Improving Operating Room Efficiency with Single-Use Disposable Instruments for Total Knee Arthroplasty

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ABSTRACT

Many strategies have been employed to improve operating room efficiency when performing total knee arthroplasty. The goals of efficiency improvements are to decrease operative time and reduce healthcare expenses while providing patients the best quality surgical care. Single-use disposable instruments are one technique to accomplish efficiency.

The authors describe their experience with a specific implant manufacturer's disposable single-use instruments for total knee arthroplasty and analyze the cost and time savings compared to traditional instrumentation.

Single-use disposable instruments are a viable option to improve OR efficiency, decrease sterile processing burden, and ensure sterile instrumentation for total knee arthroplasty. Furthermore, cost savings can be realized based on an institution's sterile processing expenses and whether the manufacturer or facility covers the cost of the single-use instruments.

INTRODUCTION

The annual volume of lower extremity arthroplasties in the United States and around the world is increasing at an exponential rate.[1] This increased volume corresponds to a rise in costs and burden on the healthcare system. Many strategies have been employed to reduce these expenses beginning with patient medical optimization, decreasing hospital and surgery center expenses, as well as targeting a decrease in complications, such as infection. Improving operating room (OR) efficiency while decreasing cost has been the focus of numerous solutions in recent years. One of the big industry shifts has been toward enabling technology, such as robotic-assisted knee arthroplasty, computer navigation, and patient-specific instrumentation and implants. While these technologies have shown some success in efficiency and improved component alignment, robotics specifically comes with a significant capital cost, large facility footprint, and difficulty for highly efficient surgeons to

become time neutral.

Single-use disposable instruments (SUDI) are an alternative to the more costly technologies and can decrease supply and instrument processing burden while offering efficient and more reliably sterile instruments. SUDI have been around for many years, but the adoption has been somewhat limited. The lag in adoption may in part be to the disconnect of which stakeholder realizes the cost savings. Cost savings with SUDI is multifactorial. First is the cost savings associated with reducing sterile processing of multiple instrument sets. While this cost varies from facility to facility, sterile processing can be between $0.59–$11.52 per instrument when considering materials, labor costs, and capital expenses.[2-4] The second area of cost savings is decreased operative time. Studies have shown an average of 20 to 30 minutes of time savings with the use of SUDI compared to traditional instruments.[5-7] Lastly, and most importantly to the patient, is the cost burden to patients of a periprosthetic joint infection (PJI). The healthcare cost per patient of a PJI can be over $65,000, and expected annual aggregate cost of PJI in the US is projected to be over $1.85 billion.[8,9] Furthermore, the impact on a patient's quality of life is immeasurable along with very high mortality rates.[10] SUDI have been shown to decrease surgical site infection.[5]

One of the major drivers toward efficiency in instrumentation is the shift in lower extremity arthroplasty to the ambulatory surgery center (ASC) setting. Total knee arthroplasty in an ASC setting has demonstrated greater safety and better patient satisfaction than TKA performed at a hospital.[11,12] ASCs also provide significant healthcare cost savings for lower extremity arthroplasty.[13] One of the limitations of an ASC, however, is they have a much smaller footprint with less storage and sterilization capabilities than large hospitals. Minimizing inventory and sterilization is of great value to the ASC.

The study institution has performed over 13,000 same-day hip and knee arthroplasties at a freestanding ASC. Over the years, the facility has streamlined metal instrumentation, but it has recent experience using a manufacturer's SUDI for total knee arthroplasty. This article will describe the authors' experience with SUDI and will review the literature associated with disposable instrumentation efficiency in knee arthroplasty.

OUR EXPERIENCE

The study institution has used the GMK® Efficiency single-use instruments (Medacta International, Castel San Pietro, Switzerland) at a free-standing ambulatory surgical center for primary total knee arthroplasty. This system is composed of a "Conventional" and "General" set along with laterality and size-specific femoral and tibial sets. Furthermore, a disposable patellar resurfacing set is available.

