Colorado Department
of Public Health
and Environment

Health Facility Acquired Infections Disclosure Initiative
Semi-Annual Bulletin: Volume 8, No. 1, January 2016
Antibiotic Stewardship in Colorado Acute Care Facilities

Introduction

This report was written to fulfill the requirements set forth in Colorado's Healthcare-Associated Infections (HAI) Disclosure Act.[1] The Colorado Department of Public Health & Environment (CDPHE) publishes two bulletins each year addressing a relevant HAI topic utilizing data reported by health care facilities to the National Healthcare Safety Network (NHSN). NHSN is a national electronic database which collects and maintains HAI data that are self-reported by health care facilities. CDPHE uses NHSN data to disclose information about facilities' HAI rates to the legislature and general public. This bulletin focuses on strategies proposed by the Centers for Disease Control and Prevention (CDC) that are relevant to the development of effective Antibiotic Stewardship Programs (ASPs) in Colorado. The data presented in this report include responses from 122 Colorado facilities—i.e., 72 Acute Care Hospitals (ACHs) and 50 Ambulatory Surgery Centers (ASCs)—with input from physician and pharmacist stewardship champions, and consists of 2014 calendar year data.

Background

Antimicrobials are drugs used to kill or inhibit the growth of microorganisms (e.g., bacteria, viruses, fungi, or parasites). Antibiotics are a subcategory of antimicrobials used for the treatment and prevention of bacterial infections. Since the 1940s, these important drugs have significantly reduced morbidity and mortality associated with infectious diseases; however, exposure to antibiotics has caused pathogenic bacteria to adapt and enhance their ability to survive. This is known as "antibiotic resistance." Resistant bacteria survive antibiotic exposure and continue to multiply in the body, potentially causing more harm to the individual or spreading to other hosts. Today, there are more resistant strains of pathogenic bacteria and fewer antibiotics capable of treating them as a result of antibiotic resistance.

Causes of Increased Drug Resistance

1. **Misuse or Overuse of Antibiotics in Humans:** According to CDC, approximately 20-50% of all antibiotics prescribed in U.S. acute care hospitals are either unnecessary or inappropriate for effective treatment.[2-5] Prescribing practices vary widely among providers and errors are not uncommon. In fact, a 2014 CDC Vital Signs publication noted that some hospital providers prescribe up to 3 times as many antibiotics as other providers, and more than half of all hospital patients received an antibiotic for at least one day during the average hospital stay.[6] Moreover, excessive antibiotic exposure is the single most important risk factor for serious infections like *Clostridium difficile*, a life threatening diarrhea that causes approximately 14,000 deaths each year.[2, 7] Consequently, improving antibiotic stewardship is both a medication-safety and patient-safety issue. Prescribing the right antibiotic, the right dose, and for the right duration can lead to significant decreases in antibiotic resistance.[2]

2. **Antibiotic Use in Food-Producing Animals:** Antibiotics are also commonly used in food-producing animals. Similar to antibiotic resistance in humans, bacteria in animals adapt in response to antibiotic exposure which can then lead to more resistant strains of bacteria. The surviving resistant bacteria can then be spread. Antibiotics should be used judiciously, with veterinary oversight, in food-producing animals to preserve effectiveness, protect health and welfare, and provide a safe food supply.[8]

CDC Recommendations

A growing body of evidence suggests that hospital-based antibiotic stewardship programs can optimize the treatment of infections and reduce adverse events associated with antibiotic misuse or overuse.[2, 9, 10] These programs help improve the quality of patient care, reduce treatment failure, and facilitate correct prescriptions for therapy and prophylaxis.[2, 11-13] Moreover, ASPs often achieve these benefits while saving valuable time, money, and resources for hospitals.[2, 14-16] In recognition of the urgent need to reform antibiotic use in health care facilities, CDC has recommended that all acute care hospitals implement ASPs and further proposed a list of core elements to achieve this goal.[2] Table 1 below outlines CDC core elements and actionable items to facilitate hospital ASPs. Other professional organizations have developed their own recommendations for antibiotic stewardship, and these guidelines are included at the end of this bulletin.

Table 1: CDC Core Elements and Actionable Items for Antibiotic Stewardship Programs.[2]

Core Element	Actionable Items
Leadership Commitment	Dedicate necessary human, financial, and information technology resources.
Accountability	Appoint a single leader responsible for program outcomes.
Drug Expertise	Appoint a single pharmacist leader to support improved prescribing.
Action	Take at least one prescribing improvement action, such as requiring reassessment within 48 hours, to check drug choice, dose, and duration.
Tracking	Monitor prescribing and antibiotic resistance patterns.
Reporting	Regularly report to staff prescribing and resistance patterns, and steps to improve.
Education	Offer education about antibiotic resistance and improving prescribing practices.

Methods

In addition to reporting HAI data to NHSN, hospitals must complete an annual hospital survey on antibiotic stewardship, infection control, and microbiology laboratory practices. The 2015 NHSN annual hospital survey was used to assess the baseline status of ASPs among Colorado ACHs and ASCs. Responses were stratified by facility type (i.e., ACH vs. ASC), hospital bed count (i.e., <150 vs. ≥150 beds), and geographical region as defined in Table 2. Data from the surveys (n=122) are presented in Tables 3 and 4, and an overview of compliance to each core element is shown in Figure 1. Appendix A provides a detailed map of survey questions and how they correspond to CDC core elements. Facilities were given credit for meeting a core element by responding "Yes" to at least one question within that element. In order to meet CDC criteria and to be considered a fully-implemented ASP, an ASP must have in place components of all 7 core elements.

Table 2: List of Colorado Counties by Region.

Region	Counties
Denver metropolitan	Adams, Arapahoe, Denver, Douglas, and Jefferson.
Northeastern	Boulder, Broomfield, Cheyenne, Clear Creek, Elbert, Gilpin, Kit Carson, Larimer, Lincoln, Logan, Morgan, Phillips, Sedgwick, Washington, Weld, and Yuma.
Southeastern	Baca, Bent, Chaffee, Crowley, Custer, El Paso, Fremont, Huerfano, Kiowa, Lake, Las Animas, Otero, Park, Prowers, Pueblo, and Teller.
Western	Alamosa, Archuleta, Conejos, Costilla, Delta, Dolores, Eagle, Garfield, Grand, Gunnison, Hinsdale, Jackson, La Plata, Mesa, Mineral, Moffat, Montezuma, Montrose, Ouray, Pitkin, Rio Blanco, Rio Grande, Routt, Saguache, San Juan, San Miguel, and Summit.

