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ORIGINAL RESEARCH

Evaluating the Follow-up of Post-discharge Positive Sterile Site Cultures and the Impact on Infection-Related Complications

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ABSTRACT

Introduction: Numerous patients have cultures pending at discharge which, if not addressed, may delay diagnosis and initiation of appropriate antimicrobials. The purpose of the study is to evaluate the appropriateness of discharge antimicrobial therapy and result documentation in patients with positive cultures finalized post-discharge.

Methods: This was a cross-sectional cohort study of patients admitted from July 1 to December 31, 2019 with positive sterile-site microbiologic cultures finalized post-discharge. Pertinent inclusion and exclusion factors were admission $\geq$ 48 h and non-sterile sites, respectively. The primary objective was to determine the frequency of discharged patients warranting antimicrobial changes based on finalized cultures. Secondary objectives included prevalence and timeliness of result documentation and rates of 30-day readmission, among intervention warranted versus not warranted. Chi-squared or Fisher's exact tests were used as appropriate. Binary multivariable logistic regression was completed for 30-day readmission stratified by infectious disease (ID) involvement due to the potential for effect modification.

Results: A total of 208 of 768 patients screened were included. Most patients were discharged from a surgical service (45.7%); deep tissue and blood were the most common culture sites (29.3%). Change in discharge antimicrobial was warranted in 36.5% of patients ($n = 76$). Result documentation was overall low (35.5%). Time to documentation was significantly shorter in patients warranting antimicrobial intervention (4 days vs. 9 days, $P = 0.039$), although rates of hospital readmission were higher in this group (32.9% vs. 22.7%, $P = 0.109$). Finally, in patients not being followed by ID, documentation of finalized results was associated with decreased odds of 30-day readmission (aOR 0.19; 95% CI 0.07–0.53).

Conclusions: A significant number of patients with cultures finalized post-discharge warranted antimicrobial intervention. Acknowledgment of finalized culture results may decrease the risk

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of 30-day hospital readmission, particularly in patients not followed by ID. Quality improvement efforts should focus on methods to improve documentation and action on pending cultures to positively impact patient outcomes.

Keywords: Hospital readmission; Infectious complications; Microbiology; Sterile-sites; Transitions of care

Key Summary Points

Why carry out this study?

Numerous patients have cultures pending at discharge that may delay diagnosis and initiation of appropriate antimicrobials if not addressed.

It is hypothesized that patients with positive cultures resulting post-discharge who do not have documentation of finalized results are likely to require antimicrobial intervention, leading to increases in hospital readmissions.

What was learned from the study?

A significant quantity (36.5%) of sterile cultures that finalize post-discharge require intervention.

Majority of patients (64.5%) within this analysis lacked documentation of acknowledgement of result finalization.

Acknowledgement and subsequent action on finalized results, particularly in patients not being followed by infectious diseases, can have an impact on hospital readmissions.

INTRODUCTION

Approximately 41% of patients in the United States have microbiology cultures pending at hospital discharge [1]. Unfortunately, many U.S. medical systems do not currently have a clear responsible party to follow-up these pending results [1–4]. This obstacle surrounding transitions of care often hinders communication of positive microbiology results, potentially leading to significant delays in diagnosis, initiation of appropriate antimicrobial therapy, and outpatient follow-up. These system failures have been theorized to lead to increases in potential patient harm, antimicrobial resistance, and hospital readmissions [1, 4, 5].

Most of the literature focusing on follow-up of positive cultures, including sterile and non-sterile sites, has been in the setting of the emergency department, with only a few recent studies describing this process in patients who were hospitalized [1, 5–7]. This study adds to current literature evaluating recently hospitalized patients with culture results finalized post-discharge and associated clinical outcomes, with a focus on sterile site cultures. Currently, there is limited guidance on how to approach pending culture data during transitions of care, and our goal is to contribute to closing this gap in knowledge [1, 6].

