Using Electronic Health Records for Antibiotic Stewardship

STRENGTHEN YOUR LONG-TERM CARE STEWARDSHIP PROGRAM BY TRACKING AND REPORTING ELECTRONIC DATA

Introduction

Why Use Electronic Systems for Stewardship?

Antibiotic stewardship (AS), or the coordinated approach to improving antibiotic use, has become an essential part of patient care and quality improvement in long-term care settings. There is no single correct way to implement stewardship activities, but there are some essential components. Centers for Disease Control and Prevention (CDC) has outlined seven core elements of antibiotic stewardship in nursing homes.[1] These elements are leadership, accountability, drug expertise, action, tracking, reporting, and education. Although any of these stewardship components could be challenging to put into place, often the most challenging for nursing homes are action, tracking, and reporting. Progress in these three areas can be accelerated by use of electronic data.

This document is meant to provide guidance to nursing homes looking to implement AS by harnessing the capabilities of an electronic health record (EHR) system. Here, we describe the general approach to using an EHR system to support stewardship implementation, key pieces of data to acquire from the system, and how an EHR system might be used to drive action and facilitate antibiotic use tracking and reporting.

Before You Get Started

As all EHR systems differ in user interface and capability, the guidance provided here is general. We encourage you to work with individuals in your facility that know the EHR system well and contact your software vendor to find out if they have any new AS capabilities available and/or can help you trouble-shoot specific challenges that arise. Even if no one in your facility is an EHR system expert for infection prevention or tracking antibiotic prescribing, there might be someone who has used the system extensively for patient admissions, tracking quality improvement measures, or finance, billing, minimum dataset development, and reimbursement. Such an individual might be able to assist you in development of reports, alerts, forms, etc. and incorporation into EHR work flow.

Definitions

Antibiotic start- Initiation of antibiotic administration; can be a single dose administration or the first dose of a multi-dose course of an antibiotic. If administration of two antibiotics is initiated on the same day, two antibiotic starts have occurred that day.

Antibiotic time-out- Active assessment of an antibiotic prescription that occurs 48–72 hours after first administration, taking into account clinical response to treatment, new diagnostic information, and culture and sensitivity testing results on the infectious organism (or lack thereof).

Data element- A piece of information collected for review, analysis, or further calculation.

Metric- A measure that can be calculated by using data elements (e.g., days of therapy by month in a facility can be calculated by adding the days of therapy for all residents over the course of the month)

Priorities Outlined in this Document

Antibiotic use (AU) tracking is central to stewardship implementation. In order to determine whether stewardship priorities and the effect of stewardship implementation, we must measure and review AU. This document highlights four priorities for AU tracking and reporting, as listed below. It is up to your team to decide where to start.

1) Identification of residents currently on antibiotics for daily antibiotic time-out assessments,
2) Measurement of AU for routine review of reports with consulting pharmacists, providers, staff, and administration,
3) Review of antibiotic appropriateness, and
4) Tracking of resident infections.

Before going into these priorities in detail, it is important that we describe the data elements and metrics required to measure and report AU.

Antibiotic Use Data Elements and Metrics

There are several ways to measure AU (e.g., antibiotic “starts”, days of therapy (DOT), point prevalence survey). If a long-term care facility has access to an EHR system, it is recommended that antibiotic starts (initiation of therapy) and DOT be tracked simultaneously. It is also recommended that, where possible, AU be based on administration (first dose administered), rather than pharmacy order or prescription. Where available, a medication administration record (MAR) is the best source of data, as it will prevent tracking of prescriptions that were changed or never filled.

Tracking antibiotic starts will allow a facility to assess the number of patients started on an antibiotic inside and outside of the facility and follow-up with these patients in real-time for post-initiation time-out and reassessment (see below). This tracking can also be linked directly

to the process of infection tracking and the retrospective determination of prescribing appropriateness.

The DOT metric reflects the number of days of antibiotic use for each resident and for a facility or unit over a given period of time. Tracking DOT will allow you to consider the appropriateness of treatment length. It will also allow comparison of overall antibiotic use across units and over time. DOT is also the measure used to track antibiotic use in hospitals.

Data Elements

Listed in Table 1 are the key data elements that should be accessible from your EHR system. For each resident administered antibiotics during your selected timeframe, these pieces of information should be extracted into a single report. If a resident is administered more than one antibiotic in a given report's timeframe, that resident will appear on the list more than once.