Figure 1: Antibiotic Stewardship Program Implementation in Colorado facilities, n=122.

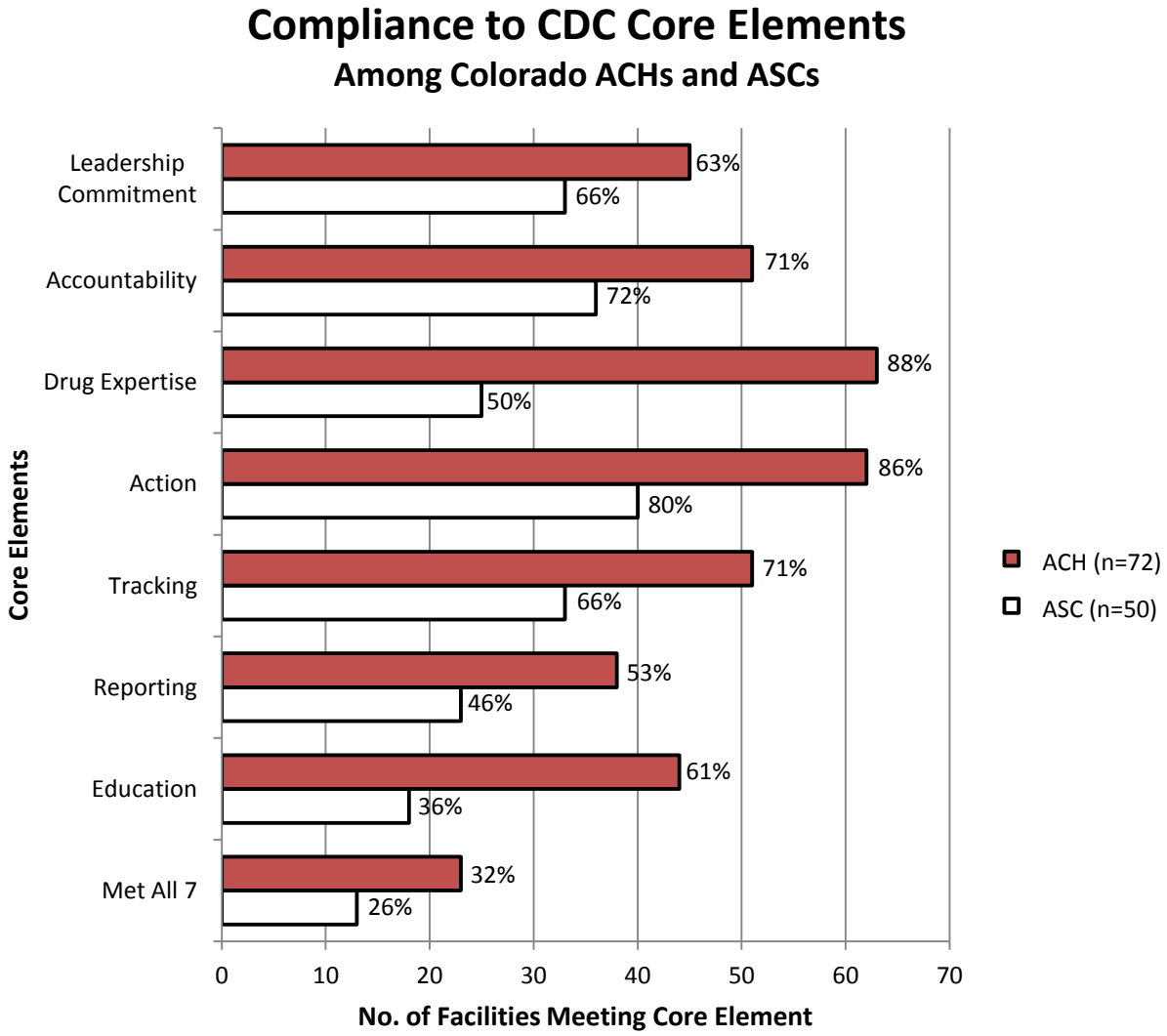

Table 3: Annual NHSN Survey Responses by Acute Care Hospitals Stratified by Bed Size and Region—Colorado, 2014.

CDC Core Elements	Survey Question	All ACHs (n=72)	< 150 Beds (n=49)	≥ 150 Beds (n=23)	Region			
					Denver Metro (n=19)	NE (n=18)	SE (n=14)	W (n=21)
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Leadership Commitment	Q23. Does your facility have a written statement of support from leadership that supports efforts to improve antibiotic use (antibiotic stewardship)?	39 (54)	21 (43)	18 (78)	15 (79)	13 (72)	6 (43)	5(24)
Leadership Commitment	Q26. Does your facility provide any salary support for dedicated time for antibiotic stewardship activities?	22 (31)	9 (18)	13 (57)	14 (74)	0 (0)	3 (21)	5 (24)
Account-ability	Q24. Is there a leader responsible for outcomes of stewardship activities at your facility?	51 (71)	30 (61)	21 (91)	17 (89)	14 (78)	9 (64)	11 (52)
Drug Expertise	Q25. Is there at least one pharmacist responsible for improving antibiotic use at your facility?	63 (88)	42 (86)	21 (91)	19 (100)	17 (94)	11 (79)	16 (76)
Action	Q27. Does your facility have a policy that requires prescribers to document an indication for all antibiotics in the medical record during order entry?	12 (17)	8 (16)	4 (17)	4 (21)	1 (6)	3 (21)	4 (19)
Action	Q28. Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antibiotic selection for common clinical conditions?	51 (71)	34 (69)	17 (74)	18 (95)	12 (67)	10 (71)	11 (52)
Action	Q29. Is there a formal procedure for all clinicians to review the appropriateness of all antibiotics at or after 48 hours from the initial orders (e.g., antibiotic "time outs")?	14 (19)	11 (22)	3 (13)	2 (11)	2 (11)	4 (29)	6 (29)
Action	Q30. Do any specified antibiotic agents need to be approved by a physician or pharmacist prior to dispensing at your facility?	34 (47)	20 (41)	14 (61)	11 (58)	10 (56)	4 (29)	9 (43)
Action	Q31. Does a physician or pharmacist review courses of therapy for specified antibiotic agents and communicate results with prescribers (i.e., audit with feedback) at your facility?	51 (71)	35 (71)	16 (70)	16 (84)	13 (72)	8 (57)	14 (67)

