#358).

3. Strategic analyses and managerial epidemiology applied to surgical care

- When my colleagues and I started analyzing operating room financial decision-making 27 years ago, there literally was nothing known other than to take bookkeeping sums. Initially we analyzed changes over time in costs by limiting consideration to common types of surgical procedures (#15). Surgeons' contribution margins per OR hour were compared, but still while limiting consideration to common types of procedures (#18); contribution margin is payment plus indirect value minus variable costs. Measuring heterogeneity among surgeons in contribution margin per OR hour (#54), decision-making based instead on adjusted or raw utilization as a surrogate was no better than random chance. Addition of linear programming to model constraints (e.g., full intensive care units) permitted budgetary analyses for the addition of more capacity (#57). We applied the mathematics to the consolidation of surgical departments among hospitals (#58). Organizations contracting to increase covered lives can reduce contribution margin for surgery when OR utilization is high (#52). We compared different ways to measure standard errors for contribution margin per OR hour, and then showed large impact of that variability on forecasts of budgetary decisions by surgeon (e.g., purchase of capital equipment to achieve growth in one subspecialty versus another) (#66). Quadratic programming can be used to adjust for that variability while making tactical (budgetary) decisions (#74). Collectively, these foundational studies showed how validly to model OR financial returns using mean-variance analysis of the portfolio of surgeons, using simply the tools built into Microsoft Excel. We added modeling for the impact of the subsequent second stage of decisions: OR allocation and case scheduling based on maximization of the efficiency of use of OR time (#89). Then, we applied the methods to strategic financial analyses (#92). Many (15) years later, when we had data for all hospitals in Iowa and thus could compare the 82 critical access hospitals to the other 41 non-VA hospitals, we were able to evaluate the effect of the critical access hospitals being paid by CMS using cost plus percentage (#273). The critical access hospitals were not preferentially performing procedures with high implant costs (#273).

- Time series analyses over decades showed that total OR use should not be planned by specialty, but overall, and need not use local population or economy as covariates (#119). Although construction decisions can be made using the resulting basic time series forecasting, other decisions do need to be made by specialty. There is accuracy in using national or state databases to obtain the counts of elective surgical cases when the information provided in the publicly available databases are combinations of procedures and days relative to admission (#289). Data envelopment analysis can use these case counts to estimate gaps in caseloads by specialty for each hospital, one's own hospital and competitor hospitals (#79); click here. We showed validity and usefulness of these analyses for making tactical decisions (e.g., surgeon recruitment) (#81). Addition of multifactor efficiency helped users interpret the data envelopment analysis results for hospitals' relative workloads of different surgical specialties (#95). Combining the data envelopment analyses with the preceding financial analysis mathematics showed that organizations that decide not to compare surgeons financially should plan the extra budgeted OR time as first-come first-scheduled unblocked open overflow OTHER time (#106). Even though these analyses are based on counts of cases, the results are reliable for operational interpretation, because time series analyses showed that counts of surgical cases and hours of OR time are interchange endpoints at hospitals (#261). There was no previous work on how to interpret the super-efficient data envelopment analysis results statistically (e.g., outliers). We showed validity of estimating statistical precision using the jackknife method (#122).
- Studies of all hospitals within various states showed large heterogeneity among hospitals in their percentage shares of annual growth in outpatient and inpatient surgical caseloads (#262). There also was limited change in the relative proportions of surgical caseloads among hospitals (i.e., small hospitals remain small decade to decade, and large hospitals remain large) (#279). My colleagues and I developed systematic processes for quantifying physiological complexity of surgical cases and showed the method's validity for comparing hospitals and freestanding surgery centers (#50). The approach can be applied validly Province wide for ambulatory surgery (#64). We applied ecological statistical methods to quantify the distribution of pediatric surgical procedures among all hospitals in Iowa (#75). We repeated the analyses among all hospitals in the province of Ontario performing surgery in children, showing validity to differentiating among hospitals based on the diversity of procedures, physiologically complex and non-physiologically-complex (#250). We generalized these methods to all types of inpatient pediatric patients statewide, not just surgical admissions (#87). Applying these methods to the surgical care of the elderly, a large teaching hospital's unique role in its state was that many of its physiologically complex procedures were rare (#80). A decade later, we were the first to apply newer ecological statistical methods showing that what differentiates a few hospitals statewide from all others is that they perform a vastly greater diversity of surgical procedures (#215). Diversity in the types of procedures is of large operational importance (e.g., there are many surgeon preference cards and the call coverage is done by specialty) (#253). However, when we studied the 201 non-federal hospitals in Florida performing physiologically complex procedures, over 8 years there was no relationship between the diversity of performed procedures and growth in surgery (#253). The same result was obtained for the 833 non-federal hospitals in Texas (#287). Neither single specialty hospitals nor large, comprehensive hospitals grew faster than others (#287). As expected, teaching hospitals had greater diversity of physiologically complex procedures than non-teaching hospitals (#263). However, there was 10-fold heterogeneity among large teaching hospitals in their diversity of procedures (#263) (i.e., many hospitals in large metropolitan areas perform many types of procedures but most of the surgical cases are routine, common procedures). Similarity analyses compare the diversity of procedures performed between pairs of facilities and among populations of facilities (#108). These techniques permit quantitative assessment of the leakage of surgical cases from one hospital's region to another (e.g., to guide surgical specialty recruitment decisions) (#108). Our studies have shown that hospitals often incorrectly judge competitor hospitals for surgery, both falsely expecting that it is mostly multiple large teaching hospitals 1 or 2 hours away as compared with the small hospital 5 minutes away, and vice-versa (#140). Accurate quantification can be made by calculating the similarity of the distributions of procedures performed among hospitals (#140). We developed and applied a new