The data elements could be retrieved from your facility EHR system and/or from your pharmacy's antibiotic export listing. Use both sources of data to ensure comprehensive and accurate data collection. Investigate discrepancies to find opportunities for quality improvement.

Some of the elements listed in Table 1 might not yet exist in your EHR or pharmacy system. These are marked with an asterisk (*). Depending on the capability of your EHR system and the size of your facility, you might decide to incorporate these elements in your electronic record keeping (recommended) or input the detail by hand after the report is generated.

Where possible, data should be exported into a useable database (e.g., Microsoft Excel), in which calculations can be conducted and data visualization can be done (e.g., graphs of use over time, by prescriber, by drug). Data exported in CSV or Excel format can be easily manipulated.

Table 1. EHR System Data for Antibiotic Stewardship

Data Element	Use	Why is this Important?
Data Needed for each Administered Course of Antibiotic		
Resident Age	• Track antibiotic prescribing by age	• Understanding who receives antibiotics in your facility, and where those residents are located, can be helpful in targeting prescribing improvements.
Resident Sex	• Track antibiotic prescribing by sex	
Unit/location	• Track antibiotic prescribing by facility location	
Antibiotic Name	• Track use of therapeutic and drug classes • Assess appropriateness of antimicrobial choice • Definition of therapeutic and drug class should be consistent with National Healthcare Safety Network (NHSN) categorization	• Some antibiotics are more harmful to individual patients and the overall problem of resistance than others, so it is important to understand prescribing trends. • Appropriateness is based on need for treatment but also selection of the appropriate drug, dose, and duration.

Data Element	Use	Why is this Important?
Therapeutic and Drug Class	• Track use of antibiotic classes • Assess appropriateness of antibiotic choice • Definition of antibiotic class should be consistent with NHSN categorization[a]	• Because resistance of bacteria is often to an entire antibiotic class, it is meaningful to track use at this level, in addition to individual drugs. • Some antibiotic classes are associated with more adverse events (e.g., fluoroquinolones)
Dose	• Assess appropriateness of antibiotic prescription	• Dose is used to assess adherence to best practices.
Duration	• Assess appropriateness of antibiotic prescription	• Duration is used to assess adherence to best practices.
Route	• Assess appropriateness of antibiotic prescription	• Route is used to assess adherence to best practices.
Indication	• Track syndromes, conditions for which antibiotics might be warranted • Assess appropriateness of antibiotic choice and prescription • Track prophylactic use of antibiotics	• Indication is used to assess adherence to best practices.
Prescriber identifier	• Track prescribing by individual providers • Provide provider-specific reports on prescribing practices • Identify need for prescribing improvement among internal, external providers	• Improving antibiotic prescribing can be difficult because it requires behavior change. • Providing data to prescribers can make them more aware of their prescribing behaviors and habits. • Routine and ongoing feedback to prescribers can help change practices, especially when practices are anonymously compared to those of other prescribers.
When Ordered (time of day)	• Track antibiotic prescribing and appropriateness by facility shift • Identify potential shift or provider support-related prescribing challenges	• Determining whether prescribing practices differ by time of day or work shift can be helpful in targeting prescribing improvements.
Location of Order (internal/external, as explicit as possible)	• Track prescriptions made within and outside of facility • Identify need for prescribing improvement among internal, external providers	• The approach to improve prescribing for internal and external providers might differ. • Prescribing changes for internal providers might come from sharing prescribing reports, group meetings to review progress, or continuing education sessions. • Addressing excess or inappropriate prescribing by external providers (e.g., emergency departments) might be best addressed with standardized us of antibiotic time-outs.
Start Date (date of first dose)	• Measure duration of antibiotic therapy for individual resident • Calculate antibiotic starts and DOT across all residents in facility	• Tracking of AU can be done by calculating DOT and/or antibiotic starts. • AU measurement allows visualization of progress over time.
End Date (date of last dose)	• Measure duration of antibiotic therapy for individual resident • Calculate DOT across all residents in facility	

