Technical BULLETIN

Antibiotic Gene Resistance Screening in the Healthcare Environment: *When and Where*

I. The Emergency Department (ED)

Antibiotic resistance has become a prominent issue within all aspects of healthcare in the United States and around the globe. The ED serves as the front line for the influx of patients, and therefore the department plays a critical role in the identification of patients with antibiotic gene resistance. It is essential that the results of these initial patient assessments be made available to pertinent members of the Infection Control and Prevention Team as soon as possible. When a significant sub-clinical infection risk or gene resistance mechanism is identified, protocols to effectively manage these patients, as well as to help prevent the spread of antibiotic resistant bacteria, is imperative to meet both clinical and financial outcome goals (see Figure 1).[1]

A. High-Risk Patients Asymptomatic of Infection

Patients who are at risk of carrying antibiotic gene resistance at the time of admission often have identifiable risk factors which include:

- *Multidrug-resistant organism (MDRO) colonization or infection within the past year*
- *Chronic hemodialysis*
- *Long-term care facility/hospital transfer*
- *Exposure to two or more antibiotics within the previous 30 days*
- *Hospitalization within the previous year*
- *Patient > 60 years with chronic health problems; particularly chronic obstructive pulmonary disease (COPD)*
- *Peritonitis*
- *ABSSSI (Acute Bacterial Skin and Skin Structure Infection)*

A prediction of MDRO colonization in these patient groups has been developed using a point scoring system using risk factors. Although this algorithm was developed for genetic drug resistance in methicillin-resistant *Staphylococcus aureus* and vancomycin resistant *enterococci*, logic would suggest that it would apply to all organisms with transferrable genetic resistance mechanisms.[2]

In addition, the Charlson Comorbidity Index (CCI) is a standardization of underlying conditions that may predispose patients to a more problematic presentation of any condition for which they are being treated (see Table 1).[3] Patients who are identified to be at-risk using the CCI criteria (cumulative CCI of ≥ 3.5) or have abnormal initial laboratory results (CBC, UA, or inflammatory markers) may also be at-risk of carrying antibiotic-resistant bacteria and appropriate screening methods can be employed.

B. High-Risk Symptomatic Patients

Identification of antibiotic-resistance genes of those patients who present to the ED with symptoms of infection, and who are in a high-risk group as noted above is central to meeting core measures. Carefully collected specimens that are representative of the infectious process should be used to determine the presence of multidrug-resistant organisms.

Patients who are symptomatic with no particular focus of infections, such as fever of unknown origin, can be screened for an antibiotic resistance mechanism using a carefully collected rectal swab. Patients who are colonized with bacteria that carry a gene that codes for antibiotic resistance typically shed these organisms via the alimentary tract. Therefore, a careful sampling of the mucosal surface of the lower sigmoid colon is ideal to identify carriers of antibiotic-resistant bacteria (Table 2).

II. Transfers Into and Out of Intensive Care Units

Patients in any of the high-risk areas of a hospital usually have a greater likelihood of having or acquiring a healthcare-associated infection that may be caused by a MDRO. These patients often develop blood stream infections, infections of the lower airway, or catheter associated urinary tract infections while being treated in these 'units'. Patients treated empirically without an accommodation for gene resistance contributes to the approximately 34,000 deaths from pneumonia and 25,000 deaths from blood stream infections each year. The use of broad-spectrum antibiotic coverage is common in these high-risk environments and the development of antibiotic resistance has been well documented.[4] The impact of infection in critical care areas is significant and an infection with the additional complications of an antibiotic-resistant bacterial infection carries an even higher burden of mortality, length of stay, and cost to the institution.

A strong case can be made to properly identify and manage patients entering a high-risk hospital environment for pre-existing infection or being colonized for genes that code for antibiotic resistance (infected or not). Similar to the logic outlined for patients in the ED, patients transferred from one area of the hospital to another, can be colonized by contact with other patients, hospital personnel, or contaminated inanimate objects. Introducing infections (clinical or sub-clinical) or organisms carrying gene resistance mechanisms into a high-risk environment can produce significant consequences.