CDC Core Elements	Survey Question	All ACHs (n=72)	< 150 Beds (n=49)	≥ 150 Beds (n=23)	Region			
					Denver Metro (n=19)	NE (n=18)	SE (n=14)	W (n=21)
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Tracking	Q27a. [If Yes to 27] Has adherence to the policy to document indication been monitored?	9 (13)	5 (10)	4 (17)	3 (16)	1 (6)	3 (21)	2 (10)
Tracking	Q28a. [If Yes to 28] Has adherence to facility-specific treatment recommendations been monitored?	32 (44)	23 (47)	9 (39)	10 (53)	6 (33)	8 (57)	8 (38)
Tracking	Q32. Does your facility monitor antibiotic use (consumption) at the unit, service, and/or facility wide?	42 (58)	25 (51)	17 (74)	13 (68)	11 (61)	7 (50)	11 (52)
Tracking	Q32a. [If Yes to 32] By which metrics? • Defined Daily Dose (DDD) • Days of Therapy (DOT) • Purchasing Data	 17 (24) 24 (33) 26 (36)	 10 (20) 14 (29) 13 (27)	 7 (30) 10 (43) 13 (57)	 6 (32) 8 (42) 10 (53)	 2 (11) 4 (22) 6 (33)	 3 (21) 5 (36) 3 (21)	 6 (29) 7 (33) 7 (33)
Reporting	Q32b. [If Yes to 32] Are facility- and/or unit- or service-specific reports on antibiotic use shared with prescribers?	22 (31)	14 (29)	8 (35)	8 (42)	6 (33)	4 (29)	4 (19)
Reporting	Q33. Do prescribers ever receive feedback by the stewardship program about how they can improve their antibiotic prescribing?	35 (49)	23 (47)	12 (52)	12 (63)	5 (28)	8 (57)	10 (48)
Education	Q34. Has your stewardship program provided education to clinicians and other relevant staff on improving antibiotic use?	44 (61)	27 (55)	17 (74)	16 (84)	8 (44)	9 (64)	11 (52)

Abbreviations: NHSN, National Healthcare Safety Network; ACH, Acute Care Hospital; NE, northeast; SE, southeast; W, west.

Table 4: Annual NHSN Survey Responses by Ambulatory Surgery Centers Stratified by Region—Colorado, 2014.

CDC Core Elements	Survey Question	All ASCs (n=50)	Region			
			Denver Metro (n=21)	NE (n=11)	SE (n=10)	W (n=8)
		n (%)	n (%)	n (%)	n (%)	n (%)
Leadership Commitment	Q23. Does your facility have a written statement of support from leadership that supports efforts to improve antibiotic use (antibiotic stewardship)?	28 (56)	13 (62)	5 (45)	6 (60)	4 (50)
	Q26. Does your facility provide any salary support for dedicated time for antibiotic stewardship activities?	13 (26)	7 (33)	3 (27)	0 (0)	3 (38)
Account-ability	Q24. Is there a leader responsible for outcomes of stewardship activities at your facility?	36 (72)	15 (71)	9 (82)	7 (70)	5 (63)
Drug Expertise	Q25. Is there at least one pharmacist responsible for improving antibiotic use at your facility?	25 (50)	13 (62)	6 (55)	3 (30)	3 (38)
Action	Q27. Does your facility have a policy that requires prescribers to document an indication for all antibiotics in the medical record during order entry?	12 (24)	8 (38)	0 (0)	3 (30)	1 (13)
	Q28. Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antibiotic selection for common clinical conditions?	29 (58)	14 (67)	6 (55)	4 (40)	5 (63)
	Q29. Is there a formal procedure for all clinicians to review the appropriateness of all antibiotics at or after 48 hours from the initial orders (e.g., antibiotic “time outs”)?	15 (30)	6 (29)	4 (36)	3 (30)	2 (25)
	Q30. Do any specified antibiotic agents need to be approved by a physician or pharmacist prior to dispensing at your facility?	24 (48)	10 (48)	5 (45)	6 (60)	3 (38)
	Q31. Does a physician or pharmacist review courses of therapy for specified antibiotic agents and communicate results with prescribers (i.e., audit with feedback) at your facility?	20 (40)	10 (48)	5 (45)	4 (40)	1 (13)

CDC Core Elements	Survey Question	All ASCs (n=50)	Region			
			Denver Metro (n=21)	NE (n=11)	SE (n=10)	W (n=8)
		n (%)	n (%)	n (%)	n (%)	n (%)
Tracking	Q27a. [If Yes to 27] Has adherence to the policy to document indication been monitored?	9 (18)	5 (24)	0 (0)	3 (30)	1 (13)
	Q28a. [If Yes to 28] Has adherence to facility-specific treatment recommendations been monitored?	21 (42)	9 (43)	5 (45)	3 (30)	4 (50)
	Q32. Does your facility monitor antibiotic use (consumption) at the unit, service, and/or facility wide?	24 (48)	10 (48)	7 (64)	3 (30)	4 (50)
	Q32a. [If Yes to 32] By which metrics? • Defined Daily Dose (DDD) • Days of Therapy (DOT) • Purchasing Data	 5 (10) 4 (8) 10 (20)	 2 (10) 1 (5) 6 (29)	 3 (27) 1 (9) 3 (27)	 0 (0) 1 (10) 0 (0)	 0 (0) 1 (13) 1 (13)
Reporting	Q32b. [If Yes to 32] Are facility- and/or unit- or service-specific reports on antibiotic use shared with prescribers?	13 (26)	6 (29)	3 (27)	2 (20)	2 (25)
	Q33. Do prescribers ever receive feedback by the stewardship program about how they can improve their antibiotic prescribing?	18 (36)	9 (43)	3 (27)	3 (30)	3 (38)
Education	Q34. Has your stewardship program provided education to clinicians and other relevant staff on improving antibiotic use?	18 (36)	9 (43)	4 (36)	1 (10)	4 (50)

Abbreviations: NHSN, National Healthcare Safety Network; ASC, Ambulatory Surgery Center; NE, northeast; SE, southeast; W, west.

