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BRIEF REPORT

Impact of Rejection of Low-Quality Wound Swabs on Antimicrobial Prescribing: A Controlled Before–After Study

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In this controlled before–after study, wound swabs were only processed for culture, identification, and susceptibility testing if a quality metric, determined by the Q score, was met. Rejection of low-quality wound swabs resulted in a modest decrease in reflexive antibiotic initiation while reducing laboratory workload and generating few clinician requests.

Keywords. antimicrobial stewardship; bacterial swab; diagnostic stewardship; Q score; resource stewardship; wound culture.

Clinical guidelines discourage the collection of swabs of superficial wounds for bacterial culture as positive results often reflect skin contamination or colonization [1–3]. Despite this guidance, these specimens are frequently collected and may trigger unnecessary antimicrobial therapy.

Screening nonsterile specimens received by the microbiology laboratory can ensure quality criteria are met before proceeding to culture with the potential to reduce low-value antimicrobial prescribing. To evaluate the clinical relevance of processing nonsterile cultures, Bartlett proposed the Q score quality metric in 1974 based on comparison of neutrophils and squamous epithelial cells seen on Gram stain [4]. Although rejecting low-quality specimens based on the Q score is now standard practice for sputum specimens, adoption for wound swabs remains inconsistent [1, 5].

The Choosing Wisely Canada campaign has recommended that laboratories implement a Gram stain screening criterion to reject low-value wound swab specimens without proceeding to culture [2]. There is a paucity of clinical studies evaluating the impact of this change. We hypothesized that rejection of low-quality wound swab specimens would reduce reflexive antibiotic initiation in response to culture results, without unintended consequences to patient outcomes. Additionally, we hypothesized that this change would result in improved efficiency within the microbiology laboratory. We performed a controlled before–after study to evaluate the impact of rejecting low-quality wound swab specimens based on application of the Q score.

METHODS

Sunnybrook Health Sciences Centre includes a 638-bed acute care academic hospital and 530-bed veterans' long-term care home in Toronto, Canada. At baseline, bacterial swabs collected from wounds on inpatient units were processed and reported by the microbiology laboratory without quality assessment. Primary pathogens (as defined by a set list) were identified and antimicrobial sensitivities provided. On March 5, 2018, the laboratory introduced the Q score, a standardized semiquantitative assessment of Gram stain neutrophils and squamous epithelial cells in superficial swabs, while continuing to process all specimens. Following this 6-month baseline period, on September 17, 2018, the Standard Operating Procedure (SOP) was changed to include the Q score (Supplementary Data) [5]. Low-quality wound specimens were immediately resulted with a message indicating that further processing would not occur unless formally requested by the ordering clinician. Operative and biopsy specimens were excluded, as were superficial swabs collected from the burn unit, where skin architecture may be distorted. Swabs were stored at 4°C for 48 hours in case additional processing was requested, in which case the swab would be processed. Otherwise, the specimen was discarded. We reasoned that when specimens are important for patient management, higher-quality specimens are collected. Therefore, the change to no longer routinely process low-quality specimens was not broadly communicated to clinicians.

A controlled before–after study was performed that included a baseline period from March 5, 2018, to September 16, 2018, and an intervention period from September 17, 2018, to September 16, 2019. All nonduplicate wound swabs collected from adult inpatients admitted to acute care or long-term care were included. If multiple specimens were

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submitted on the same day, the one with the highest quality was included. For specimens of equal quality, the one with the highest number of different isolates reported was included. Wound swabs from the burn unit, outpatient clinics, and nonadmitted emergency department patients were excluded, as well as those not subjected to the standardized microscopy quality assessment. Throughout the study, all specimens considered low-quality based on microscopy were assigned to the intervention group; those considered high-quality served as the control group.

The primary outcome was the proportion of patients with reflexive antibiotic initiation, defined as receipt of antibiotics on the fifth day after specimen collection when none were received on the date of collection. Secondary outcomes included inpatient antibiotic-days of therapy (DOT) during hospital stay and the proportion of patients with antibiotic discontinuation, defined as an antibiotic prescribed on the date of culture collection that was discontinued by day 5. All antibiotic prescribing was extracted from an auto-populated database [6]. Repeat cultures submitted from the same site within 5 days of collection were tracked. Finally, chart abstraction was performed to assess for a composite outcome of 90-day all-cause mortality, all-cause readmission, or treatment failure, defined as need for another course of antibiotics or surgical intervention.

