Antibiotic Stewardship Driver Diagram and Change Package

Introduction

Prepared by the Institute for Healthcare Improvement (IHI)
Prepared for the Centers for Disease Control and Prevention (CDC)

A Framework to Reduce Inappropriate Antibiotic Utilization in Hospitals
The Centers for Disease Control and Prevention (CDC) and the Institute for Healthcare Improvement (IHI) partnered in an effort to develop this conceptual model of key drivers for reducing inappropriate antibiotic utilization. Content experts contributed to the development of this robust driver diagram and change package with a recognition and emphasis on practicality and ease of implementation in all hospitals..

"A driver diagram is a tool to help organize our theories and ideas in an improvement effort as we answer what change can we make that will result in improvement? The initial driver diagram for an improvement project might describe the descriptive theory of improved outcomes that can then be tested and enhanced to develop a predictive theory. The driver diagram should be updated throughout an improvement effort and used to track progress in theory building[i]."

Pilot Testing: From September 2011 to June 2012, CDC and IHI worked with eight hospitals on pilot testing the enclosed set of recommendations to assess the feasibility of implementation in hospitals of varying size, acuity, and location. The Driver Diagram and Change Package were modified based on that pilot testing.

How to Use The Driver Diagram and Change Package:
The Driver Diagram attempts to lay out the various processes that can lead to optimal antibiotic use. The broad categories of these processes are referred to as Primary and Secondary Drivers. The Change Package outlines a number of specific interventions that have either been demonstrated to or experts believe will positively impact the drivers. The ultimate goal is to use the interventions in the Change Package to "drive" improved antibiotic use.

We do not recommend that any facilty attempt to implement all of the interventions at once. There are a large number of interventions outlined in the Change Package, and attempting to implement too many at one time will likely create huge challenges. Rather, the Change Package is meant to serve as a menu of options from which facilities can select specific inerventions to improve antibiotic use.

Selection of specific interventions to implement should be tailored to the areas that most need improvement at each facility. Facilities should assemble a multi-disciplinary team of physicians, pharmacists, nursing, microbiology and administration to discuss the aspects of antibiotic use that are most in need of improvement. The team can then select specific interventions from the Change Package to address those issues. It is important to select the interventions that are most supported by clinical staff.

It is essential to monitor and measure. The Driver Diagram and Change Package come with a Measurement Framework, which suggests various measures of antibiotic use that might be useful to assess the effectiveness of improvements. Just as important is the measurement of "small tests of change" to assess the implementation of interventions. Reviews of small numbers of charts or discussions with clinicians can identify potential barriers to implementation.

Antibiotic Stewardship Change Package

Overarching Driver: Leadership and Culture

Secondary Driver	***Key Change Concepts***	***Specific Change Ideas***
Promote a culture of optimal antibiotic[i] use within the facility	Engage administrative and clinical leadership to champion stewardship effort	1. Identify clinical providers as champions to be thought leaders about antibiotic stewardship. 2. Work with administrators to ensure that they understand the rationale and goals for stewardship programs and interventions so that they can provide support (financial and non-financial). 3. Engage a physician champion and core team to enhance the focus of antimicrobial stewardship into the current process of care. 4. Bring disciplines together to improve communication and collaboration about improving antibiotic use, including, as appropriate: • Infection preventionists; • Hospitalists; • Intensivists; • Emergency department physicians; • Microbiologists; • Pharmacists; • Nurses; and • Infectious disease experts. 5. Consider having the multidisciplinary group perform a gap analysis of antimicrobial use at the facility to identify priority areas for improvement.