Summary and Recommendations
Below is a summary of the 2015 NHSN annual hospital survey questions, categorized by their respective core elements, and followed by CDC recommendations for ASP improvement. Full recommendations to improve efforts for each core element can be found on the CDC website at:
http://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html

Leadership Commitment

Question 23: *Does your facility have a written statement of support from leadership that supports efforts to improve antibiotic use (antibiotic stewardship)?* Among the 122 Colorado facilities completing the survey, 39 out of 72 (54%) ACHs and 28 out of 50 (56%) ASCs reported having a written statement of support from leadership. Hospitals with ≥150 beds (n=18, 78%) had a greater proportion of written support than hospitals with <150 beds (n=21, 43%). When stratified by region, Denver metropolitan (n=15, 79%) and northeastern (n=13, 72%) hospitals had a higher percentage of written support than other regions (southeast [n=6, 43%] and west [n=5, 24%]).

Question 26: *Does your facility provide any salary support for dedicated time for antibiotic stewardship activities?* Although a majority of facilities had a leader responsible for outcomes of antibiotic stewardship activities (see Question 24), fewer facilities reported having salary support for ASPs; only 22 (31%) ACHs and 13 (26%) ASCs had dedicated salary support. Hospitals with ≥150 beds (n=13, 57%) had a greater proportion of salary support than hospitals with <150 beds (n=9, 18%). No northeastern ACHs or southeastern ASCs reported having salary support for their ASPs.

Per CDC, leadership support is critical to the success of antibiotic stewardship programs and can take a number of forms, such as: formal statements that the facility supports efforts to improve and monitor antibiotic use; including stewardship-related duties in job descriptions and annual performance reviews; ensuring staff from relevant departments are given sufficient time to contribute to stewardship activities; supporting training and education; and ensuring participation from the many groups that can support stewardship activities. Moreover, financial support greatly augments the capacity and impact of a stewardship program, and stewardship programs will often pay for themselves through savings in antibiotic expenditures and indirect costs.[2, 9, 14-17]

Accountability

Question 24: *Is there a leader responsible for outcomes of stewardship activities at your facility?* Fifty-one (71%) ACHs and 36 (72%) ASCs reported having a leader responsible for stewardship outcomes. Hospitals with ≥150 beds (n=21, 91%) had a greater proportion of dedicated leadership when compared to hospitals with <150 beds (n=30, 61%). When stratified by region, Denver metropolitan (n=17, 89%) and northeastern (n=14, 78%) hospitals had a higher percentage of dedicated leadership than other regions (southeast [n=9, 64%] and west [n=11, 52%]).

Facilities should identify a single leader who will be responsible for program outcomes.[2] Formal training in infectious diseases and/or antibiotic stewardship benefits ASP leadership, and physicians have been highly effective in this role. [2, 18-20] Larger facilities have achieved success by hiring full time staff to develop and manage stewardship programs while smaller facilities report other arrangements, including use of part-time, off-site expertise and hospitalists.[2, 21] The work of stewardship program leaders is greatly enhanced by the support of other key groups, including: clinicians and department heads, infection preventionists and hospital epidemiologists, quality improvement staff, laboratory staff, information technology personnel, and nurses. By taking a multi-disciplinary approach and engaging a core team of

health care professionals, an ASP can effectively identify and prioritize steps for antibiotic improvement.

Drug Expertise

Question 25: *Is there at least one pharmacist responsible for improving antibiotic use at your facility?* Among the 122 Colorado facilities completing the survey, 63 out of 72 (88%) ACHs and 25 out of 50 (50%) ASCs had a pharmacist responsible for improving antibiotic use. Hospitals had similar proportions of drug expertise regardless of bed size; that is, hospitals with ≥150 beds (n=21, 91%) were comparable to hospitals with <150 beds (n=42, 86%). Both ACHs and ASCs had a greater proportion of drug expertise in Denver metropolitan and northeastern regions than other regions, with 100% of Denver metropolitan hospitals (n=19) having a dedicated pharmacist.

Facilities should identify a single pharmacy leader who will co-lead the program.[2] This leader should oversee pharmacy-driven interventions, including: dose adjustments and optimization,[2, 22, 23] detection and prevention of drug-drug interactions, and implementation of automatic stop orders for unnecessarily duplicative or time-sensitive prescriptions (e.g., specified antibiotic prescriptions for surgical prophylaxis). [2, 24, 25] By utilizing pharmacy-driven interventions, antibiotic therapy can be optimized to combat highly drug-resistant bacteria while mitigating emerging antibiotic-resistant bacteria.

Action

Question 27: *Does your facility have a policy that requires prescribers to document an indication for all antibiotics in the medical record during order entry?* Twelve (17%) ACHs and 12 (24%) ASCs reported having a policy that requires documentation of indications. When stratified by bed size, hospitals with ≥150 beds (n=4, 17%) were comparable to hospitals with <150 beds (n=8, 16%). Fewer northeastern facilities (n=1, 6% for ACHs; n=0, 0% for ASCs) reported having policies for documenting indications than other regions.

Question 28: *Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antibiotic selection for common clinical conditions?* Fifty-one (71%) ACHs and 29 (58%) ASCs indicated having facility-specific recommendations based on national guidelines and local susceptibilities. Hospitals with ≥150 beds (n=17, 74%) were comparable to hospitals with <150 beds (n=34, 69%). And Denver metropolitan hospitals reported the highest percentage of facility-specific treatment recommendations (n=18, 95%).