statistical method to quantify the influence of one hospital's surgical caseload on another hospital controlling for residence distance (#90). Studying all 121 hospitals in Iowa, we determined there was negligible effect of insurance and changes to the US national payment system on the relative distribution of cases among hospitals (#266). Rather, what determines the relative distribution of cases among hospitals is the hospitals' relative success at drawing patients to travel considerable distances (#266). For example, in Florida, when we compared growth over 9 years in ambulatory surgery between 9 pediatric hospitals, 112 general hospitals, and 408 ambulatory surgery centers, growth at the pediatric hospitals was due to older, healthy children traveling further (#315). Anesthesia departments can encourage such growth by facilitating surgeons' outreach clinics (e.g., coordinating appropriate use of surgeon-specific block time) (#136). In contrast, medical and pediatric outreach clinics were too clinically removed from surgery to affect anesthesia caseloads (#136). A surgeon with large growth in cases achieved that with just 1 or 2 patients per year per referring physician (i.e., without experience with the quality of surgical care of their referred patients) (#314). Patients will travel substantial distances for surgical care when the surgeons assure that referring physicians have prompt availability to them (#314); that depends on OR management helping the surgeons dynamically have the brief breaks to respond personally to the referring physician within a few hours. Few patients have a basis to choose facilities for surgery based on their personal experience with a given facility (#254). Using blinded patient identifiers to track all patients in Iowa having surgery, fewer than 1/3rd of patients having major surgery underwent another procedure of any type at any facility in the next 2 years (#254). Patients consider the service provided not to be the surgical procedure but the procedure × date combination (#124). We showed how statistically to measure accurately proportional changes or differences in days of patient waiting while stratifying by surgical procedure (#153).

