

MAD-ID Newsletter Summer 2019



MAD-ID
MAKING A DIFFERENCE
IN INFECTIOUS DISEASES®

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Save the Dates

The 23rd annual MAD-ID Meeting will be May 27-30, 2020 at the Omni ChampionsGate Hotel. (Photo above) The Planning Committee is working hard to identify engaging and diverse infectious diseases topics and speakers for the 3.5-day event. Watch the MAD-ID website for more information as the agenda takes shape. Note that this date is a little later than when the meeting has been held the past few years, so mark your calendars!

Upcoming MAD-ID Annual Meetings

May 27-30, 2020

May 19-22, 2021

To be held at the Omni Resort at ChampionsGate

The AMR Challenge

At last spring's annual meeting, Melinda Neuhauser, PharmD, facilitated a workshop on how healthcare providers can fight antimicrobial resistance and participate in the AMR Challenge.

The **Antimicrobial Resistance (AMR) Challenge** is a worldwide effort that encourages for organizations (including private companies, healthcare institutions, and others) to make formal commitments that further the progress against antimicrobial resistance.

Has your institution committed to the AMR Challenge?

The CDC is accepting commitment submissions through August 2019. Challenge areas include: Tracking and data; Infection prevention and control; Antibiotic use; Environment and sanitation; Vaccines, therapeutics and diagnostics.

If your organization is interested in joining the global effort to fight antimicrobial resistance, see the CDC website for details!

<https://www.cdc.gov/drugresistance/intl-activities/amr-challenge.html>

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MAD-ID is committed to the AMR Challenge.

Our commitment includes:

- Leveraging our innovative and practical educational and skills training in antibiotic stewardship and infectious diseases therapeutics to optimize antibiotic use in practice.
- Supporting research to demonstrate effective interventions to improve antibiotic use and reduce the spread of resistance.

Advocacy Updates: S-FAR and the DISARM Act

MAD-ID along with 20 + Infectious Diseases organizations signed onto a letter (DISARM) directed to the Centers for Medicare and Medicaid Services to adopt a new inpatient prospective payment system to increase new technology add-on payments to 65% in an effort to improve reimbursement for novel antibiotic therapies. In addition, S-FAR (Stakeholder Forum on Antimicrobial Resistance) members are strongly encouraging the Centers for Medicare and Medicaid Services to carve novel antibiotics to treat serious or life-threatening infections out of the diagnosis-related group (DRG) and to adopt new requirements for antibiotic stewardship and surveillance. Carving antibiotics out of the DRG and reimbursing for them separately would help level the playing field for new products allowing clinicians to make the best clinical treatment decisions for their patients while helping to stabilize the very tenuous situation innovators currently face. As you are well aware, 90% of antibiotics in development worldwide come from small biotech firms who are struggling to stay in business. Urgent action is required to stabilize antibiotic development to keep pace with antibiotic resistance.

New Partnership with Contagion!



MAD-ID has joined the Strategic Alliance Partnership program with *Contagion*[®], <https://www.contagionlive.com/partner> the nation's leading multimedia resource providing up-to-date, disease-specific information to health care practitioners and specialists in the field of infectious diseases. We are excited about this partnership as both groups share a common strategic goal to inform and educate healthcare professionals with the latest information on infectious diseases. The MAD-ID's expertise in antimicrobial therapeutics and stewardship will compliment and expand Contagion's growing network of infectious diseases experts continuing to bring high quality content to the healthcare professional audience.

News from MAD-ID

- Congratulations to the **Alabama Infectious Diseases Society (ALIDS, Twitter @ALInfectDis)**, on a successful 2nd annual Antimicrobial Stewardship Conference on July 20th. MAD-ID was happy to support the event that offered 4 hours of continuing education credit.
- **The Basic Antimicrobial Stewardship Training Program** has been updated. If you've already completed basic ASP training, consider recommending it to one of your colleagues. Core and elective modules are available and include CE for pharmacists, physicians and nurses.
- For annual meeting attendees who registered for the **Advanced Antimicrobial Stewardship Training Program**, please remember to complete the online post-test quizzes at <http://mad-idtraining.org/certification/> Go to "Advanced Stewardship Training Program", click on 2019 Quizzes and create an account or log in. The enrollment key is 2019 Quizzes.