Logistic regression analysis was performed to compare the difference in proportion between the intervention and control groups both before and after the intervention. Before–after differences in proportion were also compared using the chi-square test. The study was approved by the institutional Research Ethics Board.

RESULTS

A total of 656 swab specimens from unique patients were received during the study period, with 66% (432/656) originating from acute care wards. Overall, 58% of swab specimens received were low quality (382/656); 140 were received during the baseline period and 242 during the intervention

Table 1. Baseline Patient Characteristics of Admitted Patients Undergoing Wound Swabs for Bacterial Culture

	Baseline		Intervention	
	Low-Quality	High-Quality	Low-Quality	High-Quality
	n = 140	n = 82	n = 242	n = 192
Demographics				
Age (IQR), y	67 (57–79.25)	69 (56.25–76)	68 (57–78)	61 (47–72)
Female sex	53 (37.9)	35 (42.7)	90 (37.2)	68 (35.4)
Diabetes	47 (33.6)	19 (23.2)	79 (32.6)	65 (33.9)
Charlson comorbidity score (IQR)	5 (3–8)	4 (3–6.75)	5 (3–8)	4 (2–7)
ED	42 (30.0)	23 (28.0)	69 (28.5)	72 (37.5)
Ward	71 (50.7)	42 (51.2)	114 (47.1)	100 (52.0)
ICU	20 (14.3)	17 (20.7)	52 (21.5)	16 (8.3)
LTC and chronic care	7 (5.0)	0 (0)	7 (2.9)	4 (2.1)
Wound types				
Surgical	30 (21.4)	41 (50.0)	65 (26.9)	60 (31.3)
Pressure	20 (14.3)	9 (11.0)	28 (11.6)	25 (13.0)
Diabetic or vascular	20 (14.3)	6 (7.3)	42 (17.4)	20 (10.4)
Trauma	10 (7.1)	9 (11.0)	15 (6.2)	13 (6.8)
Exit site (catheter, drain and tube)	31 (22.1)	4 (4.9)	34 (14.0)	15 (7.8)
Primary dermatological condition	14 (10.0)	2 (2.4)	21 (8.7)	19 (9.9)
Other	13 (9.3)	11 (13.4)	38 (15.7)	38 (18.6)
Intervention for source control	20 (14.3)	24 (29.3)	40 (16.5)	54 (28.1)
ID consultation	43 (30.7)	27 (32.9)	73 (30.2)	78 (40.6)
Microbiology				
Any named bacteria	59 (42.1)	38 (46.3)	28 (11.6)	95 (49.5)
MSSA	34 (24.3)	12 (14.6)	17 (7.0)	59 (30.7)
MRSA	8 (5.7)	0	2 (0.8)	9 (4.7)
Streptococci	7 (5.0)	4 (4.9)	6 (2.5)	12 (6.3)
Gram-negative bacilli	17 (12.1)	24 (29.3)	2 (0.8)	25 (13.0)
Commensal flora	85 (60.7)	46 (56.1)	48 (19.8)	97 (50.5)
No bacterial growth	35 (25.0)	15 (18.3)	20 (8.3)	37 (19.3)
Unavailable (not processed)	0	0	165 (68.2)	0

Unless otherwise noted, data are expressed as number (%) of patients.

Abbreviations: ED, emergency department; ICU, intensive care unit; ID, infectious diseases; IQR, interquartile range; LTC, long-term care; MRSA, methicillin-resistant *Staphylococcus aureus;* MSSA, methicillin-susceptible *Staphylococcus aureus.*

period. Sixty-eight percent (165/242) of low-quality wound swab specimens received during the intervention period were not processed. Patient characteristics are summarized in Table 1.