Primary Driver 1: Timely and Appropriate Initiation of Antibiotics

Secondary Driver	***Key Change Concepts***	***Specific Change Ideas***
Promptly identify patients who require antibiotics	Develop a standardized process to identify patients who require antibiotics	1. Develop standardized diagnostic criteria for identifying patients with signs and symptoms suggesting specific types of infection (e.g., community acquired pneumonia (CAP), urinary tract infection (UTI), skin/soft tissue infection (SSTI), bloodstream infection (BSI), sepsis etc). These criteria should also clearly specify situations when antibiotics are not indicated (e.g. non-infectious mimics of CAP). 2. Develop evidence-based clinical pathways[ii] that guide diagnostic testing and treatment for these common infections. 3. Consider a computerized decision support system to enable physicians to identify which patients require antibiotics.
Obtain cultures prior to starting antibiotics	Create standardized protocols for ordering and obtaining cultures and other diagnostic tests prior to initiating antibiotics	1. Utilize prompts for obtaining cultures in automated medication dispensing systems available in ED, ICU, etc. 2. Develop processes to ensure cultures are properly and consistently ***ordered*** that include: • Prompts on antibiotic orders or physician order entry to remind users to obtain appropriate cultures; • Culture prompts or default orders incorporated into standardized order sets for various conditions (e.g., CAP, UTI, SSTI, BSI); • Guidance on appropriate specimen type and culture common infections (e.g., CAP, UTI, SSTI, BSI); • Guidance on frequently inappropriate culturing practices (e.g., swabs of wounds, urine cultures from asymptomatic patients). 3. Develop processes to ensure cultures are properly and consistently ***obtained*** that include: • Protocols empowering/authorizing nursing staff to obtain cultures if other providers fail to order them when starting antibiotics; • Guidance on appropriate specimen collection for specific indications (e.g., number of blood cultures and volume of blood, cultures for anaerobic pathogens, rapid diagnostic tests); • Visual cues in locations near antibiotic storage reminding staff to ensure cultures have been obtained; • Flags or other signal (at the bedside, in the electronic medical record (EMR), in the chart) to make it apparent if cultures have not yet been obtained, and checkboxes indicating that cultures have been obtained; • A system to ensure cultures are obtained in patients transferred from the emergency department (ED) to the intensive care unit (ICU) or ward. 4. Develop processes to ensure cultures are properly and promptly transported and processed. 5. Develop standards for and assess reliability of processes for ordering and obtaining a culture for the following five steps: • Appropriate specimen; • Appropriate collection (i.e., before antibiotics were started); • Appropriate labeling; • Transport to lab (i.e., time from obtaining specimen to receipt in lab) • Processing of specimen (i.e., time from receipt in lab to start of processing).

Primary Driver 1: Timely and Appropriate Initiation of Antibiotics

Secondary Driver	***Key Change Concepts***	***Specific Change Ideas***
Do not give antibiotics with overlapping activity or combinations not supported by evidence or guidelines	Develop a way to inform clinicians about unnecessary combinations of antibiotics, including "double coverage"[iii]	1. Develop a list of agents that should generally not be combined and develop a mechanism for pharmacy to flag these combinations for review (e.g., double anaerobic coverage). 2. Leverage the EHR with decision support at the point of care to trigger ABs with overlapping activity or combinations not supported by GLs. 3. Standardize a mechanism for review and follow-up of combinations of agents that are not recommended. 4. Develop evidence-based guidelines for the specific conditions in which combination therapy is recommended and what agents should be combined (based on local formulary and patterns of resistance). • In general, use of combination therapy should be limited to empiric coverage of multiple drug resistant organisms (MDROs) prior to obtaining culture results.
Determine and verify antibiotic allergies and tailor therapy accordingly	Choose antibiotic based on patient allergies	1. Consider patient allergies when initiating or changing therapy. 2. Ensure that antibiotic allergies are obtained and documented in the medical record. Documentation should include the antibiotic and the type of reaction (e.g., anaphylaxis, rash etc). 3. Incorporate patient allergies as a required field in the EHR (ie: nursing assessment) 4. Ensure antibiotic allergy history distinguishes true allergies that would preclude use (e.g., anaphylaxis) from adverse drug reactions (e.g., diarrhea). • Involve patient and family in identifying and confirming allergies; • Consider testing for beta-lactam allergy to confirm antibiotic allergy. 6. Prominently flag medical record or computer order entry system to denote patient allergies to antibiotics. 7. Standardize all hand offs to include assessment and review of patient allergies.
Consider local antibiotic susceptibility patterns in selecting therapy	Develop a standardized process for antibiotic selection	1. Develop facility-specific guidance for diagnosing and treating infections and using antibiotics. • Consider starting with most commonly treated infections and/or most commonly used antibiotics and most common treatment errors (e.g., when anaerobic coverage is needed); • Base the guidance on evidence as well as local susceptibility data and facility formulary; • Involve pharmacy and microbiology staff in developing and supporting antibiotic selection guidance. 2. Imbed facility-specific guidance in evidence-based clinical pathways and order sets. 3. Utilize the EHR with clinical decision support functionality to support antibiotic selection. 4. Ensure that selection guidelines consider: • Site of infection; • Pharmacokinectics/dynamics of the agent • Pathogen(s) that is the most likely cause of the infection being treated and its susceptibility profile in the hospital and community; • Toxicity; • Potentially complicating comorbid conditions (e.g. renal dysfunction); • Severity of the infection; • Hospital formulary and cost.