Announcing Research Grant Awardees

The MAD-ID Research Network is pleased to announce the two recipients of the MAD-ID Antimicrobial Stewardship Research Grant for 2019-2020.

- **Dr. Michelle Science**, ID Physician at The Hospital For Sick Children, Toronto, Ontario, CA. "The Implementation and Impact of an Allergy De-Labeling program in a Paediatric Emergency Department: The De-LABel Program Expansion"
- **Dr. Jordan Smith**, Assistant Professor of Clinical Science at High Point University, High Point, NC. "Optimizing Transitions of Care Antimicrobial Prescribing at a Community Teaching Hospital. Dr. Smith's proposal was selected for funding as part of MAD-ID's AMR Challenge commitment to support antimicrobial stewardship research!"

Look for upcoming newsletters for more information about research grants as well as highlights from our award recipients past and present.

Diagnostic and Antimicrobial Stewardship: Understanding and optimizing the synergistic relationship?

Continuing Education Activity

Mandee Noval PharmD and Kimberly Claeys, PharmD BCPS

Disclosures: Dr. Noval has no conflicts of interest to disclose related to this learning activity. Dr. Claeys reports having received research grants from GenMark Diagnostics and BioFire Diagnostics and has served on the Speakers Bureau for Luminex Corporation.

Learning Objectives:

At the end of this article, learners will be able to:

1. Discuss the roles and opportunities to collaborate with the microbiology laboratory to optimize antibiotic use in the management of bloodstream, respiratory tract, and urinary infections.
2. Summarize current clinical evidence demonstrating the beneficial collaboration between diagnostic and antimicrobial stewardship.
3. Describe future directions for the clinical implementation and investigation of diagnostic and antimicrobial stewardship collaboration.

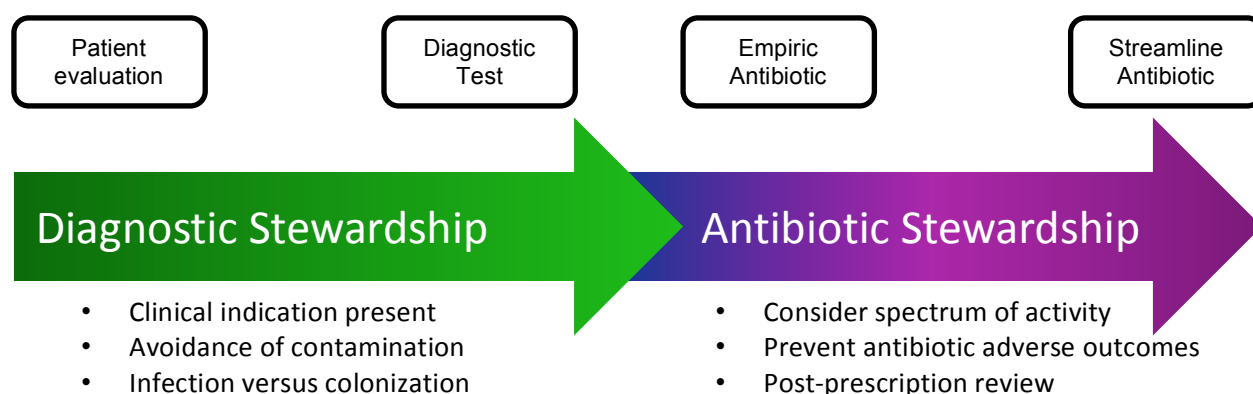
Introduction:

The purpose of antimicrobial stewardship (AMS) includes efforts to combat antibiotic resistance, decrease inappropriate antibiotic use, and prevent medication related adverse effects.(1) While the goals of AMS haven't changed, the tools available to help establish the presence or absence of infection are constantly evolving. Recent advances in molecular diagnostic technologies have been used to shorten the time to appropriate antibiotic therapy, thus improving patient outcomes. While useful, these technologies alone rarely have been shown to improve outcomes and may still lead to the use of inappropriate therapies(2). Providers must be diligent in ensuring that such diagnostic tests are ordered appropriately, and more importantly, interpreted appropriately, highlighting the importance of diagnostic stewardship.(3)

Diagnostic stewardship consists of interventions designed to modify the process of ordering (pre-analytic), performing (analytic), and reporting (post-analytic) diagnostic test results(2). It is estimated that approximately one-fifth of available tests are overused which may result in misdiagnosis and errors in drug therapy, putting patients at risk. When deciding whether the use of a diagnostic test is appropriate, the context of the patient's clinical symptoms should be coupled with the estimation of the pre-test likelihood for the suspected illness.(3) Often, tests are ordered in patients with low pre-test suspicion for infection as part of a routine work-up, with subsequent diagnostics resulting in false positives or colonization, further leading to unnecessary antibiotic use. Efforts can be made using diagnostic stewardship to prevent these tests from being ordered upfront.

