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ENVIRONMENTAL PERSISTENCE AND POST-CLEANING RECOVERY OF METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) IN ACUTE AND LONG-TERM CARE SETTINGS

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1. INTRODUCTION

Methicillin-resistant Staphylococcus aureus (MRSA) remains one of the most persistent and costly pathogens encountered in healthcare settings worldwide. While clinical surveillance and hand-hygiene compliance have long dominated infection-control strategy, the role of inanimate environmental surfaces as a reservoir for transmission has received comparatively less rigorous investigation. The thesis under review sets out to fill part of that gap by quantifying MRSA contamination on five high-touch surfaces in patient rooms, both before and after terminal cleaning, across an acute care hospital (ACH) and a long-term care facility (LTCF) in southern Nevada. This review paper critically evaluates the study's conceptual framing, methodological rigor, statistical handling, and the strength of the conclusions drawn, and situates the work within the broader literature on environmental MRSA transmission.

2. Summary of the Study

2.1 Stated Objectives and Title Discrepancy

Before assessing the study's content, one structural inconsistency deserves comment: the thesis title page identifies the work as the "Detection of Methicillin-Resistant Staphylococcus aureus (MRSA) and Vancomycin-Resistant Enterococci (VRE) in Clinical Specimens." However, the entire body of the manuscript — background, objectives, methods, results, and discussion — addresses environmental surface contamination with MRSA alone; VRE is never mentioned again after the title page, and no clinical specimens (as opposed to environmental swabs and sponges) were analyzed. This is a significant editorial oversight

that should be corrected before the document is considered finalized, since the mismatch could mislead readers, indexers, and future citation of the work.

2.2 Rationale and Objectives

Setting the title issue aside, the underlying research problem is well justified. The introduction traces the evolution of MRSA from a purely nosocomial pathogen (HA-MRSA) to a community-circulating one (CA-MRSA), and builds a logical case that environmental shedding by colonized or infected patients allows the organism to persist on surfaces for extended periods, creating an indirect transmission pathway that is often neglected relative to hand hygiene and antimicrobial stewardship. The four stated objectives are clear and testable: (1) establish MRSA prevalence on five surfaces before and after cleaning in both facility types, (2) estimate cleaning effectiveness,

(3) compare ACH versus LTCF findings, and (4) characterize the antimicrobial susceptibility profile of recovered isolates. Two directional hypotheses are proposed, predicting higher pre-cleaning than post-cleaning prevalence at each facility.

2.3 Methodology Overview

The study collected 120 environmental samples — 100 via sterile swabs (50 from each facility) and an additional 20 via moistened sponges from the LTCF — from five recurring surfaces: floor, bed rail, television remote or call bell, bathroom doorknob, and bedside table. Samples were cultured on selective chromogenic media (CHROMagar Staph aureus and CHROMagar MRSA), with confirmation of MRSA-positive isolates by real-time PCR targeting the mecA gene, and antimicrobial susceptibility profiling performed using the VITEK 2 Compact system. A Wilcoxon signed-rank test was used to compare paired pre- and post-cleaning prevalence within each facility.

2.4 Key Findings

Of the 120 samples, 18 (15%) were MRSA-positive overall. The large majority of positives — 16 of 18 (89%) — were recovered before terminal cleaning, with only 2 (11%) recovered afterward. Prevalence differed markedly by facility: the ACH yielded 6% overall positivity (12% pre-cleaning, 0% post-cleaning), while the LTCF yielded 21% overall positivity (higher pre-cleaning rates across both swab and sponge sampling). The difference between pre- and post-cleaning prevalence reached statistical significance at the LTCF (Wilcoxon $Z = -3.317$, $p = 0.001$) but not at the ACH ($Z = -1.732$, $p = 0.083$). Among surfaces, the call bell and floor yielded the highest proportions of positive samples, while the bedside table yielded none. Antimicrobial susceptibility testing showed universal susceptibility to daptomycin, linezolid, minocycline, quinupristin/dalfopristin, rifampicin, and tigecycline, near-universal

susceptibility to vancomycin (with one resistant isolate), and widespread resistance to beta-lactams and fluoroquinolones — a profile the author uses to argue that many isolates were more consistent with community-associated than healthcare-associated MRSA strains.

