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Utilizing Mind-Mapping Technique to Describe an Antimicrobial Stewardship Program for Clinical Implementation of a 7-hour Fast Antibiotic Susceptibility System

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Background

A novel fast antibiotic susceptibility diagnostics platform, with *de novo* FDA marketing authorization, provides MIC susceptibilities to clinicians treating sepsis an average of 40 hours faster than current laboratory methodologies. The delay for reporting antibiotic susceptibility test (AST) results from standard blood culture lab procedures results is typically 48-72 hours. This causes overuse of empiric antibiotics that can result in inadequate treatment and development of adverse outcomes, including potential development of multiple drug resistant organisms (MDROs) and increased risk of *Clostridium difficile*. Clinical laboratories want to adopt new life-saving technologies but often must undergo a lengthy process of justifying the purchase or convincing the Corporate Suite (C Suite) of its value.

Therefore, in order to evaluate the usefulness of fast Identification/Antibiotic Susceptibility Testing (ID/AST) technology, the antimicrobial stewardship team can use quality tools in their efforts to adopt this new device. One of the tools that is useful in teamwork is a mind-map - a diagram used to visually organize information to which associated representations of ideas and processes are added to enhance clinical implementation. This quality tool can be effectively used in clinical settings to foster teamwork and present information to the C Suite for clinical adoption. In addition, information outlining delays in standard procedures can be presented in a process pathway and fishbone diagram. One of the tools that is useful in teamwork brainstorming sessions is a gap analysis.

ID and AST with MICs in less than about 7 hours from positive blood culture

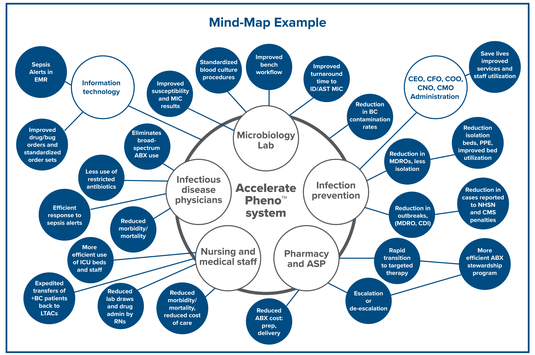
Methods

The Agency for Healthcare Research and Quality (AHRQ), the National Quality Forum, the Joint Commission, and many other national organizations endorse the use of valid and reliable measures and tools of quality and patient safety to improve health care. Many tools may be effectively applied to a variety of care settings and care processes. The use of quality tools during clinical implementation and adoption foster teamwork and enhanced communication among diverse members.

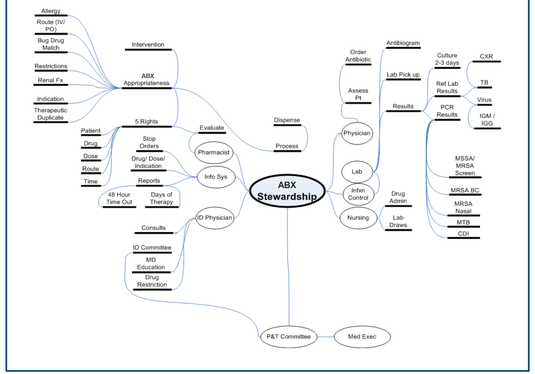
A team of 10 key opinion leaders (KOLs) that included pharmacists, infection preventionists, microbiologists, and infectious disease physicians were introduced to the use of mind-mapping, process pathways, gap analysis, and fishbone diagrams as useful tools to engage staff and obtain input into clinical implementation. KOLs worked in teams to draw mind-maps and process pathways, and to share conceptual ideas on making the business case for product adoption and implementation.

Mind-map is a diagram used to visually organize information. It is often created around a single concept, drawn as an image in the center of a blank landscape page. Associated representations of ideas such as images, words and parts of words are added to the central image. Major ideas are connected directly to the central concept, and other ideas branch out from the major ideas, either as hand-drawn "rough notes" during a lecture, meeting, or planning session (for example), or as higher quality pictures.

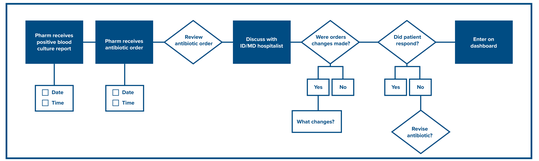
Mind-Map Example



Mind-Map Session Example on Antimicrobial Stewardship

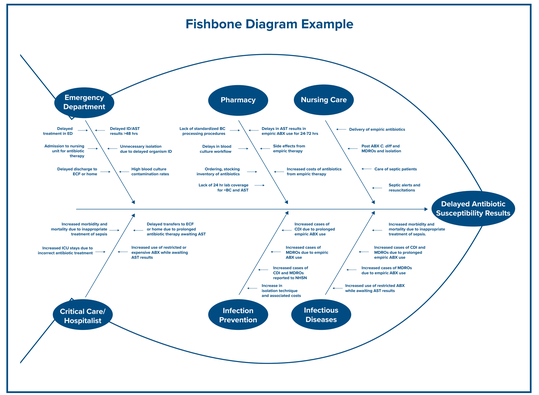


Process pathways describe the sequence of steps of procedures or processes in various hospital settings. They illustrate the route (or way of access) to reach or achieve a procedure. They are useful to identify defects in a process before implementation of new equipment, and can be used to measure areas of improvement or correction prior to clinical adoption.