While ID physicians work closely with the microbiology lab to ensure these diagnostic tools are available for use when needed, non-ID specialists may be unaware of the intricacies of such tests and their true utility.(4) A recent survey from Blaschke et al. conducted among ID physicians found that approximately 67.5% felt that rapid diagnostic testing is becoming too complex for general audiences, with 79% requesting stewardship involvement for the ordering of complicated or expensive tests. This further highlights the growing need for diagnostic stewardship and continued education for non-ID specialists routinely ordering and interpreting diagnostic tests. While the awareness regarding the importance of diagnostic stewardship for a variety of infectious diseases is growing, the best strategy of implementation has yet to be determined. This overview will focus on specific infectious disease states and may not serve as a comprehensive of all areas where AMS and diagnostic stewardship work synergistically.

Figure 1: The synergistic relationship between diagnostic and antimicrobial stewardship



Bloodstream Infections:

Perhaps the most robust data for collaboration between AMS and diagnostic stewardship is leveraging the availability of molecular rapid diagnostic test (RDT) results in the management of bloodstream infections (BSI).(1,5) Numerous studies have demonstrated that molecular RDTs significantly decrease time to organism identification, which has the potential to lead to faster optimization of therapy.(6) These molecular RDTs represent a valuable tool for AMS programs and, as it has been demonstrated in numerous publications, AMS programs are often crucial to facilitating the timeliness of antibiotic optimization based on the results of these tests.

Donner et al, through their single-center survey of primary care physicians, however, demonstrated that providers do not always respond to and adjust therapy based on clinical microbiology reports.(7) In fact, only 82% of respondents reported making changes to antibiotic therapy based on traditional microbiology/automated susceptibility testing results and only 60% reported making any adjustments based on RDT results. These findings are in spite of the readily available guidelines for interpretation of RDT results and preferred antibiotic therapy based on these results.(8) The 2017 systematic review and meta-analysis from Timbrook et al. incorporated over 30 studies and found that RDTs were associated with decreased odds of all-cause mortality (OR = 0.64, 95% CI 0.51, 0.79).(9) This result, however, was primarily driven by the studies where AMS was actively involved in the responding to RDT results (OR = 0.66, 95% CI 0.54, 0.8) versus RDT without

AMS involvement (OR = 0.72, 95% CI 0.46, 1.22). This finding is also underscored by a study from Cosgrove et al. on the use of PNA-FISH in Gram-positive BSI.(10) In this single-center study, 220 patients were randomized to standard microbiological methods versus RDT. Time to optimal therapy (defined as *in vitro* active with narrowest spectrum of activity against final organism isolated) was not significantly different between groups, 18.1 [IQR 0 – 50.6] vs 12.1 [IQR 0 – 51.8] hours, $P = 0.92$. Interestingly, however, the same group found sustained impact of AMS in Gram-positive BSI even after active AMS interventions ceased.(11) This quasi-experimental study contained three groups; pre-RDT, RDT + AMS, and then RDT alone. AMS interventions were over a seven month period and included provider education and newsletters, incorporation in current institutional guidelines, and routine review and feedback whenever blood cultures became positive for RDT target Gram-positive organism. Compared to the period with active AMS intervention, time to optimal therapy was not significantly different after interventions were halted (12 [IQR 4, 33] vs 11 [IQR 4, 37] hours, $P = 0.11$).