The authors begin every SUDI TKA case with the Conventional and General GMK® efficiency disposable tray, one tray of metal retractors, and general knee instruments (i.e., Kocher forceps, needle drivers, knife handles, etc.), and power (Fig. 1). This allows for a very rapid setup and use of a single instrument table. The GMK® Efficiency General and Conventional sets contain a single-use disposable distal femoral resection guide (Fig. 2), proximal tibial resection guide (Fig. 3), femoral sizing guide (Fig. 4), tibial sizing masks (Fig. 5), and disposable pin drivers and drills. Our workflow is to make the distal femoral resection and then size the femur. Once the femur is sized, that size and laterality of GMK® Efficiency instruments and trials can be opened. Attention is then turned to the proximal tibial resection while the femoral components are opened. The tibial resection is completed and the tibia is sized. That size tibia trial and insert trials are then opened while the femur is prepared with the previously opened 4-in-1 cutting blocks (Fig. 6). After femoral preparation is complete, the tibia is drilled and punched (Fig. 7). The disposable femoral trial component is inserted (Fig. 8) and trialing begins. Once the surgeon is happy with the balance of the knee, the femoral component lug holes are drilled, trochlear groove resection is completed, and patella is resurfaced if the surgeon chooses. All trial components are then removed, the final implants are opened, and the components are cemented in place with the final polyethylene insert.

The traditional GMK® TKA system is composed of six trays of instruments and

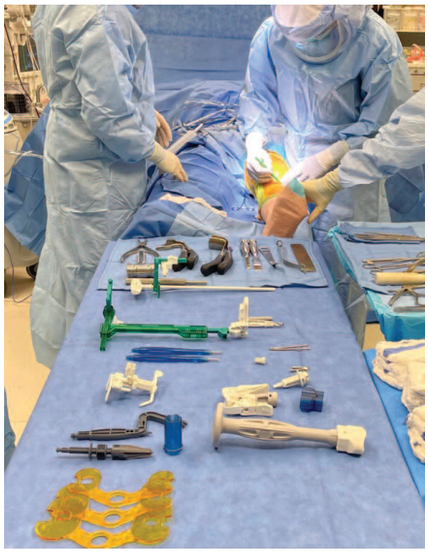

Figure 1. OR table set up with disposable General and Conventional sets along with metal retractors.

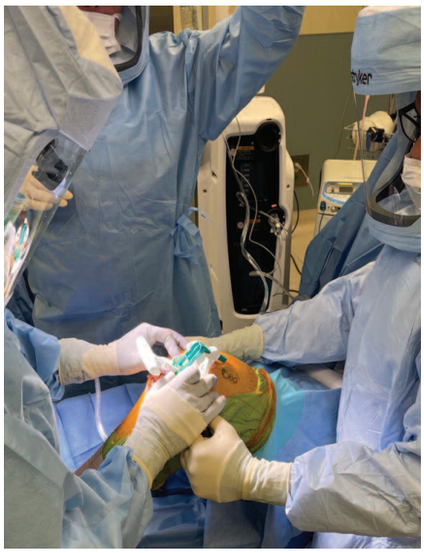

Figure 2. Intraoperative image of single-use disposable distal femoral resection guide.

Figure 3. Intraoperative image of single-use disposable proximal tibial resection guide.

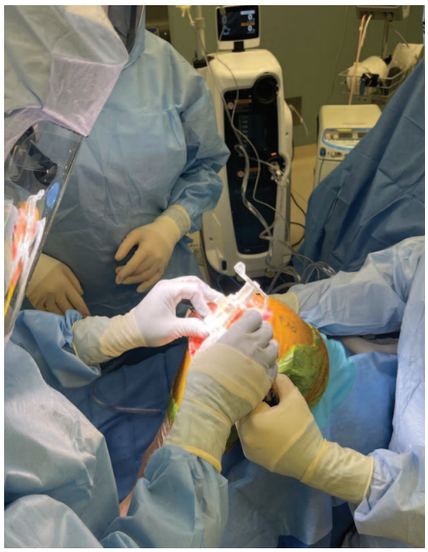

Figure 4. Intraoperative image of single-use disposable AP femoral sizing guide.

Figure 5. Intraoperative image of single-use disposable tibial sizing and alignment guide.

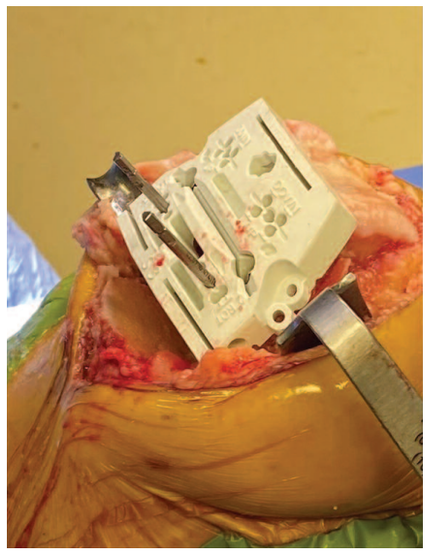

Figure 6. Intraoperative image of single-use disposable femoral 4-in-1 resection guide.

trials. Using the GMK® Efficiency system, our center has been able to limit sterile processing to one tray of metal instruments needed for every case. We have auxiliary metal instruments available such as femoral and tibial resection guides along with individually sterile processed femoral and tibial trials.

