Surgical site infections (SSIs) are a serious complication of total hip and total knee arthroplasty. Risk factors for developing SSIs can be considered in 4 categories: (1) patient-related factors, (2) surgical technique, (3) operating room environment, and (4) postoperative care. Of these factors, the operating room environment stands out as the factor that healthcare professionals have the most control over. Frequent operating room door openings are believed to disrupt laminar airflow and positive pressure. Several studies have implicated frequent door openings in the operating room with higher rates of airborne contamination and subsequently increased rates of SSIs.

High rates of door openings during total hip and total knee arthroplasty have been previously reported in the literature. However, the difference in door openings between the preincision period and the postincision period has not been clearly defined. This factor is significant; previous studies have shown an increase in airborne contamination during the preincision period compared to the postincision period. Therefore, we sought to understand the reasons for door openings in the preincision and postincision periods to provide insight on how to best develop interventions for these 2 periods.

Results

In this study, we observed 25 preincision sessions and 26 postincision sessions. Among them, 11 were total knee arthroplasties and 15 were total hip arthroplasties. The preincision period was a median of 56 minutes (IQR, 49–63). The median duration of surgery (postincision period) was 81 minutes (IQR, 67–91). Overall, we recorded 0.56 (IQR, 0.40–0.70) door openings per minute in the preincision period and 0.34 (IQR, 0.26–0.45) door openings per minute in the postincision period. We detected a significant difference between these 2 periods ($P = .0036$). The results were uniform across all 3 sites.

The following reasons were given for door openings in the preincision period, including the median number per case: 8 (25%) nurses obtaining supplies; 7 (20%) surgical team (ie attending physicians, residents, and medical students) entering and leaving the OR to check on the progress of the surgical preparation; and 7 (19%) other (eg, medication deliveries and nursing students entering and leaving) (Table 1). The following reasons were given for door openings in the postincision period, including the median number per case: 6 (18%) nurses obtaining supplies, 6 (18%) vendor getting supplies; 8 (17%) other (eg, radiology techs entering and leaving the operating room for radiograph-dependent cases or case-related questions) (Table 1).

Furthermore, 36% of door openings with a subsequent question or discussion regarding surgical equipment were rated as severe distractions (7–9 on the 9-point distraction severity scale adopted from Healey et al.). Also, 70% of door opening distractions associated with case irrelevant talk were rated as a mild distractions.

© The Author(s), 2022. Published by Cambridge University Press on behalf of The Society for Healthcare Epidemiology of America. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted re-use, distribution and reproduction in any medium, provided the original article is properly cited.
Discussion

Our results are similar, although somewhat lower than previously reported door openings, such as Bedard et al,8 who reported a rate of 0.84 door openings per minute in the preincision period and a rate of 0.54 door openings per minute in the postincision period. Based on our findings, it is unlikely that the surgical team is significantly distracted by the high rates of door openings. However, 36% of door openings associated with a question or conversation regarding surgical equipment were rated as a severe distraction and may contribute to surgical error and increased risk of SSI.

Although the literature on the effect of door openings during the postincision period is growing, little is known about the impact of door openings during the preincision period.1,8 Given the previously reported significant increase in airborne contamination during the preincision period1 and the high rate of preincision door openings, it is reasonable to hypothesize that door openings2,5,10 may affect the sterility of the instrument tray. We found a significant difference in the reasons for door opening between the preincision and postincision periods, which signifies that their roles in the increased rates of SSI are likely distinct and that they should be investigated separately.

Nurse and vendor supplies constituted a considerable number of preincision door openings (25% and 5%, respectively) and postincision door openings (18% and 18%, respectively). A promising intervention to address these door openings would be the implementation of a checklist to ensure the presence of all necessary supplies prior to the preincision period. Further research is needed to understand the effect of door openings in the preincision and postincision period as well as to discover an effective and sustainable door-opening intervention.

Table 1. Reasons for Preincision and Postincision Door Openings

| Variable         | Total Staff Break | Nurse Supplies | Vendor Supplies | Surgical Team | Hallway Door | Other |
|------------------|-------------------|----------------|-----------------|---------------|--------------|-------|
| Preincision      |                   |                |                 |               |              |       |
| Median no. per case | 0                | 8              | 2               | 7             | 3            | 7     |
| % of total door openings | 0                | 25.40          | 5.43            | 20.53         | 11.98        | 19.74 |
| Postincision     |                   |                |                 |               |              |       |
| Median no. per case | 4                | 6              | 6               | 1             | 0            | 8     |
| % of total door openings | 12.50            | 18.60          | 18.75           | 3.7           | 0            | 17.14 |

Financial support. D.N.D. received grant support from The Infectious Diseases Society of America Foundation through the Grants for Emerging Researcher/ Clinician Mentorship Program.

Conflicts of interest. All authors report no conflicts of interest relevant to this article.

References

1. Lynch RJ, Englesbe MJ, Sturm L, et al. Measurement of foot traffic in the operating room: implications for infection control. Am J Med Qual 2009;24:45–52.
2. Pokrywka M, Byers K. Traffic in the operating room: a review of factors influencing air flow and surgical wound contamination. Infect Disord Drug Targets 2013;13:156–161.
3. Perez P, Holloway J, Ehrenfeld L, et al. Door openings in the operating room are associated with increased environmental contamination. Am J Infect Control 2018;46:954–956.
4. Mears SC, Blanding R, Belkoff SM. Door opening affects operating room pressure during joint arthroplasty. Orthopedics 2015;38:e991–e994.
5. Andersson AE, Bergh I, Karlsson J, Eriksson BI, Nilsson K. Traffic flow in the operating room: an explorative and descriptive study on air quality during orthopedic trauma implant surgery. Am J Infect Control 2012;40:750–755.
6. Roth JA, Juchler F, Dangel M, Eckstein FS, Battegay M, Widmer AF. Frequent door openings during cardiac surgery are associated with increased risk for surgical site infection: a prospective observational study. Clin Infect Dis 2019;69:290–294.
7. DiBartola AC, Barron C, Smith S, et al. Decreasing room traffic in orthopedic surgery: a quality improvement initiative. Am J Med Qual 2019;34:561–568.
8. Bedard M, Pelletier-Roy R, Angers-Goulet M, Leblanc PA, Pelet S. Traffic in the operating room during joint replacement is a multidisciplinary problem. Can J Surg 2015;58:232–236.
9. Healey AN, Sevdalis N, Vincent CA. Measuring intraoperative interference from distraction and interruption observed in the operating theatre. Ergonomics 2006;49:589–604.
10. Birgand G, Azvedo C, Rukly S, et al. Motion-capture system to assess intraoperative staff movements and door openings: Impact on surrogates of the infectious risk in surgery. Infect Control Hosp Epidemiol 2019;40:566–573.