The main randomized controlled trial implementing RDT was conducted by Banerjee et al. Patients, both adults and children with Gram-positive, Gram-negative and/or fungal BSI, were randomized to one of three groups: standard blood culture processing, RDT with template responses placed in EMR, or RDT with template responses and active AMS review and feedback.(12) A total of 617 patients were randomized (207 vs 198 vs 212 per group, respectively) and included for final analysis, 54.8% were determined to have Gram-positive BSI. Investigators found that, compared to standard blood culture processing, both RDT groups had longer durations of narrow-spectrum beta-lactam agents (42 vs 71 vs 85 hours, $P = 0.04$), respectively. Additionally, both appropriate antibiotic escalation (24 vs 6 vs 5 hours, $P = 0.04$) and antibiotic de-escalation (34 vs 38 vs 21 hours, $P < .001$) occurred sooner with RDT with and without AMS involvement. There was, however, no change in clinical outcomes such as inpatient mortality (5.3% vs 5.6% vs 3.8%, $P = 0.12$) or median (IQR) inpatient length of stay (8 [5, 15] vs 8 [5, 15] vs 8 [5, 16] days, $P = 0.6$), though the study was not powered to these outcomes.

The majority of currently available literature supports the use of RDTs with AMS intervention in the management of Gram-positive BSIs. There is considerably less data focused on the beneficial to optimize antibiotic therapy focused solely on Gram-negative BSIs. There are a number of reasons for this disparity, paramount is the complex nature of resistance in Gram-negative organisms and the incomplete data provided by currently available RDTs. In a retrospective, multicenter study Pogue et al. were able to demonstrate RDTs can be validated at an institutional level bug comparison of the sensitivity and specificity of RDT results to traditional microbiological testing and the organism (and resistance marker)-antimicrobial level.(13) For instance, the investigators were able to demonstrate a high negative predictive value for third generation cephalosporin resistance in *Escherichia coli* and *Klebsiella pneumoniae* when the resistance marker for CTX-M was negative (93% to 98%, respectively). The largest study to date examining the potential role of AMS and RDTs in Gram-negative BSI was completed by Rivard et al. at the Cleveland Clinic Health System.(14) In this quasi-experimental study, investigators compared the median time to antibiotic switch from Gram-stain pre- and post-introduction of RDT for Gram-negative BSI with active AMS intervention. Interventions included real-time notification of RDT results to the AMS team Monday through Friday from 7:00 am to 9:00 pm for prospective review and feedback, as well as development of an RDT-based treatment algorithm. Although the proportion of patients that had their antibiotics switched was not significantly different (77% vs 79%), the time to antibiotic switch significantly decreased from 44.1 (IQR 18.9, 64.6) to 28.6 (IQR 8.6, 56.9) hours, $P = 0.004$. This was primarily driven by antibiotic escalation (22.9 vs

9.9 hours, $P = 0.03$), and de-escalation remained a clinical challenge (54.4 vs 49.9 hours, $P = 0.01$). Opportunities to further decrease time to antibiotic switch are in process with the use of newer technologies allowing more rapid organism identification, and even more recently, rapid antibiotic susceptibility testing (AST)(15).

Respiratory Tract Infections:

Diagnostic uncertainty surrounding respiratory infections continues to remain a challenge for AMS programs. Though viral infections account for more than one third of respiratory illnesses, patients commonly receive inappropriate treatment with antimicrobials, putting them at an increased risk of developing a multidrug resistant organism or increasing hospital length of stay.(16) With organism identification occurring in less than 40% of respiratory infections and highly non-specific symptoms, the differentiation between viral and bacterial infections can be complex.(17) Like many other types of infections, opportunities for diagnostic and antimicrobial stewardship are present in both the pre- and post-analytic phases, with conflicting evidence supporting numerous diagnostic interventions.

Respiratory viral panels (RVPs) are thought to be an effective stewardship tool with a sensitivity of >90% and a potential turnaround time of less than one hour.(18) Recent advances in RDTs have allowed for the development of multiplex PCR systems that are able to detect a wide range of viral pathogens in a short amount of time. Though highly sensitive, RVPs can be costly and past studies have not consistently demonstrated their ability to help change antimicrobial prescribing practices.(16,19) Semret et al. examined trends in antimicrobial prescribing over three years after RVP results were available to clinicians, and initially found that patients testing positive for influenza virus were more likely to have antibiotics discontinued as compared to those testing negative (OR 1.38, 95% CI 0.89, 2.16).(19) After adjusting for confounders including age and Charlson comorbidity index, this association was not found to be statistically significant, and they were able to conclude that prescribing trends were less associated with RVP results and more dependent upon radiographic findings concerning for bacterial coinfection. Similar results were seen in a study from Mercurio et al. evaluating the use of RVPs in immunocompromised patients.(16) The investigators conducted a single center quasi-experimental study comparing the use of in-house RVP testing with audit and feedback compared to a send-out test. Though the time to turnaround (46.7 hours send-out vs. 5.5 hours in-house; $P < 0.001$) and time to intervention (52.1 hours send-out vs. 13.9 hours in-house; $P < 0.001$) were reduced using an in-house RVP test, there was no difference noted in the frequency of antimicrobial optimization (30.7% vs 35.7%). Hesitation often surrounds the use of RVPs as a tool in de-escalation due to the concern for a superimposed bacterial infection, suggesting further interventions are needed.