- For 29 years my colleagues and I have been developing and applying statistical analyses of (currently called) enhanced recovery programs to reduce hospital length of stay. Procedures need to be selected deliberately, because even when they eliminate 100% (all) adverse anesthetic outcomes, large proportional reductions in total hospital length of stay can only be achieved for the highest risk procedures (#3). There also is much greater opportunity for cost savings from reducing hospital length of stay of procedures with many patients per week (#20). Thus, relating to the preceding section, large hospitals performing many cases of common physiologically complex procedures have potential to gain from enhanced recovery programs. We showed how to use publicly available data to estimate surgical departments' overall mean risk-adjusted hospital lengths of stay relative to national benchmarks (#82). This can be done not only for one's own hospital but all other hospitals in the region (#82). Studying 202 hospitals in Florida, there was, over 9 years, no change over time in the percentages of patients with discharge time before 12 noon (#291). Hospitals seeking to increase surgical throughput would better seek different strategies (#291). The appearance from US diagnosis related groups of patients being sicker was due to more frequent listing of comorbidities for billing, not that the patients were sicker (#363). Hospitals aiming to measure the impact of their enhanced recovery programs may need to obtain data from the post-acute care facilities to where their patients are admitted upon hospital discharge (#244). However, categories of procedures with reduced average lengths of stay nationally over 8 years did not have greater incidences of use of post-acute care facilities (#256). Furthermore, hospitals with briefer than average lengths of stays for common procedures neither had greater use of short-term care facilities nor greater odds of hospital readmission (#234). Thus, anesthesia departments can focus principally on achieving reductions in length of stay from their own hospital's enhanced recovery programs rather than on the informatics challenges of knowing patient flow after discharge (#234). Relating reductions in hospital length of stay to costs, there is limited potential to reduce national healthcare costs by making small reductions in hospital length of stay for many patients (#194). However, there is substantial potential societal benefit from reducing postoperative length of stay to 0 or 1 days (#247). We performed simulations showing substantial statistical power when that criterion is used as a prespecified secondary endpoint for clinical trials (#247). When the length of stay is 0 or 1 days, surgery can be performed outside of hospitals, at facilities able to care for patients for one night. Among all major therapeutic procedures performed in Florida, 72% of cases have a postoperative length of stay of 0 or 1 days

(#309). We performed a national survey of US hospitals showing that many have affiliated freestanding ambulatory surgery centers located on hospital campuses (#258), facilitating patients' overnight stay. Using time series analysis for each category of procedure, we successfully forecasted from daily OR schedules the number of cases with length of stay 0 or 1 nights, the mean absolute error < 1% over a year (#310). These methods can be used to assist decision-making at hospitals that have a high census of COVID-19 patients (#310). There is just as much information about hospital census from scheduled surgical cases by using the probability of each case staying in the hospital 0 or 1 nights versus using the full observed (empirical) probability distributions of length of stay (#322). Hospital census from the COVID-19 patients can be predicted a week ahead for surgical case scheduling by using Weibull distributions for their lengths of stay (#300).

- For 20 years, Richard Epstein and I have maintained the comprehensive, annotated bibliography of anesthesia information management systems (AIMS) so departments know desired features and applications. We created pro forma return on investment analyses for AIMS (#107). Their data provide information about the normal values for intraoperative vital signs (#21). However, there is lack of economic value in linking AIMS and the corresponding OR scheduling systems with inventory management systems to achieve just in time inventory control (#40). There is lack of value to family members in using the information from the AIMS or OR information system to populate a large board with initials or code numbers for each patient undergoing surgery (#56). We showed the importance of maintaining provider access to legacy electronic anesthesia records following replacement of one AIMS with another (#275). We studied the effect of interruptions in monitored blood pressure data on interpretations of data postoperatively (#158). What differentiated one AIMS that was used for most research studies was that the system's event logs recorded times in units of seconds or milliseconds, not 1-minute (#260). For example, with events recorded in 1-minute intervals, the sequences of administration of different drugs and associations with rapidly changing vital signs cannot be determined retrospectively. Latencies in anesthesia providers entering events (e.g., tracheal extubation) into the AIMS prevented quality managerial decisions made at the OR control desk (#126). System latencies also matter when processes are automated (#172). For example, we showed lack of value to desaturation alerts being sent automatically from the AIMS to the supervising anesthesiologist (#172). Communication latencies of wireless devices negatively impact the responsiveness of supervising anesthesiologists (#176). We quantified the timeliness of apple push notifications (#184). Controlled substance reconciliation accuracy is improved when near real-time feedback was provided from linking the AIMS with automated dispensing cabinets (#224). Residual discrepancies were caused principally by handoffs among anesthesia providers (#242). We developed an implementation of the Elixhauser comorbidity scale for use with AIMS data (#239); investigators frequently download it for risk-adjustment.