Table 1 summarizes the facility-level comparison discussed above.

Parameter	Acute Care Hospital	Long-Term Care Facility
Pre-cleaning positivity	12%	~40% (swab + sponge combined)
Post-cleaning positivity	0%	~6%
Statistical significance (pre vs post)	Not significant (p = 0.083)	Significant (p = 0.001)

3. Critical Analysis

3.1 Literature Review and Background

The background and introduction chapters are comprehensive and well-referenced, drawing on more than a hundred primary sources spanning six decades of staphylococcal research. The narrative arc — from the discovery of penicillin, to the emergence of penicillinase-producing S. aureus, to the appearance of MRSA in 1961, and finally to the HA-MRSA/CA-MRSA distinction

— is pedagogically effective and provides a solid foundation for a reader unfamiliar with the organism. The section on environmental decontamination principles (critical, semi-critical, and non-critical items) is a useful framing device that connects infection-control theory directly to the study's rationale. However, the review is almost entirely descriptive rather than analytical: it recounts findings from prior environmental-contamination studies (e.g., Boyce et al., 1997; Hardy et al., 2006; Sexton et al., 2006) without systematically comparing their sampling methods, surface types, or definitions of "positivity," which would have better prepared the reader for the wide variability in prevalence estimates (10–61%) that the author later cites to contextualize the present findings.

3.2 Methodological Strengths and Weaknesses

The use of a two-tier detection strategy — chromogenic selective culture followed by mecA-specific real-time PCR confirmation — is methodologically sound and represents current best practice for distinguishing true MRSA from methicillin-susceptible or coagulase-negative staphylococci. The inclusion of appropriate reference strains (ATCC 25923, 43300, 29212, 29213) as quality-control organisms strengthens confidence in the culture and susceptibility results.

Nevertheless, several methodological limitations reduce the strength of the conclusions that can be drawn. First, the sampling area was restricted to approximately two inches by two

inches per surface, using culture swabs originally designed for nasal rather than environmental sampling — a limitation the author acknowledges but which nonetheless likely underestimates true contamination, since larger-area methods such as contact plates or sponges have been shown elsewhere to recover more organisms. Second, the switch from swabs to sponges partway through LTCF sampling, introduced because swab yields were low, complicates direct comparison between the ACH and LTCF datasets, since differences in prevalence between facilities may partly reflect differences in sampling method sensitivity rather than true differences in contamination. Third, the study does not distinguish between rooms previously occupied by colonized versus actively infected patients, despite the author's own citation of evidence that infected patients shed substantially more organisms — a confound that could materially affect the reported prevalence rates. Fourth, the total sample size (120, unevenly split 50/70 between facilities) and especially the per-surface sample sizes (as few as 5 pairs for the TV remote) are too small to support robust statistical comparison between surfaces, a limitation the author appropriately flags but which nonetheless limits the generalizability of surface-specific conclusions.

3.3 Statistical Analysis

The choice of the Wilcoxon signed-rank test is appropriate for paired, non-parametric, small-sample data of this kind. The reporting of exact Z and p values is a strength. However, the manuscript would benefit from reporting effect sizes or confidence intervals alongside the p values, and from a formal comparison (rather than descriptive comparison only) between the ACH and LTCF datasets, given that this comparison is one of the four stated objectives. The claim that the LTCF finding is "statistically significant" while the ACH finding is not should also be interpreted cautiously, since the ACH's much lower baseline positivity (12% pre-cleaning) leaves little statistical power to detect a further reduction to 0%, independent of any true difference in cleaning efficacy between the two facility types.

3.4 PCR and Susceptibility Data

The real-time PCR section transparently reports an inhibition problem with undiluted DNA extracts and the corrective use of an internal positive control, which is good scientific practice and adds credibility to the reported CT values. The finding that all post-cleaning follow-up PCR tests were negative (i.e., no detectable mecA gene) even at sites with paired culture-positive pre-cleaning samples is a reassuring internal consistency check. The susceptibility comparison between pre- and post-cleaning isolates from the same location (Table 5 in the original) — showing several discordant resistance patterns for erythromycin, clindamycin, moxifloxacin, and trimethoprim/sulfamethoxazole — is used to argue for recontamination

rather than survival of the original inoculum. This is a reasonable but ultimately circumstantial inference; as the author acknowledges, molecular strain typing (e.g., pulsed-field gel electrophoresis or spa typing) would be required to confirm whether the pre- and post-cleaning isolates are clonally related or represent independent contamination events, and its absence is a notable gap given how central this argument is to the discussion of cleaning effectiveness.