Antimicrobial prescribing and clinical outcomes are reported in Table 2. Patients with low-quality swabs were less likely to be receiving antibiotics for a wound infection compared with high-quality swabs in both study periods ($P < .001$). At baseline, the proportion of patients with reflexive antibiotic initiation was no different between the low-quality and high-quality wound swab groups (10% vs 7.3%; odds ratio [OR], 0.71; 95% CI, 0.26–1.93; $P = .5$). Following the intervention, new antibiotic prescriptions declined significantly among the low-quality swab group as compared with the high-quality swab group (4.5% vs 9.4%; OR, 2.17; 95% CI, 1.00–4.72; $P = .05$). Within groups, there was a significant before–after decrease of new prescriptions among low-quality wound swabs ($P = .04$) but not high-quality wound swabs ($P = .58$). Despite this difference, there was no change in discontinuation of antibiotics, average DOT per patient, or reason for antibiotic therapy.

The implementation of this intervention resulted in overall resource savings for the microbiology laboratory through decreased workload and use of reagents (Supplementary Table 1). Only 2 telephone requests were received to process low-quality inpatient specimens.

No significant increase in length of stay or the proportion of patients meeting the composite clinical outcome was seen between groups before or after intervention. Repeat wound swabs did not increase during the intervention period (4.3% vs 6.6%; $P = .34$).

DISCUSSION

In this controlled before–after study, rejection of low-quality wound swabs based on application of the Q score was an effective diagnostic stewardship intervention generally accepted by clinicians.

Few studies have evaluated the clinical impact of the Q score when applied to wound swabs. Matkoski et al. retrospectively applied the Q score to existing wound culture results and found that it could reduce the number of potential pathogens reported in culture, but they did not evaluate its clinical impact [5]. Our study found that patients with low-quality swabs were significantly less likely to be receiving antibiotics for a wound infection, which re-affirms the lower value of these specimens. The few requests for culture of these specimens suggested that clinicians agreed that these specimens would not change patient management either because a wound infection was not suspected or the patient was already receiving appropriate empiric therapy.

Positive microbiologic results are known to introduce cognitive bias toward belief that an infection requiring initiation or a change in antibiotic therapy exists, even when patients are asymptomatic or already improving on the current antibiotic therapy [2, 7, 10, 12]. While education regarding appropriate specimen collection, limiting sampling to clinically infected wounds, and the pitfalls

Table 2. Patient Outcomes Before and After Application of Q Score With Rejection of Low-Quality Wound Swabs

	Baseline		Intervention	
	Low-Quality	High-Quality	Low-Quality	High-Quality
	n = 140	n = 82	n = 242	n = 192
Reflexive antibiotic prescription	14 (10.0)	6 (7.3)	11 (4.5)	18 (9.4)
Discontinuation of antibiotic by day 5	6 (4.3)	6 (7.3)	23 (9.5)	14 (7.3)
Average DOT per patient				
B-lactams	12.20	12.33	12.45	14.77
Fluoroquinolones	1.49	2.40	1.26	1.78
Vancomycin	1.15	1.16	1.46	1.81
Clindamycin, doxycycline, and TMP-SMX	1.22	0.33	1.05	1.39
Other	1.81	2.17	1.96	1.39
Antibiotic indication				
Wound related	59 (42.1)	54 (65.9)	108 (44.6)	130 (67.7)
Other reason	44 (31.4)	14 (17.1)	69 (28.5)	28 (14.6)
No antibiotic	37 (26.4)	14 (17.1)	65 (26.9)	34 (17.7)
Balancing measures				
LOS (IQR)	12 (5–28)	9 (4–20.75)	9 (3–22)	6 (3–22)
Composite clinical outcome at 90 d	54 (38.6)	26 (31.7)	72 (29.8)	45 (23.4)
Repeat wound swab	6 (4.3)	6 (7.3)	16 (6.6)	6 (3.1)

Unless otherwise noted, data are expressed as number (%) of patients. Inpatient antibiotic days of therapy were calculated for the 50 days following wound culture collection. Antibiotic indication describes those received between swab collection and day 5.

