G48: Does the number of personnel in the operating room influence the incidence of Surgical Site Infection (SSI)/Periprosthetic Joint Infection (PJI) in major orthopaedic surgery?

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Response/Recommendation: While direct evidence does not confirm the influence of the number of personnel in the operating room (OR) on SSI/PJI in major orthopaedic surgery, indirect evidence supports minimising personnel to reduce air contamination. It is recommended that this measure be included in a bundle of strategies to minimise bacterial burden in the OR environment.

Level of Evidence: Moderate

Delegate Vote:

Rationale:

Surgical Site Infection (SSI) acquisition depends on several factors, mainly the exposure to bacteria and the host's capacity to control the unavoidable bacterial contamination of the surgical wound.[1] SSIs are typically caused by bacteria inoculated into the surgical site at the time of surgery, mostly from the patient's endogenous flora (70%-90% of cases could arise from the patient microbiome)[1,2] Less frequently, SSI pathogens may originate from exogenous sources, including surgical personnel, the OR environment (including air), and all tools, instruments, and materials used during the procedure.[3,4]

OR air may contain microbial-laden dust, lint, skin squames, or respiratory droplets.[4] According to some experimental research, such as that by Ritter et al. in 1975, it is believed that personnel present in the OR are the main source of particles in the air and that the microbial air level in OR is directly proportional to the number of people moving about the room.[5] Each person sheds millions of particles per day, and skin debris may carry bacteria; both *Staphylococcus aureus* and *Staphylococcus epidermidis* (the principal causative organisms of PJIs) are shed into the environment on skin scales.[6,7] Thus, bacterial shedding by OR staff is a potential source of intraoperative contamination.[4] As a result, several guidelines (1999 CDC, 2010 APIC) have recommended for many years to limit the number of the people and OR door openings to a minimun.[4,8] The ICM 2018 also endorsed to keep OR traffic to a minimum. However, due to a lack of strong evidence supporting these measures, other recent guidelines on the prevention of SSIs do not specifically address this issue and do not propose associated recommendations.[9-11]

We conducted a literature review including articles published in English after 1990 that met the following inclusion criteria: original research articles that examined orthopaedic surgeries in humans or simulated scenarios, and provided an explicit analysis of "the

number of personnel in the OR" as a potential independent variable of SSI (or a surrogate variable of SSI like air contamination), even if it was not the principal independent variable. Studies were excluded if they only analysed "traffic flow" or" OR door openings", without considering explicitly the number of people in the OR. While these factors are closely related, there is another specific question in the present ICM regarding the potential connection between OR door openings and SSIs.

In seven studies, the outcome was the OR air contamination, measured by the bacterial counts expressed in colony formatting units (CFU), and/or the number of particles.[12-18] The outcome was the contamination of the implant in one study[19], and the incidence of SSIs in other study.[20]

The methodology in the seven studies evaluating air contamination varied significantly, complicating the analysis and comparison of results.[12-18] Among these studies, there were four single-centre[12-14,15] and three multicentre investigations.[15,17,18] All but one study -a simulated investigation in an OR-, were performed during surgical procedures, with the number of operations averaging between 20 to 60, except for one study that included over 1,200 operations.[15] Microbiological air counts were assessed using active sampling in two studies conducted at the same hospital in Sweden,[13,14] while both passive and active sampling methods were utilized in four studies,[12,15,17,18,] (with air particles in the OR additionally measured in two of them). In the "simulated study", only air particles were analysed.[16] The samplers and ventilation systems in the ORs varied across the studies. Among the seven studies analysed, three found a positive correlation between the number of persons in the OR and the count of CFU or particles.[14,15,16] However, in two of these studies, the analysis was not adjusted for other variables,[15,16] and in one of them (the simulated study), the correlation was only observed when the laminar airflow (LAF) ventilation system was turned off.[16] The third study demonstrated the effect of the number of personnel on CFU counts in a conventional ventilation system compared to a LAF system.[14] Conversely, four studies found no correlation between the number of personnel and air contamination.[12,13,17,18] Nevertheless, two of these studies demonstrated a relationship with traffic flow and the frequency of door openings in a multivariate analysis.[12,13] The remaining two studies found no significant impact from any of these factors.[17,18] However, both studies reported a low level of air contamination in the OR, and in one of them, the number of personnel and door openings were minimal and differed slightly between operations,[18] which may have contributed to the negative findings.

Bible et al. analysed 105 consecutive cases of surgical spine that required instrumentation and evaluated implant contamination.[19] Cases were randomized to have all implant trays either remain uncovered (n=54) or covered (n=51) with sterile surgical towels on opening until implants were required for the case. While coverage of implants was found to significantly reduce the implant contamination rate, other factors such as number of scrubbed personnel were not significantly associated with implant contamination. More than 2,700 clean surgeries performed in a large single centre in USA, including 734 orthopaedic procedures, were examined in a retrospective study.[20]

In the univariate analysis, as the number of people increased, there was a steady rise in infection rate. In the multivariate analysis, the ASA score and the duration of surgery were statistically significant risk factors for SSI. All other factors including age, sex, urgency, preoperative length of stay, and the number of people in the OR were not predictive of SSI. Although the number of personnel did not reach statistical significance with logistic regression, further evaluation of the data revealed that longer surgical procedures were associated with a steady increase in the number of people in the OR.

The number of personnel and traffic during operations intuitively, and based on initial investigations, appear to influence OR air contamination and the rate of SSIs. But, while the evidence shows that the duration of surgery contributes to SSI incidence, studies on the effects of personnel and traffic exhibit contradictory results. Most research has relied on surrogate endpoints, such as CFU counts in the air, to assess SSI risk. Yet, air sampling as a scientific data collection method poses challenges. Notably, there is no international standard for air sampling during surgery, making it difficult to assess and compare results from different samplers. Additionally, a specific correlation between airborne bacteria levels and subsequent SSI has not been established.[21] While proper ventilation systems in the OR are essential for diluting and removing microorganisms shed from skin scales and prevent wound contamination, numerous parameters can influence their performance. Many other factors can affect air contamination, making it challenging to measure all of them accurately and simultaneously. Nevertheless, while airborne contamination is common, it currently seems unlikely that this results in a bacterial inoculum that overwhelms local immunity and the effect of surgical antimicrobial prophylaxis.[21]

Despite the challenges in demonstrating the potential influence of the number of personnel in the OR on SSIs, this factor is one of many that collectively enhance the discipline and behaviour of OR staff. They can contribute to creating a safer environment and ultimately help to prevent SSIs.

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