# Quality Improvement Opportunities for Post-Discharge Urine Culture Follow-Up in a Tertiary Care Emergency Department: A Pilot Study

**Akshay Rajaram[1,2], Glenda Clapham, Marie-Joe Nemnom, Venkatesh Thiruganasambandamoorthy[3,4]**

[1]Department of Emergency Medicine, Queen's University, Kingston, ON, Canada
[2]Department of Family Medicine, Queen's University, Kingston, ON, Canada
[3]Department of Emergency Medicine, University of Ottawa, Ottawa, ON, Canada
[4]The Ottawa Hospital Research Institute, Ottawa, ON, Canada

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## ABSTRACT

**Objectives:** The development and evaluation of institutional quality assurance processes are important to address the follow up of abnormal test results ordered in the emergency department (ED). We conducted a health records review at an academic tertiary care ED to understand the process and times taken to follow up post-discharge urine culture results transferred to physicians for review.

**Methods:** All patients (age ≥18 years) who were seen and discharged between July 1, 2020 and June 30, 2021 and had a urine culture flagged for review were eligible for inclusion. We randomly selected 100 patients, abstracted follow-up times, and reported descriptive statistics.

**Results:** Sixty-five patients were initially identified as requiring further follow-up for their culture results. Nearly 80% of these patients required new, additional, or revised antimicrobial therapy. Overall, the mean time from ED discharge to follow-up completion was 3.4 days (SD 2.1 days). The longest contributor was the time for transfer of results from nurses to physicians for review at 1.4 days (SD 1.2 days).

**Conclusions:** We demonstrated considerable delay in the follow-up of urine culture results requiring physician review. Future work should address opportunities for reducing times to follow-up, including semi-automation of benign culture results and capture of key patient demographic information in the electronic medical record.

## RÉSUMÉ

**Objectifs**
Le développement et l'évaluation des processus institutionnels d'assurance qualité sont importants pour assurer le suivi des résultats d'examens anormaux demandés dans les services d'urgences hospitaliers. Nous avons procédé à une analyse des dossiers médicaux dans un service d'urgence universitaire de soins tertiaires afin de comprendre le processus et les délais de suivi des résultats de culture d'urine, transmis aux médecins pour revue, après la sortie de l'hôpital.

**Méthodes**
Tous les patients (âge ≥18 ans) qui ont été vus et sortis entre le 1er juillet 2020 et le 30 juin 2021 et qui avaient une culture d'urine signalée pour revue étaient éligibles pour inclusion. Nous avons sélectionné au hasard 100 patients, résumé les temps de suivi et rapporté les statistiques descriptives.

**Résultats**
Soixante-cinq patients ont été initialement identifiés comme nécessitant un suivi supplémentaire pour leurs résultats de culture. Près de 80 % de ces patients ont eu besoin d'un nouveau traitement antimicrobien, d'un traitement supplémentaire ou d'une révision du traitement antimicrobien. Dans l'ensemble, le délai moyen entre la sortie des services d'urgences et la fin du suivi était de 3,4 jours (écart-type : 2,1 jours). Le plus long délai identifié a été celui du transfert des résultats des infirmières aux médecins pour examen, soit 1,4 jour (écart-type : 1,2 jour).

**Conclusions**
Nous avons mis en évidence un retard considérable dans le suivi des résultats des cultures d'urine nécessitant un examen par un médecin. Les travaux futurs devraient porter sur les possibilités de réduire les délais de suivi, y compris la semi-automatisation des résultats de cultures bénignes et la saisie des informations démographiques clés du patient dans le dossier médical électronique.


## INTRODUCTION

Urinary tract infections are common with patients that are frequently being seen and treated in the emergency department (ED).[1] As part of the ED work-up, urine cultures are often ordered, with results pending at the time of discharge. The follow-up of culture results, including review and communication to patients and/or their primary care providers, is important to 1) ensure patients receive appropriate antimicrobial therapy and 2) meet regulatory responsibilities relating to the management of tests.[2]

Institutions have developed quality assurance (QA) processes to ensure that clinically significant test results are conveyed to patients or their primary care providers and to implement required treatment changes. Our local QA process for test follow-up relies on physicians and nurses using a two-step process. Imaging, laboratory, and microbiological results that are received after patient disposition are reviewed by a QA nurse who forwards any results requiring physician action to a physician assigned to the Clinical Decision Unit (CDU) for an eight-hour shift. The CDU physician balances the follow-up of test results with taking calls from outside hospitals and assisting with resuscitations or procedural sedation. Similarly, the QA nurse balances QA tasks by providing back-up nursing support throughout the department.