DISCUSSION

Single-use disposable instruments are a viable option for improvements in efficiency, decreased sterile processing, lowered risk of sterile contamination, and, ultimately, cost savings to the healthcare system. These benefits are especially realized at ambulatory surgical centers where storage and sterile processing is more limited than in hospitals. The percentage of joint replacements being performed at ACSs in the United States is increasing.[14]

As the number of trays sterilized and open for surgery increases, so does the potential risk for contamination. Multiple studies have suggested that reusable instrumentation could become contaminated following re-sterilization and may be associated with surgical site infection.[15-19] Siegel et al. compared primary TKA performed in 449 patients with SUDI to 169 patients performed with traditional instruments and found a significantly lower surgical site infection rate with the SUDI (0.22% vs. 2.9%, p=0.006).[5] Given the significant cost of a PJI, even minor reductions in infection rates would translate into significant healthcare cost savings.

SUDI do not have much influence on surgical time once the procedure has started, however, they do impact the overall operative time for setup and breakdown. Moreover, there is time savings in sterile processing. These time savings correspond to cost savings, and the ability to see more cases in a day and/or finish the day at an earlier time. Siegel et al. reported that with SUDI, there was an average 15-minute savings in setup time, 14-minute savings in cleanup time, and central supply time was decreased by 60 minutes compared with the use of traditional instruments.[5] In a similar instrumentation model, Moerenhout et al. found an average six-minute decrease in OR turnover time with the use of patient-specific instrumentation compared to traditional sets.[20]

Reimbursement for lower extremity arthroplasty in the United States continues to decline, while the demand is rising at an exponential rate.[1,21] Lower facility reimbursement has driven the need for rapid adoption of cost containment strategies. The facility cost savings with SUDI is highly variable depending on the facility's current sterile processing costs and negotiated costs of SUDI + implant costs. Goldberg et al. found an average cost savings per case of $994 with SUDI, with the largest cost saving being tray sterilization.[22] Siegel et al. noted that with SUDI for primary TKA, there was an initial added cost of $490 per case for

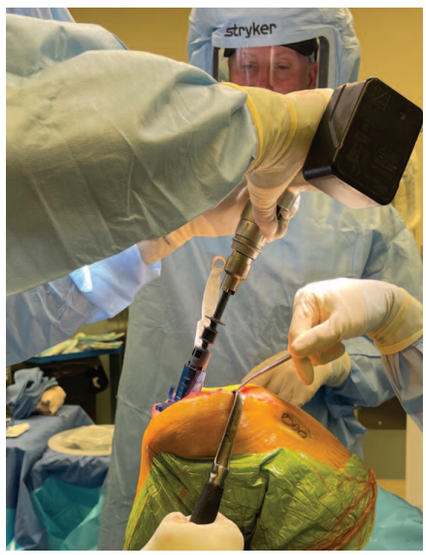

Figure 7. Intraoperative image of single-use disposable tibial preparation.

Figure 8. Intraoperative image of single-use disposable femoral trial.

the disposable instruments but a simultaneous cost savings between $480 and $600 per case taking into account the staffing and sterile processing costs.[5]

The realized cost savings with SUDI will vary based on a facility's current instrument setup, efficiency, processing costs, and negotiated pricing with the vendor. Those facilities that have already streamlined traditional instrumentation down to a few trays and have efficient turnover times may not see as significant a savings as facilities using six or more trays per TKA along with inefficient sterile processing. Ultimately, the cost of SUDI can be bundled with implant pricing in a manner that benefits both the facility and the vendor. This is similar to other "value-add" solutions that vendors offer, such as navigation, pneumatic broach impactors, or special surgeon instrumentation.

CONCLUSION

Single-use disposable instruments are a viable option to improve OR efficiency, decrease sterile processing burden, and ensure sterile instrumentation for total knee arthroplasty. Furthermore, cost savings can be realized based on an institution's sterile processing expenses and whether the manufacturer or facility covers the cost of the single-use instruments.