A fishbone diagram identifies many possible causes for an effect or problem. It can be used to structure a brainstorming session. It immediately sorts ideas into useful categories.

Fishbone Diagram Example



Gap analysis involves the comparison of actual performance with potential or desired performance. If an organization does not make the best use of current resources, or forgoes investment in capital or technology, it may produce or perform below its potential.

Gap Analysis Example

Current State

Procedure in Lab
1. Blood cultures are delivered to a core lab
2. Blood cultures are incubated in core lab
3. Positive blood culture is Gram stained
4. Blood culture organism is identified
5. Blood culture antibiotic susceptibilities are processed

Reporting of Results
1. Gram stain result is called to the nurse
2. Blood culture ID/AST results are available in the electronic health record
3. Physician and Pharmacist review ID/AST results and review/change antibiotic therapy

Lab Gaps

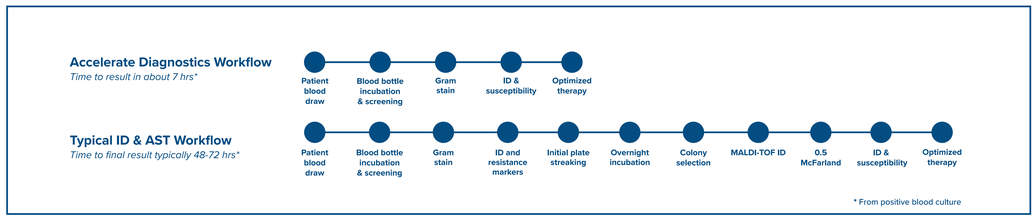
- Delivery delays to core lab >2-4 hrs
- Incubated blood cultures may not be processed for 12-18 hrs due to lack of 24 hr coverage
- Blood culture identification from time of positivity is >24 hrs
- Blood culture susceptibilities are available > 48-72 hrs

Reporting Gaps

- Nurse has difficulty contacting ID physician due to lack of 24 hr coverage
- Pharmacist has challenges with ID physicians responding to their de-escalation recommendations

Future/Desired State

1. Reduce blood culture delivery time to core lab to <1 hr with enhanced transport services
2. Reduce blood culture processing times with increased staff.
3. Implement a fast ID/AST blood culture system to finalize results in <7 hrs
4. Make blood culture ID/AST a critical value in the electronic health record
5. Hire additional ID coverage on weekends



Results

The KOL team used the quality tools to develop an extensive list of cost avoidance and return on investment opportunities. The list included items that could be measured after clinical adoption of a fast ID/AST blood culture system (the Accelerate Pheno™ system). The attendees used the quality tools to identify the following potential benefits of adopting this system:

1. Reduced morbidity and mortality
2. Enhanced patient and family satisfaction
3. Enhanced bed utilization in ED, ICU, Nursing Units, Diagnostic areas
4. Potential reduction in MDROs, *C. difficile*, and cross-infection
5. Reduced pharmacy costs and standardization of the formulary
6. More efficient lab processes and standardization of process
7. Reduced hospital supplies as a result of targeted versus empiric antimicrobial therapy
8. Potential for reduced Center for Medicare and Medicare Services penalties (readmissions with sepsis, progression to septic shock, *C. difficile*)
9. Expedited transfers back to extended care facility or long term acute care from fast ID/AST results
10. Faster reporting of positive blood cultures and susceptibilities in ED setting and ICUs, resulting in decreased length of stay and improved bed management
11. More efficient use of clinical staff - reduced pharmacy med preps and nurse medication passes, enhanced microbiology blood culture lab processes, potential for reduced sepsis responses from sepsis teams, reduced isolation for MDROs and *C. difficile*, reduced infection preventionist reporting of hospital-aquired infections, and reduced progression to sepsis cases

Conclusion

The use of quality tools is an effective method to engage KOLs and hospital staff when implementing a multi-disciplinary approach to patient care, including adoption of new technology. In the exercise presented here, attendees were able to identify items that would be important when considering implementing a new system. In this case, use of the mind-mapping, fishbone diagram, process pathways, and gap analysis allowed the attendees to identify that a fast ID/AST system for positive blood cultures could allow the healthcare team to de-escalate antibiotic therapy, provide more targeted therapy, enhance care of critically ill patients, and improve antibiotic stewardship efforts.

References
1. Ronda Hughes: Patient Safety and Quality: An Evidence-Based Handbook for Nurses. 2008
2. Joint Commission Tools for Performance Measurement, 2008
3. Brazelton de Cárdenas JN, et al. Evaluation of rapid phenotypic identification and antimicrobial susceptibility testing in a pediatric oncology center. Diagn Microbiol Infect Dis 2017

Disclosures
M Spencer, J Seaman, J Marcenelle, M Boswell, L Kirwin are all employed by Accelerate Diagnostics, Inc.