A recent systematic review examined QA processes and found that dedicated staff increased the likelihood of successful test follow-up.[3] However, the use of personnel can be costly with equivocal outcomes.[4,5] For example, one study highlighted the use of a pharmacist-led program, but the time to follow-up clinically significant culture results nearly doubled following the introduction of the intervention.[5] To set the stage for future quality improvement work, we performed a health records review to 1) calculate the times taken for key steps in the post-discharge follow-up process for review of positive urine cultures ordered in the ED and 2) describe the characteristics of culture results that required follow-up. We hypothesized that the time from identification and transfer of results to physician action would be the longest stage in the follow-up process and aimed to identify associations between patient or culture result characteristics and this stage.

## METHODS

### Study Design and Setting

We conducted a health records review of patients presenting to one of the campuses of an academic tertiary care ED with approximately 80,000 patient visits annually. This study received local research ethics board approval (20210645-01H).

### Urine Culture Ordering and Follow-up Processes

ED attending or resident physicians order urine cultures in the electronic medical record (Epic). At the study site, a pathway for urine culture exists for patients who are positive for leukocytes or nitrates on point-of-care or microscopy testing. However, these guidelines are not commonly followed, and urine cultures are ordered based on clinical context. Once final culture results (microbiological growth and sensitivities) have been reported, the QA nurse receives notifications of results in a specific message basket within Epic for all tests with results reported after patient disposition. These notifications are received on a rolling basis. The QA nurse opens the patient chart, reviews the specific encounter, culture result, and discharge disposition, and determines if an antibiotic was prescribed at discharge. If a physician action is indicated (e.g., a new order for antibiotic treatment is indicated), the QA nurse then sends an Epic message to the QA physician on duty for that day. Otherwise, the nurse performs a follow-up and closes the file.

If the patient is on an antibiotic for which the microbe is sensitive, the QA physician notifies the nurse in Epic that no further action is required. If a change in treatment is required or the patient requires follow-up, the QA physician similarly notifies the nurse in Epic. If an action is required, the QA nurse contacts the patient first to notify them of the abnormal result and the treatment plan. If a new prescription is required, the nurse faxes it to the pharmacy provided by the patient or advises the patient to pick it up from the ED. Finally, the QA nurse documents the date and time the follow-up was completed.

### Participants

All patients aged 18 and above who were seen and discharged between July 1, 2020, and June 30, 2021, and found to have a positive urine culture flagged for the QA physician for review after their discharge were eligible for inclusion. Patients were excluded if they left without being seen or against medical advice.

### Data Collection

We generated a list of patients (n=243) in Epic at the study site who met inclusion and exclusion criteria. The report also included data on the dates and times of the sequential steps in the QA follow-up process and the number and types of organisms identified in the urine culture. As this study was exploratory in nature, no sample size calculation was performed. One hundred patient charts were selected using a computer-based random number generator, and additional data were abstracted using a structured data collection form. Appendix 1 outlines all data that was collected for the project.

### Data Analysis

We calculated times for various steps in the process. We then explored whether the time from the transfer of the result (to the physician) to physician action ("time to action") was associated with the patient [sex; place of residence (home or facility); Canadian Triage Acuity Score – (CTAS), presence of an antibiotic allergy, renal function (creatinine), or corrected QT (QTc) interval], or microbiological factors (number of organisms grown, number of sensitive antibiotics) factors using Pearson Correlation Coefficient, t-test or Analysis of Variance (ANOVA), as appropriate. All statistical analyses were completed in SAS 9.4.6 All analyses were completed with a significance level of 0.05 unless otherwise stated.