It's been suggested that the use of RVPs in combination with an inflammatory marker, such as procalcitonin (PCT), may be more impactful in changing antimicrobial prescribing practices with previous studies showing a reduction in total antibiotic days.(20) Studies incorporating PCT alone as a tool for antibiotic de-escalation have shown inconsistent outcome, with concern surrounding the lack of specificity. Bianchi et al. evaluated the use of a pharmacist-led ICU bundle that incorporated the use of multiple diagnostic interventions for respiratory infections including influenza A and B PCR, RVP, *Legionella* urine antigen test, and PCT. Through a collaborative practice agreement (CPA), pharmacists were able to order criteria-driven diagnostic testing in patients on empiric antibiotics for community-acquired pneumonia. When compared to the standard of care, the CPA group had more frequent organism identification (51% vs. 34%, $P = 0.035$), more frequent de-escalation (58% vs. 26%, $P < 0.001$) but no differences in all-cause

mortality or 30-day readmission. Through a multiple logistic regression, the only variable independently associated with antimicrobial de-escalation was CPA use (OR 4.03, 95% CI 2.1, 7.7), highlighting the importance of having a multidisciplinary effort.

Opportunities for diagnostic stewardship in respiratory infections in the post-analytic phase focus on de-escalation of empiric broad-spectrum antibiotics through simple communication with the microbiology lab. In a single center quasi-experimental study by Musgrove et al, a modification in results reporting of normal respiratory flora was associated with a 5.5 fold increase in the odds of antibiotic de-escalation.(21) The study included patients hospitalized for respiratory infections receiving anti-MRSA and anti-pseudomonal antibiotics and evaluated de-escalation before and after modification of commensal respiratory flora report. Prior to the intervention, respiratory cultures with no predominant organism were reported as “commensal respiratory flora only.” Post-intervention, the report specifically noted the absence of resistant organisms reporting “commensal respiratory flora only: No *S. aureus*/MRSA or *P. aeruginosa*”. The primary endpoint of de-escalation of anti-MRSA and anti-pseudomonal antibiotics was significantly lower in the pre-intervention group compared to the post-intervention group (39% vs. 73% respectively, $P < 0.001$). Interestingly, the use of a modified comment to nudge providers was also associated with a decrease in median antibiotic days (7 days pre vs. 5 days post-intervention; $P < 0.001$), as well as a reduced incidence of acute kidney injury (31% pre vs. 14% post-intervention, $P = 0.003$), showing the importance clear communication can have on AMS and patient outcomes.

Urinary Tract Infections:

Urinary tract infections (UTIs) are one of the most common infections diagnosed across all care settings. Even though they are exceedingly common, diagnosis of true infection remains challenging as symptoms tend to be non-specific and those at highest risk of UTI are often not able to articulate the presence of these symptoms. Often, the presence of a positive urine culture drives the diagnosis of UTI and thus prescribing of antibiotic therapy. Asymptomatic bacteriuria (ASB), defined as the presence of one or more bacteria in the urine at $> 10^5$ CFUs/mL without signs/symptoms attributable to the urinary tract, is often treated as a true infection or a potential cause of future infection, though this is often not the case.(22) This treatment leads to unnecessary exposure to antibiotic therapy, which in and of itself can lead to negative consequences, such as drug-drug interactions, adverse drug events, development of antibiotic resistance, or *C. difficile* infection.(23,24)