Results of molecular or conventional testing on patients exiting any of the high-risk areas of the hospital who have had a documented infection (with or without antibiotic resistance) should be shared with personnel along the continuum of care or at discharge to another healthcare facility.[5] It is essential that the proper isolation protocols be addressed for any area of the hospital accepting these patients and to the facility that may be involved in caring for the patient for an extended period of time; e.g. a long-term care facility. As outlined in this technical bulletin, a comprehensive approach to screen for MDROs could be a useful part of an effective antibiotic stewardship program. Once discharged, the patient's home environment should also be evaluated if there are 'at-risk' family members present.

III. Screening Patients and the Hospital Environment for Bacteria That Contain Antibiotic Resistance Genes: A Part of Antibiotic Stewardship

A. Environmental surfaces in high-risk patient treatment areas can be screened using a calibration grid as outlined in Figure 2. Standardization collection techniques can provide useful information that can be used to guide decontamination efforts when heavily colonized areas are identified. It is important to include some method of a standardized collection technique so that results from one sample can be compared to that of another.

B. Bacteria Isolated from patients' specimens during routine culture and susceptibility testing that are suspected of carrying a resistance gene(s) can be submitted for testing as well. Organisms that have been carefully sub-cultured from the original specimen can be suspended into the transport media provided by Diatherix laboratories and submitted for testing.

C. Antimicrobial Stewardship Program leaders should routinely receive reports of antibiotic resistance screening as a means of improving infection control, confirming antibiotic resistance trends from retrospective antibiogram report data, and provide a metric for overall program monitoring.

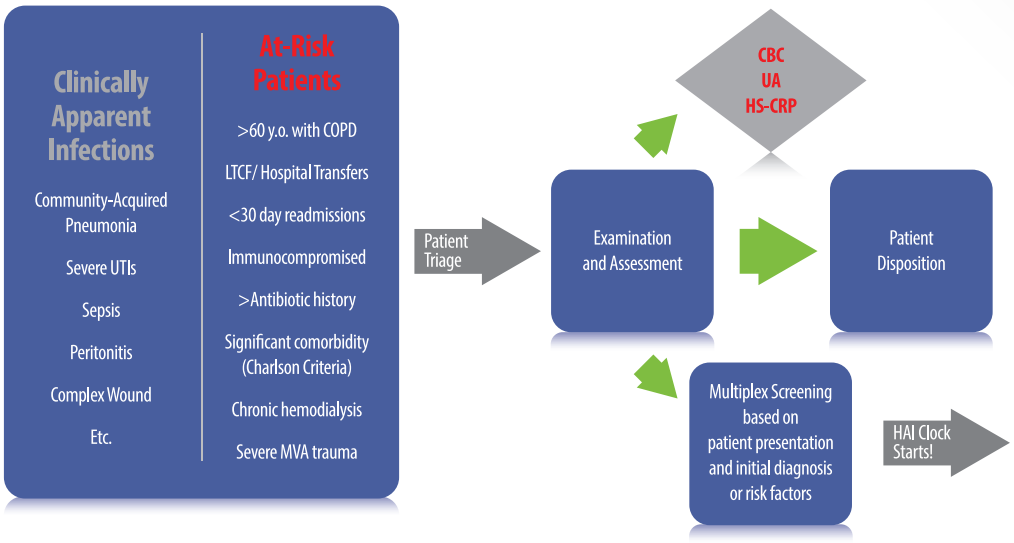
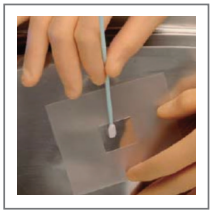


Figure 1. Initial Patient Assessment *(those with and those 'at risk' of developing infection during their hospital stay)*



Surface sampling within a high-risk hospital environment such as the ICU, NICU, or CCU may be beneficial to document the prevalence of a given antibiotic resistant bacteria. Care should be taken to swab a defined grid on a given surface so that an accurate comparison can be made to assess the effectiveness of decontamination procedures. Multiple grid sizes may be needed to effectively sample all potentially contaminated surfaces within the environment. Swabs moistened with a suitable molecular grade solution can be rolled within a grid of predetermined size to provide comparative data between samplings at some predetermined interval.[6]