4. Statistical and biomathematical analyses for anesthesia science

- In my career, I have performed statistical analyses for 92 studies. To support this work, I have performed several studies of statistical and simulation methods. I developed a way to quantify drug-drug synergy based on total doses of drugs administered to effect (#410). I used Monte-Carlo simulation to compare statistical methods for analgesic doses among groups and found best performance with Wilcoxon-Mann-Whitney and Kruskal-Wallis tests (#405). Similarly, I used Monte-Carlo simulation to compare visual analog scale measurements among groups of women during labor; best performance was obtained from using Student t-tests and analysis of variance (#411). The cost utility of labor analgesia depends heavily on duration of use (#16). During the COVID-19 pandemic, I studied simulations of designed OR ventilation systems showing that, in ORs, SARS-CoV-2 would be of high concentration far from the patient, along walls and their return air grills (i.e., air exchange registers) (#324), confirmed in our prospective observational studies (#493 and #499) and then by others' air flow studies (#704). While generalized confidence intervals give exact confidence intervals for ratios of means and ratios of standard deviations based on the log-normal distribution, when the data themselves are Weibull distributed, as

common in anesthesia, the estimates based on the log-normal are unbiased but with conservative confidence intervals (i.e., slightly wider than necessary, with P <0.05 reliable) (#391). I have not only reviewed >8030 papers, for 122 different journals over the past 5 years, I also have performed studies to improve the quality of statistical reviews. Checklists completed by manuscript authors were contemplated to reduce statistical weaknesses in studies (#599). However, narrative review showed that they have little efficacy as compared with statistical review of each paper to be accepted (#419). Systematically evaluating the 555 statistical reviews that I performed for the Anesthesia Patient Safety Foundation section of *Anesthesia & Analgesia*, most weaknesses in the papers were not the analytics but the statistical writing (#420). Journals routinely consider how best to make data available to readers (e.g., as supplemental content). We showed substantial risks to patient privacy from posting observational data with procedure and diagnosis codes, necessary to be included for risk adjustment of even the simplest statistical models in anesthesia (#228). Fraud can be detected for some randomized trials by checking baseline, demographic characteristics that should equally divided among assigned groups (#418). Understanding the valid interpretation of P-values and their use as a measure of post hoc reliability is important and can be applied to anesthesia research (#607).

- I have used mathematical models to understand cardiac and brain physiology. I developed the first pharmacokinetic-pharmacodynamic model for an *in vivo* process, specifically vagal control of heart rate, and then applied the model to understand the role of monitoring heart rate variability intraoperatively. Following termination of vagal stimulation, the sinus node of the intact animal responds to acetylcholine as if the sinus node were one oscillator (#396). Muscarinic receptors on the postganglionic vagal nerve endings in the heart do not mediate the response to vagal nerve stimulation (#398). I combined the mathematical models of cardiac cell electrophysiology and vagal nerve acetylcholine release to explain why cardiac cycle length increased geometrically with the concentration of released acetylcholine (#399). Then, I simulated the diffusion of acetylcholine in two-dimensional inhomogeneous geometry from micrographs (#400); this was done when computers had floppy disk drives. Modeling acetylcholine kinetics within the neuroeffector junctions of the sinus node showed that the concentration of acetylcholine appears to follow first-order linear kinetics because physiological response is a boundary effect (#404). I combined these models to simulate the respiratory sinus arrhythmia (#401) and vagal-stimulation induced sinus arrhythmias (#402). Applying these results, under conditions of general anesthesia, the amplitude of the respiratory sinus arrhythmia is an inaccurate surrogate for efferent vagal activity (#403). Subsequent collaboration was with Bradley Hindman to support his studies of brain injury. We simulated extracorporeal brain cooling to estimate the time required for different parts of the brain to reach desired hypothermic temperatures (#406). We then conducted a similar analysis examining the impact of hemodilution (#408). We simulated cerebral venous blood hemoglobin oxygen saturation during hypothermic cardiopulmonary bypass and showed that is not a reliable index for cerebral metabolic rate (#409). Based on these insights, we reanalyzed original experimental data from pediatric cardiac surgery patients during profoundly hypothermic cardiopulmonary bypass (#415). Under deep hypothermia, the brain uses mostly dissolved oxygen (#415). We simulated the effect of hemoglobin concentration on brain oxygenation during focal stroke, showing an unfavorable effect with hemoglobin concentrations less than 10 g/dL (#416). We simulated the absorption of arterial air emboli absorption during cardiopulmonary bypass (#413), microscopic cerebral arterial air emboli (#417), hyperbaric oxygen therapy for cerebral air embolism (#414), and the rate of pneumocephalus absorption under normobaric conditions (#412).