Secondary Driver	***Key Change Concepts***	***Specific Change Ideas***
Consider local antibiotic susceptibility patterns in selecting therapy ***(continued)***	Develop a standardized process for antibiotic selection ***(continued)***	5. For usual clinical scenarios in patients who are not critically ill, ensure that selection guidelines target for the "norm," rather than for rare or unlikely events. • Choose antibiotics with the narrowest spectrum and least cost possible. 6. For critically ill patients, ensure that selection guidelines permit broad spectrum coverage of antibiotic resistant pathogens based on local susceptibility patterns. 7. Ensure facility guidelines make antibiotic susceptibility patterns and the cost of antibiotics visible to clinicians at the point of care.
Start Treatment Promptly	Develop processes that support prompt treatment of patients requiring antibiotics	1. Develop standard order sets/pathways for common infections that clearly specify appropriate time from ordering to administration and monitor adherence to these standards. • Consider signage in the chart or room to specify the time by which antibiotics must be given. 2. Develop a system for ensuring prompt treatment of patients transferred from the ED to the ICU or ward. 3. Identify patients experiencing delays in antibiotic ordering and administration and assess and address delay-prone aspects of the system. 4. Define a process to expedite decision making when attending physician is not immediately available to order therapy.
	Ensure antibiotics are readily available	1. Follow the delivery chain from order to pharmacy and back again to ascertain where efficiencies can be gained. 2. Consider keeping frequently used antibiotics available in the ED and on the floor[iv].
Specify expected duration of therapy based on evidence and national and hospital guidelines	Incorporate evidence-based guidelines for duration of antibiotics into standard protocols and/or computerized decision support	1. Develop evidence-based clinical pathways that standardize the duration of treatment. 2. Permit physicians to opt out of the standard duration of treatment, but require documentation of the rationale[v]. 3. Consider a system for automatically discontinuing antibiotics based on national and facility guidelines e.g. after 24 hours (surgical prophylaxis). 4. Consider requiring re-ordering of antibiotics after a specified time period, e.g. 7-10 days. 5. Utilize the EHR with clinical decision support functionality to establish appropriate duration. 6. Reassess the need for and prescribed duration of antibiotics daily and at all transitions in care.

Primary Driver 2: Appropriate Administration and De-escalation

Secondary Driver	*Key Change Concepts*	*Specific Change Ideas*
Make antibiotics patient is receiving and start dates visible at point of care and in electronic health records (EHR), as applicable	Ensure a clear history of patient antibiotic use is obtained and available.	1. Define a prominent location in the medical record and at the bedside for antibiotic therapy to be documented (e.g., "this is day X of Y") – this may require modifications to the Medical Administration Record (MAR) 2. Build a check-in on start/stop dates into the process of care (ie: patient rounding) 3. Use reminders in the EHR if this information is not complete. 4. Make sure start dates, stop dates and duration are also available in the pharmacy electronic system and available for review. 5. Develop a system to ensure that antibiotic days are counted correctly (e.g., does the first day of therapy count as day zero or day one?). 6. On admission, collect a complete list of the antibiotics a patient is taking (i.e., what antibiotic the patient is on, at what dose, when it was started). 7. When modifying antibiotics, establish system/mechanism to prevent a new start date when 1st regimen of AB is modified. EHR may require specific programming to do this properly.
Give antibiotics at the right dose and interval	Establish a process for delivery customized to the antibiotics and the patient	1. Imbed dose and interval in guidelines, clinical pathways, and order sets. (e.g. UTI) Make explicit the cases where pharmacy will do dosing. 2. Customize the administration based on individual patient, pathogen, site of infection, toxicity, and pharmacokinetic and pharmacodynamic characteristics of the drug. 3. Ensure guidelines, pathways and order sets include alerts on when dose adjustments might be indicated (e.g., for renal dysfunction). 4. Utilize the EHR with clinical decision support functionality to establish right dose and interval. 5. Establish a mechanism for pharmacy to review cases where dose adjustments might be indicated (e.g., in patients with renal dysfunction, or when more toxic agents like aminoglycosides are prescribed). Include a reminder system to pharmacy to identify appropriate patients.
Stop or de-escalate[vi] therapy promptly based on the culture and sensitivity results	Establish process for prompt notification of culture and antibiotic susceptibility results[vii]	1. Standardize the notification process by setting a time frame within which culture results must be reported and to whom. 2. Leverage the EHR system with clinical decision support functionality to faciliatate notification. 3. Develop list of "critical results"/positive cultures to report to the physician via page or automated means such as a text message (e.g., MDRO). • Ensure that the reporting system includes mechanisms to alert responsible clinical staff when the attending physician is unavailable; • Develop and monitor a standard timeframe for reporting and receiving critical results.

