Assessing the Efficacy of Hand Hygiene & Contact Precaution Adherence Rates on Nosocomial MRSA Transmission given Staffing and Behavioral Constraints within a Surgical Intensive Care Unit

TAY Joc Cing[2], GUO Zaiyi[2], Hardiyanto WIBISONO[2], CHAN Wei Boon[2], Paul Ananth TAMBYAH[1*]

[1]National University Hospital
5 Lower Kent Ridge Road
Singapore 119074
*Email: mdcpat@nus.edu.sg

[2]ROSS Scientific Pte Ltd
Innovation Centre, Units 211-212, 16 Nanyang Drive,
Singapore 637722

Background/Aim: Hand hygiene adherence and staffing levels are known to impact nosocomial MRSA transmissions. However, most studies do not quantify the real effect of these factors on colonization given host heterogeneities, contact patterns, existing interventions or the environmental topology.

Methods: Based on a cross-sectional study of two weeks, which also employed automated movement tracking, an agent-based model was developed that matched a SICU environment and 12-patient cohort, including 1:1 staff-to-patient assignment, non-uniform adherence rates inside and outside a patient's room, and a probabilistic model of hand hygiene compliance given the number of touch events. Simulated human activities and movements were face validated while MRSA transmission dynamics was quantitatively validated by matching 25% of patients colonized at discharge among others. We then tested the effect of nurse and physician adherence rates of 20%, 40%, 60% and 80%, and alternative staffing levels through assignments of 1-staff-to-3-patients, 1-to-2 and 1-to-1. Adherence rates of staff nurses were reduced by 15% points per increase in number of assigned patients to phenomenologically model the interrelationship between adherence and workload. MANOVA analysis of the factors, together with co-location data and disease transmission route dynamics were used as support and confirmation.

Results: Co-location data validated the high contact frequency but lower contact durations patients had with nurses as compared to low contact frequencies and high contact durations with physiotherapists. A disease spread graph gave evidence of cross transmission. A 20% point increase in nurse adherence gave a 4% to 24% point decrease in colonization rate subject to staffing level, physician adherence and current nurse adherence rate while a 20% point increase in physician adherence gave a 0% to 4% point decrease for the same conditions. The impact of physician adherence is significant only when nurse adherences are high (60% - 80%). With a decrease in staffing, there is an increase in patient to patient transmission via shared staff and a decrease in 'bugs' brought from the community. If adherence rates of staff nurses dropped by greater than 15% points, this caused an increase in colonization else the effect was not significant. And if adherence rates were not reduced by increased workload, then there was decreased colonization. MANOVA analysis verified the impact of nurse adherence and confirmed the large stochasticities expected in such models.

Conclusion: We have realistically simulated the discharge colonization rate of MRSA within a 13-bedded SICU using real behavioral data. Nurse adherence was found to be the most impactful factor. Physician adherence is less impactful and is conditional on nurse adherence, while the effect of staffing levels is conditional on the level of impact it has on nurse adherence. Staffing level is not a significant factor if staff have high adherence rates.