The aim of this study is to describe the inpatient population with microbiology cultures pending at hospital discharge, determine the prevalence, appropriateness, and timeliness of culture follow-up, and compare clinical outcomes in those with versus without a need for antimicrobial intervention. We hypothesized that patients with positive cultures resulting post-discharge who do not have acknowledgement of follow-up on finalized results are likely to receive antimicrobials that require intervention, leading to increases in hospital readmissions.

METHODS

This was a cross-sectional cohort study completed at the University of Maryland Medical Center (UMMC) in Baltimore, MD, USA, which included patients admitted between July 1 and December 31, 2019. UMMC is a large (846 beds), quaternary care, primary adult resource, and urban academic health sciences center. UMMC encompasses a wide variety of subspecialty services, including six infectious disease

consult teams. Adult patients were included if they were admitted for ≥ 48 h with positive sterile site cultures that finalized post-discharge. Patients excluded were those with positive cultures from non-sterile sites, cultures that finalized > 30 days after collection, and those who were transferred to another facility or discharged to a hospice. This study was approved by the University of Maryland Baltimore Institutional Review Board with a waiver of informed consent. All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national), as well as with the Declaration of Helsinki 1964 and its revised amendments.

Data collected included patient demographics, types of sterile cultures obtained while receiving inpatient care, final organism identification, primary medical care team, and Infectious Diseases (ID) team involvement in care. Infectious disease involvement was defined as following during the inpatient admission. Additional data collected included all inpatient and outpatient antibiotics, route of antibiotics, total antibiotic duration, length of stay, timing of culture collection and finalization, and documentation of results acknowledgement. For patients with multiple positive cultures from the same site, the information was collected once to avoid duplication of results. No patients were included with positive cultures from different sterile sites.

The primary study objective was to determine the prevalence of patients with post-discharge positive sterile-site cultures warranting antimicrobial therapy intervention, defined as requiring a change in antimicrobial therapy (escalation or de-escalation) based on finalized susceptibility results (e.g., bug/drug mismatch or exceedingly broad therapy) [8].

Secondary objectives included evaluating the prevalence and timeliness of documentation of culture acknowledgement, including intervention when warranted. Finalized results were defined as acknowledged if there was documentation within the electronic medical record (EMR) by either the addition of a progress note, culture note, or telephone call documentation. Timeliness was measured in calendar days as the difference between time of culture acknowledgement documentation and time of culture finalization. Additional secondary objectives included evaluation of 30-day hospital readmission rates in those requiring antimicrobial intervention versus those who did not. Readmission data was limited to encounters occurring within the University of Maryland Medical System viewable in the EMR, and was further defined as infection-related or non-infection-related based on admission diagnosis.

Statistical Analysis

Descriptive statistics were completed for baseline characteristics, patient demographics, and culture information, which included percentages for categorical data and median with interquartile ranges (IQR) for continuous data. Comparisons were made between patients warranting intervention versus those who did not. Categorical data was analyzed using χ^2 test and Fisher's exact test, where appropriate. Continuous non-parametric data were analyzed using Mann–Whitney U test. P values < 0.05 were considered statistically significant. To assess for potential confounding, odds ratios were estimated using multivariable logistical regression analysis with 30-day hospital re-admission as the dependent variable of interest. Variables of interest were those that met model entry criteria ($P < 0.2$) or of biological plausibility, and entered the model using backwards stepwise logistic regression. Variables remained in the model if statistically significant ($P < 0.05$) or improved model precision. Due to the potential for effect modification, ID team involvement was assessed for statistical interaction through model stratification. Statistical analysis was completed with SPSS (v.28; IBM).