Secondary Driver	*Key Change Concepts*	*Specific Change Ideas*
Stop or de-escalatevi therapy promptly based on the culture and sensitivity results ***(Continued)***	Stop or de-escalate antibiotic based on culture result	4. Standardize the process for discontinuing antibiotics: • When positive cultures most likely represent colonization rather than infection. • If cultures are negative or alternative non-infectious agent is diagnosed in 48 to 72 hours. Permit physicians to opt out of automatically discontinuing antibiotics based on negative culture results, but require documentation of the rationale. 5. If indication for antibiotics is clearly identified, de-escalate therapy to target the susceptibilities of the pathogen. 6. Standardize all hand offs to include review of culture results or pending culture results, antibiotic duration, and current plans for antibiotic discontinuation. 7. Include de-escalation guidelines in standard pharmacy training.
Reconcile and adjust antibiotics, at all transitions and changes in patient's condition	Look for all opportunities to stop or change (de-escalate or broaden) antibiotic therapy when patient condition changes and/or when changing levels of care	1. Utilize every Multi-Disciplinary Round (MD) and transition in care to ensure: • Antibiotic matches pathogen and sensitivity; • The dose and dose interval are correct given current clinical status (e.g., renal function may change); • Appropriate toxicity monitoring is occurring; • Duration is clearly specified and there is an end date for the therapy; • Opportunities for discontinuation or de-escalation in therapy are considered; • Whether patient can be converted from intravenous to oral (IV to PO) antibiotics. 2. Consider an "antibiotic time out" to support reconciling and adjusting antibiotics. 3. Pay special attention to antibiotic duplication on conversion day.
Monitor for toxicity reliably and adjust agent and dose promptly	Ensure appropriate monitoring and adjustment of agent	1. Ensure a reliable process to monitor for antibiotic toxicity and promptly adjust agent and dose. • Facility antibiotic guidelines, order sets, and pathways should include information on what toxicity monitoring should occur for the recommended antibiotic(s). • Consider developing specific guidelines/pathways/order sets to ensure proper toxicity monitoring of more toxic agents (e.g., aminoglycosides). 2. Select antibiotics that maximize therapeutic impact while minimizing toxicity.

Primary Driver 3: Data Monitoring, Transparency, and Stewardship Infrastructure

Secondary Driver	***Key Change Concepts***	***Specific Change Ideas***
Monitor, feedback, and make visible data regarding antibiotic utilization, antibiotic resistance, ADEs, *C. difficile*, cost, and adherence to the organization's recommended culturing and prescribing practices	Establish real-time monitoring and measurement systems	1. Develop a process for ongoing monitoring and measurement of: • Antibiotic utilization and resistance patterns; • *C. difficile* rates. • Costs associated with antibiotic use • Process measures for timely and appropriate initiation of antibiotics • Process measures for appropriate administration and de-escalation 2. Using these measures, report a "family of measures" for antibiotic stewardship to senior leadership on a monthly basis: • include measure of cost • present data in time series chart to show trends • annotate charts with information on the stewardship program 3. Develop a way to communicate local and hospital data on antibiotic susceptibility patterns. • Inform antibiotic formulary selections based on local and hospital susceptibility patterns. 4. Develop a mechanism for systematically reviewing antibiotic selection and administration and influencing physician choice based on behavior science principles, including but not limited to[viii]: • Prospective audit and feedback of adherence to hospital standards with peer benchmarking; • "Academic detailing"; • Education targeted at continuing medical education and maintenance of certification requirements; • Mobilization of local opinion leaders and change agents; • One-on-one mentoring of non-adherent physicians about antibiotic use and evidence-based care. 5. Develop a mechanism to provide visible and ongoing feedback: • Prominently post data on ADEs, *C. difficile* rates, antibiotic utilization, and resistance patterns where all hospital staff can see; • Provide direct feedback data to prescribers on their antibiotic use, including cost; • Provide staff with feedback about antibiotic compliance using posters, email, newsletters, etc.; • Consider making data on utilization, resistance, and ADEs available in public areas to inform and educate patients and families about the importance and role of antibiotic usage. • Ensure the C-suite and CFO understand the rationale and results of the program to support it financially.

