

G 42 : Is there a role for the use of personal protection systems (surgical helmets/spacesuits) in prevention of Surgical Site Infection (SSI)/ Periprosthetic Joint Infection (PJI) after major orthopedic procedures?

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Response/Recommendation:

There is no high-level evidence that personal protection systems (PPS) reduce the incidence of SSI/PJI. In contrast, inappropriate use of PPS may increase contamination of the surgical wound.

Level of Evidence: Strong

Delegate Vote:

Rationale:

Personal protection systems (PPS), comprising surgical helmet systems (SHSs) and protective attire, are widely used in total joint arthroplasty (TJA) for their potential to reduce infection by creating barriers between surgical personnel and the sterile field. Initially introduced by Sir John Charnley¹ as a fully enclosed body exhaust suit, creating airflow from within the suit to outside the operating room, it resulted in over 90% reduction in periprosthetic joint infection (PJI). The exhaust tubing was found to be impractical and cumbersome, leading to its replacement with the non-exhausted systems in recent decades. However, evidence regarding their effectiveness is mixed, with some studies suggest potential contamination risks associated with improper use of PPS¹⁻⁴. The other reason to use a PPS is to help protect the surgical team from airborne contamination from the patient.

In order to answer the above question, we searched Pubmed and Embase (Ovid) databases from 1969-2024. The delegates were informed of a current systematic review and meta-analysis (Kamath et al)⁵ which has been accepted for publication in *Clinical Orthopaedics and Related Research*, 2025. All delegates critically reviewed this and agreed that it was a comprehensive analysis of the research question and, as such, should form the basis of our recommendation. A further 7 studies were added after assessment of the database search.

In the comprehensive review by Kamath et al, surgical helmets were reported to have widespread contamination, particularly when improper donning techniques were employed. Activating the fan of the surgical helmet before complete gowning caused significant contamination, including microbial spread up to 5 feet around the surgeon (Lynch et al)⁶. Similarly, Tarabichi et al⁷ observed reusable helmets often cultured positive for pathogens, highlighting the inconsistent sterilization practices in many institutions and emphasized the need for standardized cleaning protocols to mitigate these risks. Lynch et al. again observed a marked reduction in bacterial contamination when helmet fans were run for at least three minutes before entering the operating room, suggesting an easy-to-implement contamination control measure. However, Hubble et al. (1996)⁸ found that certain types of gowns worn with surgical helmets, particularly balloon-cotton clothing, exacerbated contamination risk.

The positive pressure airflow generated by helmet fans presents a potential contamination pathway. Studies reviewed by Kamath et al. and others highlighted increased airborne particle

and microbial contamination. Fraser and Young et al⁹ (2015) demonstrated significant egress of contaminated air from the glove-gown interface and recommended sealing this region with tape. Tateiwa et al. (2024) found that while surgical helmets effectively minimized microbial spread during critical surgical steps, particle contamination increased during personnel movements. Optimizing the helmet design may mitigate these risks. For example, using a toga setup instead of a two-piece gown significantly reduced contamination near critical areas (Kamath et al., 2025). Similarly, dual-fan systems demonstrated better air exhaust control than single-fan models, directing airflow away from the sterile field (Ling et al., 2018).

Direct evidence linking surgical helmets to reduced infection rates remains limited.

Retrospective analyses of registry data have yielded mixed results. Hooper et al. (2011) observed increased revision rates due to deep infections in helmet-equipped surgeries, but more recent multivariate analyses found no significant differences when confounding factors were adjusted. Lynch et al. (2022) suggested that contamination risks could be mitigated without increasing infection rates if proper protocols were followed.

Conclusions

There is no high-level evidence that PPS reduce the incidence of SSI/PJI. Inappropriate use may increase wound contamination. If surgical helmets are used, activating the fans only after complete gowning, use of dual-fan systems or toga setups, and a standardized donning procedure, which includes sealing the gown-glove interface with adhesive tape, may further mitigate contamination risks. Improved cleaning and bioburden reduction protocols are essential for reducing bacterial reservoirs in reusable helmets. Educating surgical teams on the proper use of SHSs is imperative.

References

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