Figure 2. Environmental Sampling for Antimicrobial Resistance

Table 1. Charlson Comorbidity Index (Score ≥ 3.5 = Increased Risk)

Score	Charlson Comorbidity Index Scoring System Condition
1	*Myocardial infarction (history, not ECG changes only)*
1	*Congestive heart failure*
1	*Peripheral vascular disease (includes aortic aneurysm ≥ 6 cm)*
1	*Cerebrovascular disease: CVA with mild or no residua or TIA*
1	*Dementia*
1	*Chronic pulmonary disease*
1	*Connective tissue disease*
1	*Peptic ulcer disease*
1	*Mild liver disease (without portal hypertension, includes chronic hepatitis)*
1	*Diabetes without end-organ damage (excludes diet-controlled alone)*
2	*Hemiplegia*
2	*Moderate or severe renal disease*
2	*Diabetes with end-organ damage (retinopathy, neuropathy, nephropathy, or brittle diabetes)*
2	*Tumor without metastases (exclude if >5 y from diagnosis)*
2	*Leukemia (acute or chronic)*
2	*Lymphoma*
3	*Moderate or severe liver disease*
6	*Metastatic solid tumor*
6	*AIDS (not just HIV positive)*

NOTE: For each decade >40 years of age, a score of 1 is added to the above score.
Abbreviations: ECG, electrocardiogram; CVA, cerebrovascular accident; TIA, transient ischemic attack; AIDS, acquired immunodeficiency syndrome; HIV, human immunodeficiency virus

Table 2. Specimen Collection for Screening Patients At-Risk of Carrying MDRO Organisms

Patient Type	Patient Presentation	Primary Specimen Source	Alternate Specimen Source	Alternate Specimen Source
Symptomatic Patient	Upper Respiratory Infection	Nasopharyngeal swab or aspirate of purulent material from inner ear, sinuses or fluctuant mass	Swab of purulent material from the site of inflammation or infection. (Assessment of clinical presentation should be considered before specimen collection).	
Symptomatic Patient	Lower Respiratory Infection	Fluid or brushings collected from a protected brush bronchoscopy (optimal)	Bronchial alveolar lavage	Induced sputum collection
Symptomatic Patient	Skin and Soft Tissue Infection or Wound	Swab collection of purulent material that is representative of the advancing margin of the infection (optimal)	Aspirate of purulent material from a loculated area of the lesion	
Symptomatic Patient	Urinary Tract Infection	Urine obtained from a straight catheter collection (optimal; particularly in obese patients)	Urine obtained from a properly collected clean catch procedure	
Asymptomatic Patient	Suspected Gene-Resistant Carrier	Rectal Swab. Collect specimens using a flocked swab that is inserted approximately 1 inch beyond the anal sphincter. Carefully rotate the swab to sample anal crypts (optimal)		

Note: Collection manuals are available that provide a more detailed set of instructions

Bibliography:

1. Gross, E. Multi-Drug Resistant Bacteria: Implications for the Emergency Physician. AHC Media. June 11, 2007.
2. Tacconelli, E. New strategies to identify patients harbouring antibiotic-resistant bacteria at hospital admission. Clin. Micro. Inf., Vol 12, Issue 2. Feb 2006. pp. 102-109.
3. Quan, H et al. Updating and Validating the Charlson Co morbidity Index and Score for Risk Adjustment in Hospital Discharge Abstracts Using Data from 6 Countries. American Jour. Epid. Vol 173, No. 6. Feb. 2011.
4. Antibiotic Resistance Threats in the United States. 2013. CDC. Atlanta, GA.
5. Diekema, D and Edmond, M. Look Before You Leap: Active Surveillance for Multidrug-Resistant Organisms. CID. 2007; 44:1101-7.
6. Alfa et al. Validation of adenosine triphosphate to audit manual cleaning of flexible endoscope channels. Am J Infect Control 2013 Mar;41(3):245-248.

DIATHERIX®

Linking Diagnostics to Therapeutics™

866.979.4242 / www.diatherix.com