RESULTS

Of 768 patients evaluated, 208 patients met inclusion criteria. Most patients were discharged from a surgical (45.7%) or medicine service (43.3%), with minimal discharge from a trauma service (11%). Approximately half of these patients (51.4%) were being followed by

Table 1 Baseline characteristics

	Overall ($n = 208$)	No intervention warranted ($n = 132$)	Intervention warranted ($n = 76$)	*P*-value
Age (years)	51 (37–63)	51 (36.3–62)	51 (38.3–64.8)	0.65
Male, *n* (%)	117 (56.2)	71 (53.8)	46 (60.5)	0.35
Discharging service, *n* (%)				
Medicine	90 (43.3)	58 (43.9)	32 (42.1)	0.8
Surgical	95 (45.7)	62 (47)	33 (43.4)	0.62
Trauma	23 (11)	12 (9.1)	11 (14.5)	0.23
Culture site, *n* (%)				
Blood	61 (29.3)	45 (34.1)	16 (21.1)	0.047
Bone/joint fluid	32 (15.4)	20 (15.2)	12 (15.8)	0.902
Cardiac	5 (2.4)	4 (3.0)	1 (1.3)	0.397
GI abscess	21 (10.1)	9 (6.8)	12 (15.8)	0.039
Dental abscess	16 (7.7)	14 (10.6)	2 (2.6)	0.038
OR/tissue/deep wound culture	61 (29.3)	33 (25.0)	28 (36.8)	0.071
Other	12 (5.8)	7 (5.3)	5 (6.6)	0.704
Organism, *n* (%)				
Gram-positive	124 (59.6)	93 (70.5)	31 (40.8)	< 0.001
Gram-negative	49 (23.5)	25 (18.9)	24 (31.6)	0.04
Fungal	22 (10.6)	11 (8.3)	11 (14.5)	0.17
Polymicrobial	12 (5.8)	3 (2.3)	9 (11.8)	0.006
Other	1 (0.5)	0 (0)	1 (1.3)	0.36
Antimicrobials prescribed, *n* (%)				
Intravenous	34 (16.3)	24 (18.2)	10 (13.2)	0.345
Oral	111 (53.4)	78 (59.1)	33 (43.4)	0.029
None	63 (30.3)	30 (22.7)	33 (43.4)	0.002
Length of stay (days)	4 (2.0–9.0)	4 (3.0–8.0)	4 (2.0–9.0)	0.95

ID while admitted. The most common culture sites were blood and tissue/deep wound cultures, each accounting for 61 (29.3%) cultures (Table 1). The majority of cultures (59.3%) were monomicrobial with Gram-positive organisms identified. The median length of stay of the group was 4 days (IQR 2.0–9.0). Additionally, most patients were discharged on oral antimicrobials (53.4%) compared to intravenous (16.3%) or none (30.3%). Documentation of acknowledgement of finalized results was completed in 74 (35.5%) patients.

Table 2 Multivariate logistical regression of 30-day hospital readmission

Covariate	Unadjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
ID team involvement				
Documentation of Result	0.52	(0.22–1.21)	–	–
Intervention Warranted	0.42	(0.18–1.01)	0.41	(0.18–1.01)
Bacteremia	1.3	(0.51–3.12)	–	–
No ID team involvement				
Documentation of Result	0.52	(0.22–1.3)	0.19	(0.07–0.53)
Intervention Warranted	0.86	(0.35–2.13)	–	–
Bacteremia	0.95	(0.35–2.58)	–	–

Patients with antimicrobial therapy warranting intervention due to finalized cultures occurred in 76 (36.5%) patients. Among patients warranting intervention, 62 (81.6%) warranted antimicrobial escalation, 13 (17.1%) had de-escalation opportunities, and 1 (1.3%) warranted both de-escalation and escalation based on the results of a polymicrobial culture. Patients not prescribed antimicrobials upon discharge were significantly more likely to warrant intervention (43.7% vs. 22.7%, respectively, $P = 0.002$). Patients with Gram-positive organisms were less likely to warrant intervention, while patients with Gram-negative or polymicrobial cultures were more likely to warrant intervention (Table 1). Inpatient ID team involvement did not have a statistically significant impact on patients warranting intervention (53.8% vs. 47.4%, $P = 0.372$). Documentation of results acknowledgement was completed more frequently in patients that warranted intervention (47.4% vs. 28.8%, $P = 0.007$), and time to documentation was notably shorter in this group as well (4 days vs. 9 days, $P = 0.04$).