## RESULTS

### Characteristics of patients requiring follow-up

Of the 100 patients with positive urine culture [mean age 66.4 years (SD 24.6 years), 59% female (95% CI 49.2-68.1%)] were included in the study, 65 patients (mean age 71.0 years, SD 21.5) required further follow-up. CTAS scores were 2 in 26.2% (95% CI 17.0-38.0%; n=17), 3 for 67.7% (95% CI 55.6-77.8%; n=44), and 4 for 6.1% (95% CI 2.4-14.8%; n=4). No patients were triaged as CTAS 1 or 5. 84.6% (95% CI 74.0-91.4%; n=55) of cultures requiring follow-up grew a single organism. The most common bacteria grown was *Escherichia coli*.

### Process times and outcomes

The QA process for urine culture follow-up is illustrated in Figure 1. The mean time from ED discharge to urine culture results appearing in Epic was 1.3 days (SD 1.5 days). The mean time from culture results appearing in Epic to transfer for physician review was 1.4 days (SD 1.2 days). The mean time for the physician to provide further follow-up instructions after receiving nursing notification was 2.6 hours (SD 6.6 hours). This time was not significantly

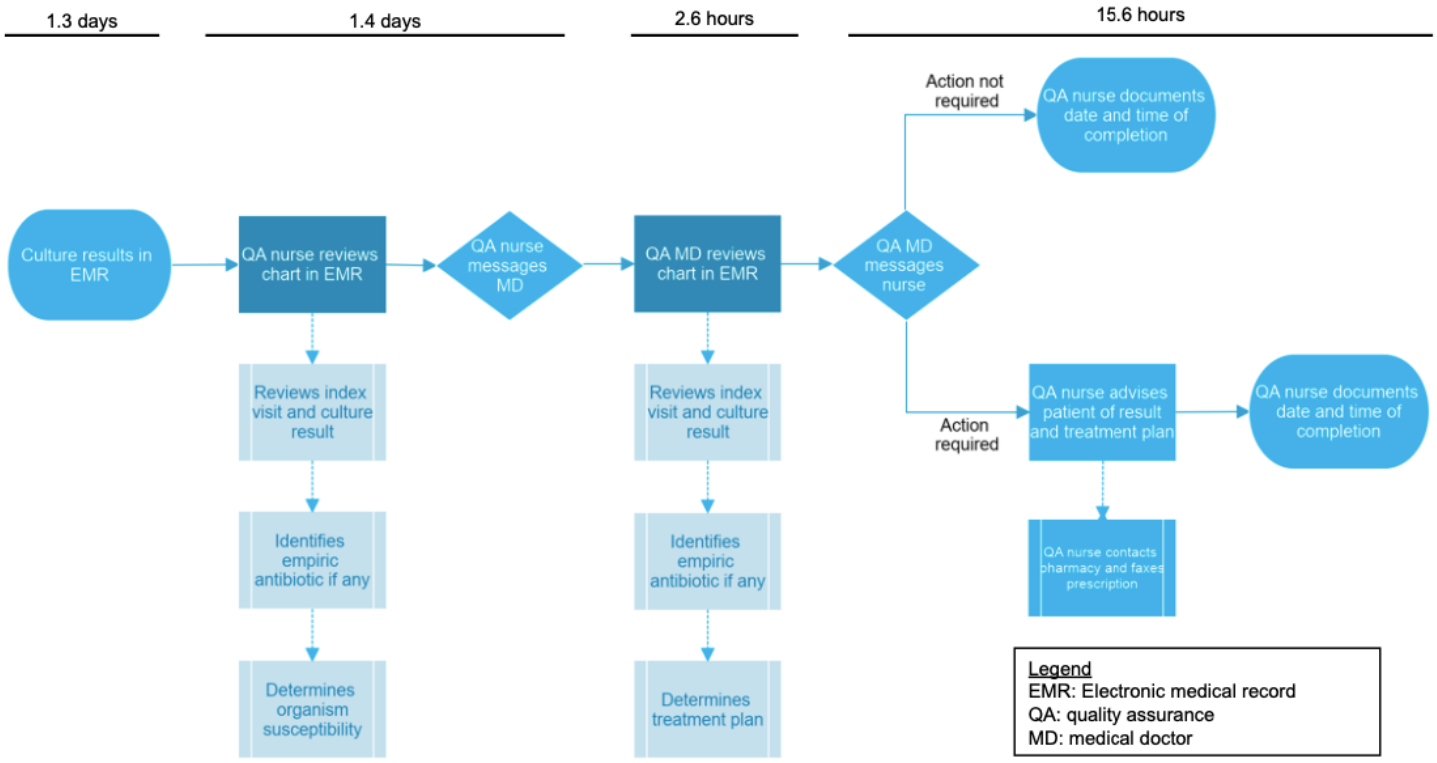


**Figure 1. Current process for follow-up of urine culture results pending at discharge.**

associated with assessed patient or microbiological factors. Table 1 reports the association between the time to action and assessed patient or microbiological factors.

The mean time between a nurse receiving instructions and patient follow-up was 15.6 hours (SD 23.6 hours). Overall, the mean number of days from ED discharge to follow-up completion was 3.4 days (SD 2.1 days). 98.4% (95% CI 91.8-99.7%; n=64) of patient follow-ups were documented. 71.9% (95% CI 59.9-81.4%; n=46) of these patients were successfully contacted on the first attempt, 23.4% (95% CI 14.8-35.1%; n=15) required a second attempt, and 4.7% (95% CI 1.6-12.9%; n=3) required three attempts.

### Characteristics of types of physician action

Of the 65 patients initially identified as requiring culture follow-up, 34 required a change in antibiotic while 17 required an antibiotic (no empirical antibiotic was prescribed at discharge) or an additional antibiotic (add-on therapy). Six patients required clinical follow-up with a non-ED health-care provider. Two patients were asked to return to the ED for reassessment and both patients were successfully contacted on the first attempt. Two patients had culture results that did not require any action. For four patients, no physician action was documented.