3.5 Discussion and Conclusions

The discussion chapter does a reasonable job of situating the 15% overall prevalence within the wide range reported in earlier literature and offers plausible explanations for both the facility-level differences and the surface-level differences (e.g., material composition effects on organism survival). The interpretation that many isolates resembled community-associated rather than healthcare-associated MRSA, based on susceptibility-profile similarity to a prior CA-MRSA study, is an interesting hypothesis but is explicitly presented as unconfirmed, which is appropriately cautious. The conclusion chapter is somewhat repetitive of the results and discussion sections rather than offering substantial new synthesis, and the recommendations for future work (standardizing environmental sampling protocols, strain typing, larger-area sampling, and separating colonized from infected source patients) are sensible but fairly generic; more specific, prioritized recommendations tied to this study's particular findings (for example, targeted daily disinfection of call bells and floors specifically in LTCFs) would have strengthened the practical contribution of the thesis.

4. Strengths of the Study

- Addresses an under-studied comparison between acute care and long-term care facilities, a distinction largely absent from prior environmental-MRSA literature.
- Employs a robust, two-step detection protocol (selective culture plus mecA PCR confirmation) with appropriate quality-control organisms.
- Transparent reporting of a PCR inhibition problem and its resolution, which strengthens methodological credibility.
- Explicit, testable hypotheses and appropriate non-parametric statistical testing for paired, small-sample data.
- Honest and reasonably thorough self-identification of study limitations in a dedicated section.

5. Weaknesses and Limitations

- Title-content mismatch: the title references VRE and "clinical specimens," neither of which appears in the study itself.
- Small, uneven per-surface and per-facility sample sizes limit statistical power and generalizability.
- Inconsistent sampling method (swab vs. sponge) between and within facilities confounds facility-level comparisons.
- No distinction between colonized and infected source patients, despite acknowledged relevance to shedding rates.
- No molecular strain typing to substantiate claims about recontamination versus survival, or about CA-MRSA versus HA-MRSA origin.
- Findings are geographically and temporally limited (two facilities, southern Nevada), restricting external validity.

6. Significance and Practical Implications

Despite its limitations, the thesis contributes empirical, facility-specific data to a literature that has historically focused almost exclusively on acute care hospitals. The finding that terminal cleaning substantially reduced but did not entirely eliminate MRSA contamination — particularly the identification of two post-cleaning positive sites within the same LTCF room with divergent susceptibility profiles — is a clinically meaningful observation. It reinforces the argument, already present in the literature the author cites, that terminal cleaning protocols require both correct disinfectant concentration and adequate contact time, and that environmental recontamination between cleaning and the next patient admission is a real and measurable risk, particularly in long-term care settings where infection-control resources are often more limited than in acute care hospitals. The susceptibility data, while not definitive, usefully reinforce the continued frontline reliability of vancomycin, linezolid, and daptomycin against environmental MRSA isolates in this region.

7. CONCLUSION

This thesis presents a methodologically competent, if modestly scaled, investigation into MRSA contamination of high-touch environmental surfaces in acute and long-term care facilities. Its principal empirical contributions — a measurable reduction in MRSA positivity following terminal cleaning, a statistically significant cleaning effect in the LTCF but not the ACH, and a facility-level prevalence contrast (21% versus 6%) — are of practical interest to

infection-control practice, particularly regarding the comparatively under-studied long-term care setting. The work would be strengthened by resolving the title-content discrepancy, standardizing the sampling method across facilities, incorporating molecular strain typing to substantiate claims about recontamination and strain origin, and expanding the sample size in a future study to allow for more robust surface-by-surface and facility-by-facility statistical comparison. With these revisions, the underlying dataset and analysis would represent a solid, publishable contribution to the environmental-MRSA literature.