Abbreviations: DOT, days of therapy; IQR, interquartile range; LOS, length of stay; TMP-SMX, trimethoprim-sulfamethoxazole.

of wound swab result interpretation has the potential to improve antimicrobial prescribing, laboratory-based interventions can enable more rapid and robust change in prescribing practices [7–11]. In our study, we observed a small but significant change in prescribing without dedicated education of clinicians. The lack of change in antibiotic prescribing among patients with high-quality swabs suggests that the change in prescribing practice was driven by the change in laboratory processing alone.

On the other hand, the impact of this diagnostic stewardship intervention had a relatively modest effect on antibiotic prescribing practices as compared with diagnostic stewardship interventions involving urine cultures. One difference may be that positive urine cultures carry a greater influence on clinicians' diagnosis of urinary tract infection even in the absence of symptoms, as compared with wound cultures [7–9].

Our study has several important limitations. First, it was a single-center study limited to inpatients. Second, the fidelity to the laboratory changes was not optimal, but should improve with further training in the laboratory. Third, the rates of reflexive antimicrobial prescribing in response to wound culture results were relatively low at our institution, with many patients receiving antibiotics for other clinical indications. While this context likely led to a smaller impact on antimicrobial stewardship, it re-enforces the lack of value of low-quality wound swabs in clinical management. Fourth, the high-quality wound swab group was an imperfect control due to differences in baseline patient characteristics. Nevertheless, the groups differed in reflexive prescribing only during the intervention, with a differential effect seen in the low-quality group, suggesting that the change in antimicrobial prescribing was related to the intervention. Finally, this study was not powered to detect small differences in patient outcomes; therefore, further multicenter clinical evaluations are warranted.

Rejection of low-quality wound swabs resulted in a modest decrease in reflexive antibiotic initiation while reducing laboratory workload and generating few clinician requests. This novel application of diagnostic stewardship should be considered for broader implementation and evaluation.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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Patient consent. Research Ethics Board approval was obtained, and the need for individual consent was waived.

References

1. Leber AL. *Clinical Microbiology Procedures Handbook*. 4th ed. Washington, DC: ASM Press; **2016**.
2. Leis JA, Hatchette T, Ciccotelli W, et al. Choosing wisely Canada—top five list in medical microbiology: an official position statement of the Association of Medical Microbiology and Infectious Disease (AMMI) Canada. JAMMI **2018**; 3:61–70.
3. Gardner SE, Haleem A, Jao YL, et al. Cultures of diabetic foot ulcers without clinical signs of infection do not predict outcomes. Diabetes Care **2014**; 37:2693–701.
4. Bartlett RC. *Medical Microbiology: Quality Costs and Clinical Relevance*. New York: John Wiley & Sons, Inc.; **1974**.
5. Matkoski C, Sharp SE, Kiska DL. Evaluation of the Q score and Q234 systems for cost-effective and clinically relevant interpretation of wound cultures. J Clin Microbiol **2006**; 44:1869–72.
6. Elligsen M, Walker SA, Simor A, Daneman N. Prospective audit and feedback of antimicrobial stewardship in critical care: program implementation, experience, and challenges. Can J Hosp Pharm **2012**; 65:31–6.
7. Leis JA, Rebick GW, Daneman N, et al. Reducing antimicrobial therapy for asymptomatic bacteriuria among noncatheterized inpatients: a proof-of-concept study. Clin Infect Dis **2014**; 58:980–3.
8. Lamb MJ, Baillie L, Pajak D, et al. Elimination of screening urine cultures prior to elective joint arthroplasty. Clin Infect Dis **2016**; 64:806–9.
9. Smith MA, Puckrin R, Lam PW, et al. Association of increased colony-count threshold for urinary pathogens in hospitalized patients with antimicrobial treatment. JAMA Intern Med **2019**; 179:990–2.
10. Morgan DJ, Malani P, Diekema DJ. Diagnostic stewardship-leveraging the laboratory to improve antimicrobial use. JAMA **2017**; 318:607–8.
11. Taylor MT, McCready J, Havey T, et al. Assessment of a 2-step urine culture ordering process for detecting asymptomatic bacteriuria among hospitalized patients. JAMA Netw Open **2020**; 3:e1921665.
12. Loewenstein G, Brennan T, Volpp KG. Asymmetric paternalism to improve health behaviors. JAMA **2007**; 298:2415–7.