## DISCUSSION

In our study of the follow-up of positive urine culture results, the mean time from ED discharge to follow up of positive urine culture results was more than three days. We hypothesized that the longest stage in the follow-up process would be attributed to physician review given the various steps required, including opening the record, reviewing the index visit, and identifying an appropriate antibiotic if needed. However, this stage was the shortest in the process and was not associated with patient or microbiological factors. In contrast, a mean of 50 hours for those culture results requiring follow-up fell under the purview of the QA nurse.

While the overall time to urine culture follow-up in our study is likely context dependent, it differs considerably from those times reported in the literature. One study reported a mean pre-intervention culture follow-up time from laboratory report to family contact of just over 20 hours, while another reported a mean pre-intervention follow-up culture time from discharge to patient contact of 38 hours.[5,7] In our sample of patients, reducing the follow-up process to 20 hours would have saved over 4,000 hours cumulatively in-patient delay.

While it is difficult to assess if the times of the various stages in our follow-up process were clinically significant, we know that delays in treatment of organisms resistant to empiric antibiotics can result in adverse outcomes including upper urinary tract infections, bacteremia or sepsis, and ongoing symptoms, including pain.[1] Conversely, continuation of unneeded antibiotics contributes to antibiotic resistance, a problem with significant healthcare and economic costs.[8] As such, timely follow-up has the potential to improve patient and population outcomes.

## LIMITATIONS

Our results should be interpreted with caution. We deliberately focused on urine cultures as opposed to broadly examining all microbiological samples to reduce heterogeneity. Coupled with small sample sizes and contextual differences, our results may not be generalizable to other types of cultures (e.g., blood, wound) or settings. For exploratory analyses, we did not include specific values (e.g., renal function, corrected QT interval) as they were not present for all included patients. We also did not assess the length of time taken to complete the individual physician and nursing actions (i.e., a time and motion analysis) for each step in the process (e.g., opening and reviewing the electronic chart, calling a patient) as this was beyond the scope of this work. For example, in addition to managing test result follow-up, QA nurses on multiple occasions must stop their QA work to support patient care in various areas. Consequently, the times calculated may not accurately reflect the true time taken. Our study also examined a period during the COVID-19 pandemic, a time when staffing shortages may have influenced nursing coverage and therefore, the work of the QA nurse.