Question 29: *Is there a formal procedure for all clinicians to review the appropriateness of all antibiotics at or after 48 hours from the initial orders (e.g., antibiotic "time outs")?* Among the 122 Colorado facilities completing the survey, 14 (19%) ACHs and 15 (30%) ASCs reported having a formal procedure for antibiotic review. Hospitals with ≥150 beds (n=3, 13%) had a smaller proportion of antibiotic review procedures than hospitals with <150 beds (n=11, 22%). ACHs in the southeastern and western regions (n=4, 29% and n=6, 29%, respectively) had a greater percentage of review procedures than those in the Denver metropolitan or northeastern regions (n=2, 11% and n=2, 11%, respectively).

Question 30: *Do any specified antibiotic agents need to be approved by a physician or pharmacist prior to dispensing at your facility?* Thirty-four (47%) ACHs and 24 (48%) ASCs reported requiring physician or pharmacist approval for specified antibiotics. Hospitals with ≥150 beds (n=14, 61%) had a greater proportion of approval requirements than hospitals with <150 beds (n=20, 41%). And regionally, ACHs in the southeastern region (n=4, 29%) had the lowest percentage of antibiotic approval policies than other regions.

Question 31: *Does a physician or pharmacist review courses of therapy for specified antibiotic agents and communicate results with prescribers (i.e., audit with feedback) at your facility?* Fifty-one (71%) ACHs and 20 (40%) ASCs reported providing antibiotic feedback. Hospitals with ≥150 beds (n=16, 70%) were comparable to hospitals with <150 beds (n=35, 71%). ASCs in the western region had the lowest percentage of antibiotic feedback (n=1, 13%) when compared to other regions.

In developing an effective stewardship program, antibiotic optimization can be achieved by requiring the documentation of dose, duration, and indication for all courses of antibiotics. Making this information accessible helps ensure that antibiotics are modified as needed and/or discontinued in a timely manner.[2, 3, 27, 28] Additionally, facility-specific treatment recommendations—based on national guidelines and local susceptibilities—can enhance antibiotic selection and duration. One strategy is to utilize hospital antibiograms, a periodic review of local antibiotic susceptibilities submitted by the hospital's clinical microbiology laboratory. Antibiograms are often used to assess local susceptibility rates, inform clinicians on prescribing empiric antibiotic courses, and monitor local resistance trends within a facility.[26] They can also be used to compare susceptibility rates across health care facilities and track regional trends.

Furthermore, CDC recommends incorporating antibiotic "time outs" into antibiotic policies. Antibiotics are often started empirically in hospitalized patients while diagnostic information is being obtained. However, providers often do not revisit the selection of the antibiotic after more clinical and laboratory data (including culture results) become available.[2, 29-32] An antibiotic "time out" prompts a reassessment of the continuing need and choice of antibiotics when the clinical picture is clearer and more diagnostic information is available. All clinicians should perform a review of antibiotics 48 hours after antibiotics are initiated.

Other interventions include receiving authorization prior to administration and providing feedback to prescribers. Some facilities restrict the use of antibiotics based on the spectrum of activity, cost, or associated toxicities to ensure that use is reviewed with an antibiotic expert before therapy is initiated.[2, 33] And external reviews of antibiotic therapy by an expert in antibiotic use have been highly effective in optimizing antibiotics in critically ill patients and in cases where broad spectrum or multiple antibiotics are being used.[2, 34-36]

Tracking

Question 27a: *Has adherence to the policy to document an indication been monitored?* Among the 122 Colorado facilities completing the survey, 9 out of 72 (13%) ACHs and 9 out of 50 (18%) ASCs indicated monitoring their documentation policy. Hospitals with ≥150 beds (n=4, 17%) were comparable to hospitals with <150 beds (n=5, 10%). Regionally, no northeastern ASCs monitored documentation for antibiotic indications.

Question 28a: *Has adherence to facility-specific treatment recommendations been monitored?* Thirty-two (44%) ACHs and 21 (42%) ASCs reported monitoring facility-specific treatment recommendations. Hospitals with ≥150 beds (n=9, 39%) were comparable to hospitals with <150 beds (n=23, 47%).

Question 32: *Does your facility monitor antibiotic use (consumption) at the unit, service, and/or facility wide?* Forty-two (58%) ACHs and 24 (48%) ASCs reported monitoring antibiotic use at the unit, service, or facility level. Hospitals with ≥150 beds (n=17, 74%) had a greater proportion of antibiotic monitoring than hospitals with <150 beds (n=25, 51%).

Question 32a: *If Yes, by which metrics?* Seventeen (24%) ACHs and 5 (10%) ASCs indicated using Defined Daily Dose (DDD); twenty-four (33%) ACHs and 4 (8%) ASCs reported using Days of Therapy (DOT); and twenty-six (36%) ACHs and 10 (20%) indicated using Purchasing Data to monitor antibiotic use. Please note that at some facilities more than one metric is used to monitor antibiotic use at the unit, service, and/or facility wide levels.

Measurement is critical to identify opportunities for improvement and assess the impact of improvement efforts.[2, 37] For antibiotic stewardship, measurement may involve evaluation of both process (are policies and guidelines being followed as expected?) and outcome (have interventions improved antibiotic use and patient outcomes?). Facilities should perform periodic assessments to determine if prescribers have made recommendations based on clinical indications, appropriately applied diagnostic criteria, and prescribed treatment in a timely manner that complies with hospital antibiotic use policies. As part of NHSN, CDC has developed an antibiotic use module that automatically collects and reports monthly antibiotic data, and can be used to analyze antibiotic use in aggregate, by specific antibiotic agents, or by patient care location.[2, 38] Facilities are encouraged to incorporate the antibiotic use module into their ASPs.

Reporting

Question 32b: *If Yes, are facility- and/or unit- or service-specific reports on antibiotic use shared with prescribers?* Among the 122 Colorado facilities completing the survey, 22 out of 72 (31%) ACHs and 13 out of 50 (26%) ASCs indicated that reports on antibiotic use are shared with prescribers. Hospitals with ≥150 beds (n=8, 35%) were comparable to hospitals with <150 beds (n=14, 29%).

Question 33: *Do prescribers ever receive feedback by the ASP on how they can improve their antibiotic prescribing?* Thirty-five (49%) ACHs and 18 (36%) ASCs reported providing feedback to prescribers. Hospitals with ≥150 beds (n=12, 52%) were comparable to hospitals with <150 beds (n=23, 47%). Regionally, northeastern ACHs (n=5, 28%) had a smaller proportion of facilities providing prescriber feedback than other regions.