Secondary Driver	*Key Change Concepts*	*Specific Change Ideas*
Develop and make available expertise in antibiotic use	Cultivate local expertise among staff	1. Improve antibiotic knowledge of clinical staff, including hospitalists, nurses, physician assistants, nurse practitioners, etc. (e.g., ordering of cultures, antibiotic spectra). 2. Develop and make available expertise in pharmacology (i.e., pharmacokinetics and pharmacodynamics) and antibiotic spectrum and activity, and ensure that such expertise is available to clinicians at the point of care. 3. Consider developing short, targeted educational messages, ideally based on local issues, that can be disseminated on a regular basis (e.g., monthly). 4. Develop and disseminate key antibiotic use messages to facility staff using a variety of mechanisms, depending on resources (e.g., posters, emails, meeting announcements, posters, academic detailing etc).
	Develop a process for antibiotic formulary management	1. Designate a group to make decisions about the facility antimicrobial formulary (e.g., P&T committee, antimicrobial subcommittee). 2. Develop formal criteria for use of defined antibiotics as a guide for use by pharmacists on the floor. 3. Consider developing criteria for use or requiring prior approval for the use of certain antibiotics, e.g., those that are "last lines of defense," highly toxic or very expensive. 4. If not already done, consider closing the antimicrobial formulary.
Ensure expertise is available to clinicians at the point of care	Create processes to ensure availability of expertise	1. In hospitals with extensive clinical pharmacist support, develop protocols for pharmacists to directly intervene at the point of care to improve selection and administration of antibiotics. • Consider antibiotic alerts in clinical decision support systems with guidance on defined antibiotics. 2. In hospitals without extensive clinical pharmacist and infectious disease specialist support: • Develop a system to have access to clinical pharmacist and infectious disease experts for consultations in complex situations; • Consider shared or virtual expertise in settings where infectious disease and/or clinical pharmacists are not available in house; • Develop training for staff pharmacists to enhance their ability to support antibiotic therapy at the point of care. 3. In academic centers, ensure that infectious disease fellows are fully trained and competent to provide advice at the point of care or virtually, including on nights and weekends. 4. In facilities where ID consultation is available, consider developing criteria for situations where ID consultation is strongly recommended (e.g., complicated infections, prior to placing PICC lines for home IV antibiotics). 5. Develop a process for real time decision support at the point of care. 6. Create a structure for validating competency across disciplines and roles.

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Notes:

[i] "Antibiotic" is used throughout the change package to support specific efforts to improve patient care and decrease costs related to antibiotic utilization. Appropriate use of other antimicrobials, such as antifungal agents, should also be considered.

[ii] Clinical pathways are used throughout the change package as a method for translating clinical practice guidelines into a clear paper or computerized document specifying key actions that need to be performed at specific times. These pathways are intended to provide real-time decision support at the point of care to facilitate implementation of evidence-based guidelines. They should be developed with multi-disciplinary input to ensure that providers can utilize them within their normal work flow. Three key components of successful pathways include:

1. Clearly specified key evidence-based actions;
2. Timing of these actions; and
3. Documentation of deviations or variations in care, including opt-out provisions.

[iii] "Double coverage" or "combination therapy" refers to the practice of intentionally administering antibiotics with overlapping spectra of activity.

[iv] *Consider keeping frequently used antibiotics available in the ED and on the floor.*
It is important that antibiotics stored at the point of care—in the ED or the OR—are maintained and restocked. Ensure that there is documentation of administration of antibiotics obtained from local stocks.

[v] Two standard opt-out provisions to allow for provider discretion are:

1. Permit physicians to opt out of the standard duration of treatment, but require documentation of the rationale whenever prescribing against evidence-based guidelines;
2. Permit physicians to opt out of automatically discontinuing therapy based on local policy (e.g., prophylactic antibiotics for surgery), but require documentation of the rationale.

[vi] De-escalation refers to the practice of changing to more targeted therapy and/or discontinuing empirical therapy based on clinical criteria and culture results.

[vii] *Establish process for prompt notification of culture and antibiotic susceptibility results.*
For the purposes of this change package "cultures" is being used as a general term that reaches beyond the strictest definition to include results of rapid diagnostic tests, including viral tests.