Management of UTIs and ASB represents a prime opportunity for collaboration between diagnostic and antimicrobial stewardship initiatives.(3) Once a urine culture becomes positive, AMS review and intervention post prescription of antibiotics becomes more challenging. In a survey of physician residents, only 33% of respondents reported the ability to differentiate ABS from UTI and 38% reported that they would still treat ASB secondary to downstream concerns.(25) In fact, 50% reported prescribing antibiotics for ASB without clear indication (i.e. pregnancy). This data is supported by a recent meta-analysis of over 4000 patients that demonstrated inappropriate ASB treatment was approximately 45% (95% CI: 39%, 50%).(26) Diagnostic stewardship works to optimize the diagnosis of UTIs by limiting unnecessary urine culturing in the pre-analytic phase, thus working upstream and synergistically with AMS. There are numerous opportunities for collaboration between infection prevention, clinical microbiology, and AMS programs during both the pre- and post-analytic phases.

In the pre-analytic phase several interventions have shown to be beneficial to decrease either falsely positive urine culture, and/or antibiotic prescribing in ASB. Trautner et al. have been successful in decreasing treatment of catheter-associated ASB through a combination of evidence-based guidelines for treatment of UTIs versus diagnosis of ASB, active provider education, and peer-to-peer evaluations to decrease unnecessary UC ordering and antibiotic prescribing.(27) In their quasi-experimental study, rates of urine culture ordering significantly decreased after intervention (41/1000 bed-days vs 23/1000 bed-days, $P < 0.001$), which was not seen in the contemporary control group. Cases of ASB receiving treatment also significantly decreased (1.6/1000 bed-days vs 0.6/1000 bed-days, $P < 0.001$). Keller et al. utilized the electronic medical record (EMR) to alert providers ordering UC or urinalysis with UC to seek alternatives in the absence of true urinary symptoms.(28) Although investigators found a significant reduction in UCs ordered (decreased 6% post-implementation), there was no difference in antimicrobial use.

Conditional reflex urine culture policies have also been implemented to limit UCs performed to only those that meet certain criteria based on results of the urinalysis. In a quasi-experimental study of intensive care unit patients from Epstein et al., limiting UC testing to those with urinalysis results demonstrating 10 or more WBC per high powered field resulted in a significant decrease in UCs performed ($P = 0.0012$).⁽²⁹⁾ There was, however, no change in the monthly rates of catheter-associated UTIs ($P = 0.45$) comparing pre-intervention to post-intervention periods. The same investigators later evaluated antibiotic use and found not change post-implementation of reflex urine cultures (449 days of therapy (DOTs)/1000 patient-days vs 425 DOTs/1000 patient-days).⁽³⁰⁾ In a subgroup of 500 patients, 250 per implementation group, new courses of antibiotics directed towards management of UTIs did significantly decrease (41% versus 23%, $P = 0.002$).

In the post-analytic phase there are also opportunities to decrease antibiotic prescribing even if the UC was potentially obtained inappropriately. Studies have evaluated pharmacist-led review and intervention on UC data. Zhang et al. implemented an Emergency Medicine-based program where finalized UCs were prospectively reviewed and made recommendations to either start, stop, or modify antibiotic therapy.⁽³¹⁾ Among 457 UCs that were reviewed, 136 (29.8%) met criteria for ASB in non-pregnant patients and 54 (40%) were prescribed antibiotics. Recommendations to discontinue antibiotic therapy were made in 35 cases, with an 80% acceptance rate resulting in approximately 113 antibiotic free days. Other investigators have evaluated the impact of restriction on reporting UC results.⁽³²⁾ Leis et al. stopped routine reporting of UC results in non-catheterized patients, instead instructing providers to call the microbiology laboratory for results if infection was truly suspected.⁽³²⁾ Only 14% of UC results in non-catheterized patients were reported post-implementation. Treatment of ASB decreased from 48% to 12%, resulting in an absolute risk reduction of 36% (95% CI, 15%, 57%, $P = 0.002$). As demonstrated, there are numerous opportunities in the pre- and post-analytic phases for collaboration between diagnostic and antimicrobial stewardship to optimize testing and antibiotic prescribing for UTIs.

Next Steps & Future Directions:

While these recent advances in diagnostic testing have started to transform AMS programs and improve patient outcomes, several unmet needs remain. Current methods of diagnostics are becoming more rapid in their ability to tell us about the presence or absence of organisms, but they lack the ability to tell us whether this represents true infection or simply colonization⁽³³⁾. Furthermore, current technologies, though rapid, still often require hours to days for organism identification and growth before these tests can be completed. Thus, patients may remain on suboptimal empiric antibiotic therapy in the interim.