Data Element	Use	Why is this Important?
	• Assess appropriateness of antibiotic duration	
Days Present/length of stay	• Calculate days that resident has been present in facility during current admission • Sum of all resident days present can be used as denominator in calculation of DOT rates	• Days present is used as a resident-level denominator for understanding antibiotic use.
Short/Long-Term Stay (if available)*	• Track prescribing by resident characteristics	• Understanding who receives antibiotics in your facility, and where those residents are located, can be helpful in targeting prescribing improvements.
Antibiotic Time-Out Conducted at 72 Hours (if utilized; yes/no)*	• Track compliance with essential AS intervention	• Antibiotic time-outs occur to determine if a change in antibiotic is needed or if an antibiotic can be discontinued. • New information (e.g., diagnostic test results, patient response) is taken into consideration. • In nursing homes, this usually occurs 72 hours after initial administration or return of the resident from another care setting (e.g., emergency department).
Creatinine Clearance (if available)*	• Assess appropriateness of antibiotic prescription	• When available, pharmacists use creatinine clearance to adjust antibiotic prescriptions for safety and efficacy. • Making this information available to pharmacists upon script submission is ideal. • Retrospective review of creatinine clearance can be used to assess prescription appropriateness.
Data Needed for Facility-level Denominator		
Resident days (stratified by unit)	• Equal to the number of residents present in the facility (and each unit) at a single time (e.g., 8AM) each day • Used to calculate facility and unit rates of antibiotic starts and DOT	• Resident days is used as a facility-level denominator for understanding antibiotic use.

Antibiotic Use Metrics

AU data elements (Table 1) can be used to calculate AU metrics, which facilitate tracking and assessment of prescribing for individual residents, across a facility, across units, and over time. Table 2 lists some basic metrics that should be calculated by using your EHR data.

Table 2. Calculated Metrics for Antibiotic Stewardship

Metric	How to Calculate	Use	Why is this Important?
Days of Therapy (DOT) for Each Resident	• Count of the number of individual antibiotic drugs (not doses) given to a resident on each calendar day of the selected timeframe	• Determine DOT during individual resident stay • Summed to determine DOT	• DOT are useful to evaluate total AU burden.

Metric	How to Calculate	Use	Why is this Important?
	• DOT for each drug = administration end date –start date +1 • DOT for each drug is counted separately, then summed for total resident DOT over timeframe	across facility (see below)	• Incorporates both number of drugs given and days of exposure.
Days of Therapy (DOT)/1,000 Resident Days	• Numerator (x): sum of resident DOT over selected time frame, for selected units • Denominator (y): sum of resident days over selected timeframe, for selected units • Calculate = x/y*1,000	• Track DOT across all residents in facility over selected timeframe • Calculate for entire facility or by unit	
Antibiotic Starts/1,000 Resident Days	• Numerator (x): sum of antibiotic starts listed in dataset over selected time frame, for selected units • Denominator (y): sum of resident days over selected timeframe, for selected units • Calculate = x/y*1,000	• Track antibiotic starts across all residents in facility over selected timeframe • Calculate for entire facility or by unit	• Antibiotic starts can be easier to measure than DOT. • Antibiotic start tracking allows measurement of AU and facilitates review of prescription appropriateness (indication, dose, duration, and route). • Measurement of antibiotic starts allows exclusion of prescriptions that originated externally.
Percent of Antibiotic Starts Receiving Assessment Time-Out	• Numerator (x): sum of completed antibiotic time-outs over selected time frame, for selected units • Denominator (y): sum of antibiotic starts over selected timeframe, for selected units • Calculate = x/y*100%	• Measure compliance with prospective antibiotic assessment (time-out) protocols, if in place. • This might be a challenging metric to calculate, depending on type and compliance with EHR documentation.	• In addition to tracking AU, a key part of AS is coordination of efforts to improve prescribing. • Use of antibiotic time-outs ensures each antibiotic prescription is reviewed in real-time.

Antibiotic Time-Out Assessments

AS is the implementation of coordinated interventions intended to improve the use of antibiotics. Antibiotic time-outs are a core practice in stewardship, as they provide a real-time way to assess antibiotic appropriateness. More specifically, time-outs allow assessment of drugs prescribed empirically based on clinical response and when the results of diagnostic tests become available. A reassessment conducted at 72 hours (a timeframe that incorporates potential weekend limitations) after initiation of the antibiotic should focus on the following questions:[2]

- Does this patient have an infection that will respond to an antibiotic?
- If so, is the patient on the right drug(s), dose(s), and route(s) of administration?