Thirty-day hospital readmission was higher in patients that warranted intervention, though not statistically significant (32.9% vs. 22.7%, $P = 0.109$). When further evaluating infection-related readmissions for patients that were readmitted within 30 days, rates were similar in both groups (73.3% vs. 76%, $P = 0.821$). Statistical interaction was present between ID team intervention and the primary exposure of warranting antimicrobial intervention, therefore the results were stratified by presence of ID consult (Table 2). Variables considered for model inclusion were source of culture (blood), documentation, and warranting antimicrobial intervention. Among those without ID team involvement, results acknowledgement documentation was associated with a decreased odds of 30-day hospital readmission.

DISCUSSION

In this study, more than one-third of patients with positive sterile-site cultures finalized post-discharge required changes in antimicrobial therapy. This was a similar finding to Jones et al., who also found that a significant number of patients (21%) required antimicrobial intervention after discharge [7]. Our study expanded

upon these findings by including a larger patient population and evaluating sterile-site cultures specifically to prioritize infections where intervention is often essential. The duplication of findings indicates that a solution is needed to address this significant discrepancy in transitions of care by standardizing culture result follow-up.

This study was one of the first to thoroughly look at documentation of acknowledgement of finalized culture data after hospital discharge and its potential impacts on clinical patient outcomes. We found that there was a significant deficiency in documentation in all patients with positive final cultures after discharge, with more than 70% of all patients not having documentation of culture acknowledgement. Even with patients that ultimately warranted an antimicrobial intervention, documentation was only modestly improved, with more than 50% of patients still lacking documentation of finalized results. This lack of clinical documentation creates uncertainty as to whether the result was acted upon, and the retrospective nature of this study makes this difficult to assess. Nevertheless, this lack of documentation ultimately highlights a significant area of opportunity related to transitions of care.

Additionally, this evaluation found that 30-day hospital readmission was increased in patients with cultures warranting antimicrobial intervention. While not statistically significant, this readmission rate of more than 30% may be clinically and financially significant, and is in accordance with previous literature [9]. When further evaluating cause of readmission, more than 70% of patients were readmitted due to an infectious complication within both groups. However, when evaluating patients who were not being followed by ID, we found that documentation of result finalization was associated with a significant reduction in hospital readmission. The same distinction was not found among patients being followed by ID, likely because of the extensive outpatient ID follow-up visits dedicated to reviewing microbiology results. This validates how crucial clinical documentation and follow-up of culture results is in preventing hospital readmission, especially when there is not already a consult service in place to follow-up these pending results.

This study had several limitations, including the assumption that lack of clinical documentation within the EMR indicated finalized culture results were not seen. It is likely that results were often seen by clinicians but not documented, particularly in cases where a finalized result would not have changed management. Although this clinical assumption could have overestimated the number of patients who had an opportunity for intervention, it also highlights an area for improvement surrounding result documentation. Potentially also limiting the investigation was the single-system nature of evaluating 30-day hospital readmission rates. This left the potential for our analysis to miss patients that were readmitted to other institutions, which could falsely decrease the number of 30-day readmissions. Lastly, due to the retrospective nature of the investigation, we were limited in our ability to assess overall appropriateness of antimicrobial therapy, including evaluations of antimicrobial duration and need for therapy after intervention (e.g., surgical intervention resulting in source control).

These findings highlight the need to standardize pending culture follow-up and to identify patients requiring antimicrobial intervention sooner. Additional studies are warranted to validate these initial findings and to evaluate improvement strategies to streamline follow-up of finalized culture results post-discharge.

CONCLUSIONS

A significant number of sterile cultures that finalize post-discharge require antimicrobial intervention. Lack of documentation of result acknowledgement, particularly in patients who are not being followed by ID, can impact hospital readmission rates. Further studies are needed to evaluate quality improvement efforts focusing on improvements in documentation and follow-up of pending culture results.

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Compliance with Ethics Guidelines. This study was approved by the University of Maryland Committee on Research Involving Non-Human Subjects Institutional Review Board (Baltimore, MD). All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) as well as with the Declaration of Helsinki 1964, as revised in amendments. Informed consent was waived.

Data Availability. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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