Methods for direct organism identification are under development, including a bacterial panel developed by T2 Biosystems designed to directly detect the presence of six different pathogens in the blood. (15,33) The panel is limited in the scope of organisms it's able to detect and does not provide information regarding resistance patterns, however it may allow clinicians to make empiric antibiotic choices based on local antibiograms. While still relatively new, recent studies show promising results with a decrease in time to organism identification by 20 hours (5.5 ± 1.4 h T2 vs 25.2 ± 15.2 h conventional, $P < 0.001$) and a higher sensitivity than conventional techniques (89.5% vs. 83.3%) suggesting methods may be even more likely to identify organisms missed by traditional methods. In addition to organism identification, new RDTs may be able to assist with AST, including the Accelerate Pheno™ which uses rapid phenotypic methods to provide information regarding susceptibility within 7 hours. Both of these methods have the potential to optimize the management of BSI, but further information regarding practicality of administration is needed(15,34).

Similar advances are underway for other types of infections, with rapid diagnostic tests under development for management of respiratory infections. As previously mentioned, the differentiation between viral and bacterial infections continues to remain problematic, and clinical trials of a multiplex lower respiratory tract (LRTI) PCR are ongoing with the ability to identify both bacterial targets and viral pathogens. Current LRTI panels from BioFire® are able to detect 18 bacteria, 7 antibiotic resistance markers, and 9 viruses with a sensitivity of 96.2% and specificity of 98.3% in bronchoalveolar-like samples. The system requires minutes of hands-on time and results in approximately one hour, allowing rapid adjustment of antimicrobial therapy when needed(35). Proposed use of diagnostic tests with biomarkers responding as a host response to infection may show improved utility of test results to determine whether the presence of these organisms represents true infection; however, further research of the combination of these newer methods are required.

Conclusions:

Though many challenges exist for AMS programs, coupling efforts with diagnostic stewardship serves as an additional resource in ensuring appropriate antibiotic use. While the data is strongest for diagnostic stewardship in BSIs, the strategies discussed may be used in various types of infections to encourage appropriate use of diagnostic resources, prevent over treatment of false positive results, and overall improve patient outcomes. By recognizing the impact that pre- and post-analytical interventions can

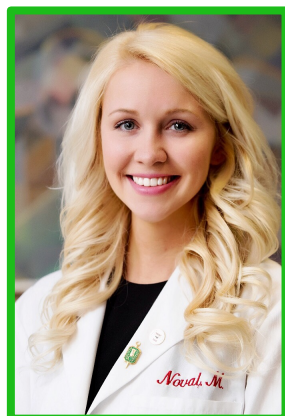
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About the authors



Mande Noval is a second-year pharmacy resident in infectious diseases at the University of Maryland School of Pharmacy. She completed her PGY-1 pharmacy residency at the University of Maryland Medical Center.



Kimberly Claeys is an Assistant Professor specializing in Infectious Diseases and University of Maryland School of Pharmacy and Antimicrobial Stewardship Pharmacists at University of Maryland Medical Center.

Instructions for Obtaining CE

The self-assessment quiz that can be found at the end of this article can be completed for 1 CEU of Continuing Pharmacy Education credit. The quiz may be completed online (<http://madidtraining.org/newsletter/>) at no cost for MAD-ID members. Non-members should print and mail the completed quiz, along with a \$15.00 check made payable to MAD-ID to: MAD-ID, 537 Calico Retreat, Mt. Pleasant, SC 29464-2765. Your CE credit will be reported on CPE monitor within 4 weeks of receipt.

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Knowledge-based activity.

Target audience: pharmacists and other healthcare providers (expires July 2020)

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Self Assessment Questions

(To be completed online (<http://mad-idtraining.org/newsletter/>) or, in the case of non-MAD members, printed and mailed. You must achieve a grade of 80% or better to receive continuing education credit.)