- Can a more targeted antibiotic be used to treat the infection (de-escalate)?
- Does the resident need broader spectrum coverage (escalation)?
- How long should the patient receive the drug(s)?

EHR systems can facilitate the time-out process by any of the following:

- Providing automated alerts for each patient on antibiotics, timed for 72 hours post-initial administration
- Generating a list of all patients in need of a 72-hour antibiotic review on a given day
- Documenting the completion of an antibiotic time-out in the resident health record, for assessment of staff compliance with time-out protocols (see also Table 2)

Major EHR systems have the capability to set alerts, generate user-defined reports, and include additional fields in resident health records. Work with facility staff experienced with your EHR system or contact your EHR vendor if you need assistance in setting up the above recommended management settings.

Review of Antibiotic Use

We will highlight two components of AU review: amount of antibiotics used and appropriateness of AU. EHR data and metrics described in the previous section will be relevant here. Development of AU reports is dependent on the availability of discrete data. Because prescribing expertise is required for critical assessment of prescribing data, both components of AU review should be conducted with a prescriber and/or consultant pharmacist.

Reviewing AU can facilitate identification of use patterns and impact measurement of AS interventions. Work with your consultant pharmacist or other relevant prescribing experts to develop a list of ways in which the data should be stratified. For example, you can generate reports of antibiotic starts or DOT by facility unit, short/long-term stay residents, drug class, or indication. Keep in mind that, when assessing the impact of AS implementation, interventions might not influence all measures of AU. For example, if you have implemented a 72-hour antibiotic time-out policy or are making efforts to shorten the duration of use, you might not see a difference in antibiotic starts, but you would likely see a decrease in DOT. If you are including interventions to improve antibiotic selection, you might not see a change in overall antibiotic starts or DOT, but you would likely see a difference when stratified by drug class. Work with your AU consultant, EHR-savvy staff, and, if necessary, the EHR vendor to develop the right dataset and reports for your intended review process.

By using the data elements and metrics described above, you might also develop prescriber-specific reports, so that individual providers can review their own prescribing practices over time and, if desired by the AS program and administration, in comparison with other providers serving facility residents. Although presenting an advanced level of complexity, facilities with strong information technology capabilities might stratify provider-specific reports by syndrome and drug to highlight practices in areas targeted for AS interventions (e.g., management of asymptomatic bacteriuria and urinary tract infections).

Review of Antibiotic Appropriateness

Retrospective Prescription Review

Prescribing appropriateness can be assessed with the EHR data elements described above. You will need to also review the facility's infection tracking log and/or resident health records for the same timeframe as the AU data. If possible, consider incorporating infection categorization data fields into your EHR system, so that infection surveillance information is recorded directly into resident health records. See more on this in the section below.

Appropriateness review can be conducted by using resident-level antibiotic starts data and/or DOT data. If antibiotic starts data are used, antibiotic necessity, drug choice, and dose can be assessed. If DOT data are used, duration of therapy can also be assessed.

Move resident by resident down the list of administered antibiotics, referring to the infection tracking log to determine appropriateness. Prescribing appropriateness in each of these categories [i.e., antibiotic necessity (yes/no), drug choice (appropriate/inappropriate), dose (appropriate/inappropriate), and +/- duration (insufficient/appropriate/excessive)] should be described for each antibiotic order. Some residents might be reviewed more than once if they have had multiple antibiotic prescriptions in the review timeframe.

Develop facility-specific diagnostic criteria based on Loeb criteria or McGeer criteria.[b] These can can be used to review clinical antibiotic appropriateness, both for real-time prescribing decisions and for retrospective assessment.[3,4] CDC has assessment tools available for retrospective AU appropriateness assessment.[5] Consider using these forms when reviewing data with the consultant pharmacist and/or provider.

A separate database can be developed to track these measures of appropriateness by individual antibiotic prescription. Microsoft Excel or similar database software would work well for this.

Prospective Prescription Review by Pharmacist

Where possible, work with your consultant pharmacist and dispensing pharmacy to understand what information (data elements) should be sent with a prescription to ensure that real-time medication review can be conducted. For example, to determine whether alternative drug selection or dose adjustments are needed, pharmacists would need to have the following data elements submitted with the prescription request: resident name, date of birth, sex, medical record number, allergies, weight, height, most recent serum creatinine level or glomerular filtration rate (GFR), and presence of underlying renal or liver disease (yes/no). Additional information that might be helpful to the pharmacist includes history of multi-drug resistant infection or *Clostridium difficile* infection.