As a result of frequent monitoring efforts, feedback should be given regularly in order to provide up-to-date information on antibiotic use and resistance to relevant health care workers. For interventions that provide feedback directly to clinicians, it is also important to document interventions and track responses to feedback (e.g., acceptance).[2]

Education

Question 34: *Has your ASP provided education to clinicians and other relevant staff on improving antibiotic use?* Forty-four (61%) ACHs and 18 (36%) ASCs reported providing education to clinicians and other staff on improving antibiotic use. Hospitals with ≥150 beds (n=17, 74%) provided a greater proportion of education than hospital with <150 beds (n=27, 55%). And Denver metropolitan area (n=16, 84%) had a higher percentage of educational feedback than other regions.

Antibiotic stewardship programs should provide regular updates on antibiotic prescribing, antibiotic resistance, and infectious disease management that address both national and local issues.[2, 3] There are many options for providing education on antibiotic use such as didactic presentations which can be done in formal and informal settings, messaging through posters and flyers and newsletters or electronic communication to staff groups. Reviewing de-identified cases with providers where changes in antibiotic therapy could have been made is another useful approach. And variety of web-based educational resources are available that can help facilities develop education content.[2, 39] Education has been found to

be most effective when paired with corresponding interventions and measurement of outcomes.[2, 18]

Conclusions

This bulletin uses data gathered from the National Healthcare Safety Network (NHSN) to describe current antibiotic stewardship program (ASP) practices among Colorado acute care hospitals (ACHs) and ambulatory surgery centers (ASCs) in order to highlight and promote uptake of CDC recommendations. CDC core elements with the most need for improvement among ACHs include: reporting (53%), education (61%), and leadership commitment (63%). Among ASCs, CDC core elements with the most need for improvement include: education (36%), reporting (46%), and drug expertise (50%).

In order to meet CDC criteria and to be considered a fully-implemented ASP, an ASP must have in place components of all 7 core elements. Assuming a facility met a core element by responding "Yes" to at least one question within that element, 32% of acute care hospitals and 26% of ASCs in Colorado meet the criteria for having a fully-implemented ASP.

CDPHE strongly recommends each acute care hospital become familiar with CDC guidance on ASPs, "Core Elements of Hospital Antibiotic Stewardship Programs," and implement recommended actions. Although this resource is developed for hospitals, components can be applied to other facility types. In this report, these recommendations were applied to both acute care hospitals and ASCs. It is notable that only 32% of hospitals in Colorado meet all 7 core elements for a fully-implemented ASP, indicating that more work needs to be done in Colorado to improve ASPs in hospitals.

Other Resources:

National Action Plan

In March 2015, President Obama introduced the National Action Plan for Combating Antibiotic-Resistant Bacteria.[40] The plan outlines federal initiatives to enhance the domestic and international capacity to prevent and contain outbreaks of antibiotic-resistant organisms; maintain efficacy of current or new antibiotics; and develop next-generation diagnostics, antibiotics, vaccines, and other therapeutics. By 2020, the National Action Plan is expected to create major reductions in the incidence of urgent and serious threats, including Carbapenem-resistant *Enterobacteriaceae* (CRE), methicillin-resistant *Staphylococcus aureus* (MRSA), and *Clostridium difficile*.

Goals of the National Action Plan

1. Slow the emergence of resistant bacteria and prevent the spread of resistant infections.
2. Strengthen national One-Health surveillance efforts to combat resistance.
3. Advance development and use of rapid and innovative diagnostic tests for identification and characterization of resistant bacteria.
4. Accelerate basic and applied research and development for new antibiotics, other therapeutics, and vaccines.
5. Improve international collaboration and capacities for antibiotic-resistant prevention, surveillance, control, and antibiotic research and development.

The complete National Action Plan report can be found on the white house website at:
https://www.whitehouse.gov/sites/default/files/docs/national_action_plan_for_combating_antibiotic-resistant_bacteria.pdf

Antibiotic Stewardship Change Package

In July 2012, CDC collaborated with the Institute for Healthcare Improvement (IHI) to develop a Driver Diagram and Change Package for antibiotic stewardship improvement.[41] The Driver Diagram attempts to describe various processes that can lead to optimal antibiotic use including: leadership and culture; the timely and appropriate initiation of antibiotics; appropriate administration and de-escalation; and data monitoring, transparency, and stewardship infrastructure. The Change Package outlines interventions related to the drivers that have either been demonstrated to or that experts believe will impact the success of the Driver Diagram. The Change Package also contains recommended metrics for the measurement and evaluation of change implementations. Additional information can be accessed on the IHI website at:
http://www.cdc.gov/getsmart/healthcare/pdfs/Antibiotic_Stewardship_Change_Package_10_30_12.pdf

CDC Vital Signs

The August 2015 edition of CDC Vital Signs emphasizes the importance of a comprehensive, collaborative effort among local health care facilities to prevent the spread of antibiotic-resistant bacteria.[42] Even if one facility follows recommended infection control practices, bacteria can still be transmitted between facilities when patients are transferred. Consequently, a lack of coordination between facilities puts patients at increased risk. CDC recommends that public health departments track and alert health care facilities to antibiotic-resistant organisms or outbreaks in the area, and encourages facilities to share information and infection control action plans to stop the spread of bacteria. This edition of CDC Vital Signs edition can be found on the CDC website at:
http://www.cdc.gov/vitalsigns/stop-spread/index.html