- 1. Which of the following is true regarding the synergistic relationship between AMS and diagnostic stewardship?**
 - a. Diagnostic stewardship can only be coupled with AMS in the post-analytic phase, targeting antibiotic de-escalation based on culture results
 - b. Diagnostic stewardship and antimicrobial stewardship are entirely different entities and have no impact on each other
 - c. Collaboration will ensure diagnostic tests are ordered, performed, and interpreted appropriately to more accurately recommend the appropriate and timely antimicrobial therapy
 - d. Pre-analytic interventions have been shown to be far superior to all other types of diagnostic stewardship interventions

- 2. For the management of bloodstream infections (BSI), which of the following is true?**
 - a. There remains limited data to support the use of rapid diagnostic tests with AMS intervention in the management of BSIs, especially for Gram-positive infections
 - b. A variety of interventions can be completed in collaboration with AMS, including development of treatment algorithms and real-time review and feedback
 - c. Data has demonstrated the positive clinical impact of RDTs in BSI has often demonstrated in the absence of AMS intervention, thus time and resources should be focused elsewhere
 - d. Due to the relatively simple nature of Gram-negative resistance, current RDTs offer complete information on potential mechanisms of resistance and thus are easy to implement

- 3. For the management of respiratory infections, which of the following is true regarding available pre- and post-analytic interventions?**
 - a. The use of respiratory viral panels have been shown to consistently increase rates of antibiotic optimization and discontinuation
 - b. Procalcitonin serves as a highly sensitive and specific biomarker to differentiate between viral and bacterial infections and has been shown to consistently increase rates of antibiotic optimization and discontinuation
 - c. Alterations in the reporting of microbiology results to specifically comment on the absence of specific organisms (ex. MRSA, *Pseudomonas aeruginosa*) has been associated with an increase in antibiotic de-escalation
 - d. The use of a pharmacist-driven bundle to order rapid diagnostics has not been shown to have an impact on patient outcomes and should thus remain provider driven

- 4. For the management of urinary tract infections, which of the following is true regarding potential collaborations between AMS and diagnostic stewardship?**
- The only point where collaboration between AMS and diagnostic stewardship is possible is during the post-analytic period where antibiotic use is easiest to change
 - Collaborations have been shown to be beneficial during both the pre-analytic and post-analytic periods, where AMS and diagnostic stewardship can decrease testing and antibiotic use
 - The analytic period represents that most opportunity for AMS collaboration with diagnostic stewardship to decrease unnecessary urine testing
 - Urinary tract infections represent an area where little collaboration is possible between AMS and diagnostic stewardship because of the lack of RDT available
- 5. Which of the following does NOT represent a major challenge and current limitation of available testing that limits collaboration between AMS and diagnostic stewardship?**
- The lack of complete data regarding true infection versus colonization and/or contamination
 - The need for organism growth before some RDT can be completed, resulting in delays to antibiotic optimization
 - The need to rely on incomplete or unavailable data regarding phenotypic antibiotic susceptibilities
 - There is a lack of data to support collaborative relationships between AMS, Infection Prevention, and the clinical microbiology laboratory

Learning Activity Assessment

Please provide your honest assessment of the value of this learning activity so that we can continue to improve our offerings.

Please indicate your degree of agreement or disagreement with the following statements regarding this learning activity by indicating strong agreement (a), general agreement (b), no opinion (c), mild disagreement (d), or strong disagreement (e):

Criteria	Strong agreement	General agreement	No opinion	General disagreement	Strong disagreement
The information presented was relevant to my practice	a	b	c	d	e
This program/session met the stated learning objectives	a	b	c	d	e
The information was presented in an objective and balanced manner without commercial bias	a	b	c	d	e
The information presented will alter/affect my practice (usefulness)	a	b	c	d	e
The educational materials enhanced my learning	a	b	c	d	e
The learning method was effective	a	b	c	d	e
The learning assessment activity (self-assessment quiz) was appropriate	a	b	c	d	e
The faculty/authors were of appropriate quality	a	b	c	d	e

OUR MISSION. The mission/purpose of the Foundation is to provide education, in the form of traditional continuing education, skills training, and other pertinent life-long learning methods, to pharmacists and other healthcare professionals concerning pharmacotherapy as it pertains to the prevention and treatment of infectious diseases and to do all things necessary or convenient to further these goals, with a special emphasis on antimicrobial stewardship.

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Colleges of Pharmacy & Medicine
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Columbia School of Nursing and Nurse
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