## FUTURE WORK

Following the review of these findings with our local departmental QI and patient safety (QIPS) committee, we uncovered several opportunities for improvement in addition to addressing the limitations previously described.

Locally, the longest stage in our QA process was from the availability of culture results to the transfer of results to the physician. For the nearly 40% of culture results not requiring further action, the mean delay to transfer of culture results to physicians for review was nearly 34 hours. To address this issue, our team is reviewing and refining the underlying rules of reports generated within the electronic medical record to eliminate results being inappropriately routed (i.e., not requiring follow-up) thereby improving the "signal" to "noise" ratio for QA nurses. Similarly, machine learning may be used to completely automate the identification and/or follow-up of benign culture results (e.g., cultures with no growth or where bacterial susceptibility matches the antibiotic prescribed at discharge), thereby reducing the amount of time spent by staff and the time delay.[9] While AI-based identification of pertinent findings requiring follow-up has been feasible in the context of radiology, specific algorithm development, validation, and external testing for microbiological follow-up is currently unknown.[10]

Nearly 30% of culture results that were followed up required more than one attempt for successful patient contact with significant variation in the time to follow-up. Anecdotally, nurses reported challenges identifying patients' pharmacies and delays in faxing prescriptions. Capturing this information in the electronic medical record (EMR) at triage may enhance downstream process efficiencies by supporting the completion of follow-up. For example, Burchett et al. describe the recording of patients' preferred pharmacy and the addition of an "e-prescribe" function as critical to the success of their intervention in reducing the time to urine culture follow-up.[7] In conjunction with our local information management group, we are exploring ways to collect and update pharmacy information including at registration, at triage, and through a connected patient portal (e.g., MyChart). An automated EMR report to identify and track issues causing delays in patient follow-up is also being developed and will be made available to QA nurses and physicians. Finally, trials are underway to align QA nursing shifts with times when culture results are received and assess the impact of a dedicated nurse practitioner responding to microbiological results.

## CONCLUSION

Post-discharge follow-up of urine cultures ordered in the ED are important for ensuring appropriate antimicrobial exposure and timely care. In this exploratory retrospective chart review at a single centre, more than three days were required to complete follow-up for urine culture results identified post-discharge with most of the process overseen and completed by QA nurses. Compared with other institutions, there is a considerable delay in the follow-up process. Informatics-based interventions could yield significant reductions in time to urine culture follow-up and, potentially, workloads for nursing-led QA activities. In

addition to addressing the limitations of the present study, future work will examine the impact of these interventions on culture follow-up times.

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**Table 1. Association between time to physician action and various patient and microbiological characteristics.**

| Characteristic | Details | p-value | Statistical test |
|---|---|---|---|
| Age at the time of discharge | | 0.62 | Pearson Correlation Coefficient |
| Sex | Males: N=28; 136.1 min (2.3h)<br>Females: N=37; 171.3 min (2.9h) | 0.73 | t-test |
| Residence (home or facility) | Facility: N=15; 221.4 min (3.7h)<br>Home: N=50; 136.5 min (2.3h) | 0.47 | t-test |
| CTAS score for index visit | CTAS 2: N=17; 225.0 min (3.7h)<br>CTAS 3: N=44; 139.3 min (2.3h)<br>CTAS 4: N=4; 48.6 min (0.8h) | 0.65 | ANOVA |
| Presence of allergy to any antibiotic | Allergy: N=16; 124.6 min (2.1h)<br>No allergy: N=49; 166.4 min (2.8h) | 0.72 | t-test |
| Presence of a Cr result in the last six months | Result: N=55; 155.6 min (2.6h)<br>Unknown: N=10; 159.1 min (2.7h) | 0.98 | t-test |
| Presence of a QTC interval in the last six months | QTC: N=31; 204.3 min (3.4h)<br>Unknown: N=34; 112.2 min (1.9h) | 0.37 | t-test |
| Number of organisms grown | 1 organism: N=55; 182.5 min (3.0h)<br>2 organisms: N=9; 11.6 min (0.2h)<br>3 organisms: N=1; 4.9 min (0.1h) | 0.46 | ANOVA |