References

1. House Bill 06-1045. https://www.colorado.gov/pacific/sites/default/files/HAI_House-Bill-06-1045.pdf. Accessed September 10, 2015.
2. Centers for Disease Control and Prevention. Core Elements of Hospital Antibiotic Stewardship Programs. http://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html. Accessed October 28, 2015.
3. Camins BC, King MD, Wells JB, et al. Impact of an antimicrobial utilization program on antimicrobial use at a larger teaching hospital: a randomized controlled trial. *Infection control and hospital epidemiology: the official journal of the Society of Hospital Epidemiologists of America.* Oct 2009;30(10):931-938.
4. Levin PD, Idrees S, Sprung CL, et al. Antimicrobial use in the ICU: indications and accuracy—an observational trial. *Journal of hospital medicine: an official publication of the Society of Hospital Medicine.* Nov-Dec 2012;7(9):672-678.
5. Fridkin SK, Baggs J, Fagan R, et al. Vital Signs: Improving Antibiotic Use Among Hospitalized Patients. *MMWR. Morbidity and mortality weekly report.* 2014;63.
6. Centers for Disease Control and Prevention. Antibiotic Rx in Hospitals: Proceed with Caution. http://www.cdc.gov/vitalsigns/antibiotic-prescribing-practices/. Accessed October 28, 2015.
7. Hensgens MP, Goorhuis A, Dekkers OM, Kuijper EJ. Time interval of increased risk for *Clostridium difficile* infection after exposure to antibiotics. *The Journal of antimicrobial chemotherapy.* Mar 2012;67(3):742-748.
8. American Veterinary Medical Association. Antibiotic Use Is Changing. Talk to Your Veterinarian. Available at: https://www.avma.org/public/Health/Pages/Antibiotic-Use-Changing.aspx. Accessed: October 28, 2015.
9. Davey P, Brown E, Charani E, et al. Interventions to improve antibiotic prescribing practices for hospital inpatients. *The Cochrane database of systematic reviews.* 2013;4:CD003543.
10. Malani AN, Richards PG, Kapila S, Otto MH, Czerwinski J, Singal B. Clinical and economic outcomes from a community hospital's antimicrobial stewardship program. *American journal of infection control.* Feb 2013;41(2):145-148.
11. Stach LM, Hedican EB, Herigon JC, Jackson MA, Newland JG. Clinicians' Attitudes Towards an Antimicrobial Stewardship Program at a Children's Hospital. *Journal of the Pediatric Infectious Diseases Society.* September 1, 2012 2012;1(3):190-197.
12. Kaki R, Elligsen M, Walker S, Simor A, Palmay L, Daneman N. Impact of antimicrobial stewardship in critical care: a systematic review. *The Journal of antimicrobial chemotherapy.* Jun 2011;66(6):1223-1230.
13. Nowak MA, Nelson RE, Breidenbach JL, Thompson PA, Carson PJ. Clinical and economic outcomes of a prospective antimicrobial stewardship program. *American journal of health-system pharmacy : AJHP : official journal of the American Society of Health-System Pharmacists.* Sep 1 2012;69(17):1500-1508.
14. Griffith M, Postelnick M, Scheetz M. Antimicrobial stewardship programs: methods of operation and suggested outcomes. *Expert review of anti-infective therapy*. Jan 2012;10(1):63-73.
15. Roberts RR, Hota B, Ahmad I, et al. Hospital and societal costs of antimicrobial-resistant infections in a Chicago teaching hospital: implications for antibiotic stewardship. *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America.* Oct 15 2009;49(8):1175-1184.
16. Sick AC, Lehmann CU, Tamma PD, Lee CK, Agwu AL. Sustained savings from a longitudinal cost analysis of an internet-based preapproval antimicrobial stewardship program. *Infection control and hospital epidemiology : the official journal of the Society of Hospital Epidemiologists of America.* Jun 2013;34(6):573-580.
17. Standiford HC, Chan S, Tripoli M, Weekes E, Forrest GN. Antimicrobial stewardship at a large tertiary care academic medical center: cost analysis before, during, and after a 7-year

program. *Infection control and hospital epidemiology: the official journal of the Society of Hospital Epidemiologists of America.* Apr 2012;33(4):338-345.
18. Dellit TH, Owens RC, McGowan JE, Jr., et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America*. Jan 15 2007;44(2):159-177.
19. Rohde JM, Jacobsen D, Rosenberg DJ. Role of the Hospitalist in Antimicrobial Stewardship: A review of Work Completed and Description of a Multisite Collaborative. *Clinical therapeutics*. Jun 5 2013.
20. Srinivasan A. Engaging hospitalists in antimicrobial stewardship: the CDC perspective. *Journal of hospital medicine: an official publication of the Society of Hospital Medicine*. Jan 2011;6 Suppl 1:S31-33.
21. Yam P, Fales D, Jemison J, Gillum M, Bernstein M. Implementation of an antimicrobial stewardship program in a rural hospital. *American journal of health-system pharmacy: AJHP: official journal of the American Society of Health-System Pharmacists.* Jul 1 2012;69(13):1142-1148.
22. Canton R, Bryan J. Global antimicrobial resistance: from surveillance to stewardship. Part 2: stewardship initiatives. *Expert review of anti-infective therapy.* Dec 2012;10(12):1375-1377.
23. Avdic E, Cushinotto LA, Hughes AH, et al. Impact of an antimicrobial stewardship intervention on shortening the duration of therapy for community-acquired pneumonia. *Clinical infectious disease: an official publication of the Infectious Diseases Society of America*. Jun 2012;54(11):1581-1587.
24. Rattanaumpawan P, Morales KH, Binkley S, et al. Impact of antimicrobial stewardship programme changes on unnecessary double anaerobic coverage therapy. *The Journal of antimicrobial chemotherapy*. Nov 2011;66(11):2655-2658.
25. Gomez MI, Acosta-Gnass SI, Mosqueda-Barboza L, Basualdo JA. Reduction in surgical antibiotic prophylaxis expenditure and the rate of surgical site infection by means of a protocol that controls the use of prophylaxis. *Infection control and hospital epidemiology: the official journal of the Society of Hospital Epidemiologists of America*. Dec 2006;27(12):1358-1365.
26. Joshi, S. (2010). Hospital antibiograms: A necessity. *Indian journal of medical microbiology, 28*(4), 277.
27. Braxton CC, Gerstenberger PA, Cox GG. Improving antibiotic stewardship: order set implementation to improve prophylactic antimicrobial prescribing in the outpatient surgical setting. *The Journal of ambulatory care management.* Apr-Jun 2010;33(2):131-140.
28. Malcolm W, Nathwani D, Davey P, et al. From intermittent antibiotic point prevalence surveys to quality improvement: experience in Scottish hospitals. *Antimicrobial resistance and infection control.* 2013;2(1):3.
29. Bornard L, Dellamonica J, Hyvernat H, et al. Impact of an assisted reassessment of antibiotic therapies on the quality of prescriptions in an intensive care unit. *Medecine et maladies infectieuses.* Sep 2011;41(9):480-485.
30. Kaye KS, Antimicrobial de-escalation strategies in hospitalized patients with pneumonia, intra-abdominal infections, and bacteremia. *Journal of hospital medicine: an official publication of the Society of Hospital Medicine*. Jan 2012;7 Suppl 1:S13-21.
31. Pardo J, Klinker KP, Borgert SJ, Trikha G, Rand KH, Ramphal R. Time to Positivity of Blood Cultures Supports Antibiotic De-escalation at 48 Hours. *The Annals of pharmacotherapy.* Nov 18 2013.
32. Stocker M, Ferrao E, Banya W, Cheong J, Macrae D, Furck A. Antibiotic surveillance on a pediatric intensive care unit: easy attainable strategy at low costs and resources. *BMC pediatrics*. 2012;12:196.
33. Dancer SJ, Kirkpatrick P, Corcoran DS, Christison F, Farmer D, Robertson C. Approaching zero: temporal effects of a restrictive antibiotic policy on hospital-acquired *Clostridium difficile*, extended-spectrum beta-lactamase-producing coliforms and methicillin-resistant *Staphylococcus aureus*. *International journal of antimicrobial agents.* Feb 2013;41(2):137-142.
34. DiazGranados CA. Prospective audit for antimicrobial stewardship in intensive care: impact on