Incorporating a form into the EHR system for pharmacy orders would help to ensure that these data are passed on to the pharmacy. Facilities, in Minnesota, must either deliver or fax the prescriber's written and/or faxed order to the pharmacy. Any verbal order or telephone order that was reduced to writing by the nurse will also need to be delivered or faxed to the

pharmacy. Work with your EHR vendor or experienced staff at your facility to see if incorporating a form for pharmacy orders in your EHR is possible.

Using EHR to Improve Infection Tracking

It is possible to incorporate communication tools (e.g., Situation, Background, Assessment Request (SBAR) forms) and protocols (e.g., diagnostic order forms, testing algorithms, criteria for antibiotic initiation) into EHR systems. In fact, in a well-organized EHR interface, the action of filling out a communication form, such as a disease-specific SBAR, can directly support the action of appropriate antibiotic administration. This is because: 1) All appropriate clinical information is passed on to the provider, who can then confidently consider the need for an antibiotic, even if located offsite; 2) The electronic communication form can be integrated with diagnostic and treatment algorithms, which can guide staff to make appropriate decisions regarding submission of diagnostics and/or request for provider antibiotic order assessment; and 3) SBAR can be reviewed to determine appropriateness of treatment and identify opportunities for improvement.

There is existing guidance on what data are recommended for nursing home infection tracking, and a sample Excel-based infection tracking form is available in the Minnesota Antibiotic Stewardship Program Toolkit for Long-term Care Facilities.[6]

Case Study

In 2017, Walker Methodist Health Center in Minneapolis committed to use an SBAR tool to improve management of asymptomatic bacteriuria and urinary tract infections (UTI) in long-term care residents. The following steps were taken to meet this quality improvement goal.

1. **Gather a team.** Medical Director, Directors of Nursing, Nurse Technologist, Infection Prevention Nurse, and a local doctorate of nursing student were involved.

2. **Develop the SBAR tool.** The team made minor modifications to an existing SBAR tool.[7] Loeb criteria for initiation of antibiotics for UTI, incorporated into the SBAR tool, allowed nurse and provider to determine whether empiric antibiotic use and urine diagnostics were indicated.

3. **Integrate the SBAR tool into the EHR system.** The Nurse Technologist developed a user-defined form in the EHR system that could be filled in by nurses for residents with suspected UTI. The electronic form was built with an incorporated scoring function, providing an automated assessment of whether Loeb criteria for initiation of antibiotics were or were not met for each resident.

4. **Staff training.** Training sessions were held for nurses and other relevant staff. Information was provided on the importance of the UTI initiative, Loeb criteria, and use of the EHR SBAR form. Staff were asked to use the SBAR for every suspected UTI. Education was also included in new staff training. Providers were made aware of the initiative and provided with a facility antibiogram and prescribing recommendations for UTI.

5. **Implementation and auditing of SBAR form completion.** The Nurse Technologist utilizes the EHR system, pharmacy order database, and laboratory urinalysis orders to audit compliance with SBAR completion for all suspected UTI. The Infection Prevention Nurse follows up directly with staff when forms are not filled out. SBAR completion rates are tracked over time and shared with staff and providers to encourage compliance.

Notes

a CDC has classified antibiotics for the NHSN Antibiotic Use and Resistance Module. Because nursing homes might someday be reporting AU into this module, staff should consider incorporating this classification system now. The classification table is available at: https://www.cdc.gov/nhsn/pdfs/pscmanual/11pscaurcurrent.pdf

b Although McGeer criteria are meant for identifying infections for the purposes of retrospective case surveillance, they can be used as criteria to guide initiation of antibiotic treatment, if used with the following caveats. First, because clinical use of McGeer criteria might result in more frequent of empiric prescribing, a robust post-prescription assessment ("antibiotic time-out") plan must be in place. Second, if McGeer criteria are used to retrospectively assess appropriateness of antibiotic treatment, they should be applied without use of the diagnostic test criteria (e.g., urine culture, chest x-ray), as this information was likely not available at the time of antibiotic order.

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