AUTHORS' DISCLOSURES

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REFERENCES

1. Inacio MCS, Paxton EW, Graves SE, et al. Projected increase in total knee arthroplasty in the United States; an alternative projection model. Osteoarthritis Cartilage 2017;25:1797–803.
2. Adler S, Scherrer M, Rückauer KD, et al. Comparison of economic and environmental impacts between disposable and reusable instruments used for laparoscopic cholecystectomy. Surg Endosc 2004;19:268–72.
3. Demoulin L, Kesteloot K, Penninckx F. A cost comparison of disposable vs reusable instruments in laparoscopic cholecystectomy. Surg Endosc 1996;10:520–5.
4. Prat F, Spieler J-F, Paci S, et al. Reliability, costeffectiveness, and safety of reuse of ancillary devices for ERCP. Gastrointest Endosc 2004;60:246–52.
5. Siegel GW, Patel NN, Milshteyn MA, et al. Cost analysis and surgical site infection rates in total knee arthroplasty comparing traditional vs. single-use instrumentation. J Arthroplasty 2015 Dec;30(12):2271–4.
6. DeHaan AM, Adams JR, DeHart ML, et al. Patient-specific versus conventional instrumentation for total knee arthroplasty: peri-operative and cost differences. J Arthroplasty 2014;29(11):2065–9.
7. Dell'Osso G, Celli F, Bottai V, et al. Single-use instrumentation technologies in knee arthroplasty: State of the art. Surg Technol Int 2016;28:243–6.
8. Morcos MW, Kooner P, Marsh J, et al. The economic impact of periprosthetic infection in total knee arthroplasty. Can J Surg 2021;64(2):E144–E148.
9. Premkumar A, Kolin DA, Farley KX, et al. Projected economic burden of periprosthetic joint infection of the hip and knee in the United States. J Arthroplasty 2021;36(5):1484–9.
10. Lum ZC, Natsuhara KM, Shelton TJ, et al. Mortality during total knee periprosthetic joint infection. J Arthroplasty 2018;33(12):3783–8.
11. Crawford DA, Adams JB, Berend KR, et al. Low complication rates in outpatient total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2020;28(5):1458–64.
12. Kelly MP, Calkins TE, Culvern C, et al. Inpatient versus outpatient hip and knee arthroplasty: Which has higher patient satisfaction? J Arthroplasty 2018;33(11):3402–6.
13. Huang A, Ryu JJ, Dervin G. Cost savings of outpatient versus standard inpatient total knee arthroplasty. Can J Surg 2017;60(1):57–62.
14. Kahlenberg CA, Richardson SS, Gruskay JA, et al. Trends in utilization of total and unicompartmental knee arthroplasty in the United States. J Knee Surg 2021;34(10):1138–41.
15. Dancer SJ, Stewart M, Coulombe C, et al. Surgical site infections linked to contaminated surgical instruments. J Hosp Infect 2012;81:231–8.
16. Al-Jandan BA, Ahmed MG, Al-Khalifia KS, et al. Should surgical burs be used as single-use devices to avoid cross infection? A case-control study. Med Princ Pract 2016;25:159–62.
17. Waked WR, Simpson AK, Miller CP, et al. Sterilization wrap inspections do not adequately evaluate instrument sterility. Clin Orthop Relat Res 2007;462:207–11.
18. Mont MA, Johnson AJ, Issa K, et al. Single-use instrumentation, cutting blocks, and trials decrease contamination during total knee arthroplasty: a prospective comparison of navigated and nonnavigated cases. J Knee Surg 2013;26:285–90.
19. Mobley KS, Jackson 3rd JB. A prospective analysis of clinical detection of defective wrapping by operating room staff. Am J Infect Control 2018;46:837–9.
20. Moerenhout K, Allami B, Gkagkalis G, et al. Advantages of patient-specific cutting guides with disposable instrumentation in total knee arthroplasty: A case control study . J Orthop Surg Res 2021;16(1):188.
21. Mayfield CK, Haglin JM, Levine B, et al. Medicare reimbursement for hip and knee arthroplasty from 2000 to 2019: An unsustainable trend. J Arthroplasty 2020;35(5):1174–8.
22. Goldberg TD, Maltry JA, Ahuja M, et al. Logistical and economic advantages of sterile-packed, single-use instruments for total knee arthroplasty. J Arthroplasty 2019;34(9):1876–83.

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