resistance and clinical outcomes. *American journal of infection control.* Aug 2012;40(6):526-529.
35. Di Pentima MC, Chan S. Impact of antimicrobial stewardship program on vancomycin use in a pediatric teaching hospital. *The Pediatric infectious disease journal.* Aug 2010;29(8):707-711.
36. Toth NR, Chambers RM, Davis SL. Implementation of a care bundle for antimicrobial stewardship. *American journal of health-system pharmacy: AJHP: official journal of the American Society of Health-System Pharmacists.* May 1 2010;67(9):746-749.
37. Institute for Healthcare Improvement. Science of Improvement: Establishing Measures. 2011; http://www.ihi.org/knowledge/Pages/HowtoImprove/ScienceofImprovementEstablishingMeasures.aspx. Accessed 10/28/2015.
38. Centers for Disease Control and Prevention. Antibiotic audit forms. 2013; http://www.cdc.gov/getsmart/healthcare/implementation.html. Accessed 10/28/2015.
39. Gauthier TP, Lantz E, Heyliger A, Francis SM, Smith L. Internet-Based Institutional Antimicrobial Stewardship Program Resources in Leading US Academic Medical Centers. *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America*. Feb 2014;58(3):445-446.
40. National Action Plan for Combating Antibiotic Resistant Bacteria. https://www.whitehouse.gov/sites/default/files/docs/national_action_plan_for_combating_antibiotic-resistant_bacteria.pdf. Accessed September 3, 2015.
41. Institute for Healthcare Improvement. July 2012. http://www.cdc.gov/getsmart/healthcare/pdfs/Antibiotic_Stewardship_Change_Package_10_30_12.pdf. Accessed September 3, 2015.
42. Centers for Disease Control and Prevention. Vital Signs. August 2015. http://www.cdc.gov/vitalsigns/stop-spread/index.html. Accessed October 28, 2015.

Appendix A

NHSN Annual Hospital Survey: Antibiotic Stewardship Questions (Q23-Q34) mapped to the Core Elements from Mar 2014 CDC Vital Signs *Antibiotic Rx in Hospitals: Proceed with Caution*[6]
Leadership Commitment: Dedicate necessary human, financial, and information technology resources. ▪ Q23. Does your facility have a written statement of support from leadership that supports efforts to improve antibiotic use (antibiotic stewardship)? ▪ Q26. Does your facility provide any salary support for dedicated time for antibiotic stewardship activities?
Accountability: Appoint a single leader responsible for program outcomes. ▪ Q24. Is there a leader responsible for outcomes of stewardship activities at your facility? • If Yes, what is the position of this leader: (choose one) □ Physician □ Pharmacist □ Other
Drug Expertise: Appoint a single pharmacist leader to support improved prescribing. ▪ Q25. Is there at least one pharmacist responsible for improving antibiotic use at your facility?
Action: Take at least one prescribing improvement action, such as requiring reassessment within 48 hours, to check drug choice, dose, and duration. ▪ Q27. Does your facility have a policy that requires prescribers to document an indication for all antibiotics in the medical record or during order entry? ▪ Q28. Does your facility have facility-specific treatment recommendations, based on national guidelines and local susceptibility, to assist with antibiotic selection for common clinical conditions? ▪ Q29. Is there a formal procedure for all clinicians to review the appropriateness of all antibiotics at or after 48 hours from the initial orders (e.g., antibiotic "time outs")? ▪ Q30. Do any specified antibiotic agents need to be approved by a physician or pharmacist prior to dispensing at your facility? ▪ Q31. Does a physician or pharmacist review courses of therapy for specified antibiotic agents and communicate results with prescribers (i.e., audit with feedback) at your facility?
Tracking: Monitor prescribing and antibiotic resistance patterns. ▪ Q27a. [If Yes to 27] Has adherence to the policy to document an indication been monitored? ▪ Q28a. [If Yes to 28] Has adherence to facility-specific treatment recommendations been monitored? ▪ Q32. [If Yes to 32] Does your facility monitor antibiotic use (consumption) at the unit, service, and/or facility wide? • Q32a [If Yes to 32] By which metrics? (choose all that apply) □ Days of Therapy □ Defined Daily Dose □ Purchasing Data □ Other
Reporting: Regularly report to staff prescribing and resistance patterns, and steps to improve. ▪ Q32b [If Yes to 32] Are facility- and/or unit- or service-specific reports on antibiotic use shared with prescribers? ▪ Q33. Do prescribers ever receive feedback by the stewardship program about how they can improve their antibiotic prescribing?
Educations: Offer education about antibiotic resistance and improving prescribing practices. ▪ Q34. Has your stewardship program provided education to clinicians and other relevant staff on improving antibiotic use?