Appendix A: CHARM Description

What is CHARM?

The Collaboration to Harmonize Antimicrobial Registry Measures (CHARM) project is a nationwide program developed to help quantify and assess appropriateness of outpatient antibiotic use. The CHARM project has been approved by the Ferris State University Institutional Review Board (IRB). CHARM is designed to collect and report outpatient antimicrobial prescribing in clinics, urgent care centers, emergency department, and dental practices. Data are transformed into interactive, user-friendly dashboards that are used by partner institutions to track and report outpatient antimicrobial use. Each CHARM dashboard is equipped with filters that allow for viewing the data according to timeframe, diagnosis, prescriber group/individual prescriber, antimicrobial, guideline concordance, and patient demographics. These filters can be stacked on top of each other to allow significant manipulation of data that would otherwise be difficult for clinicians who are unfamiliar with working with large data sets.

Data Acquisition:

CHARM partners with health systems with outpatient clinics, urgent care centers, emergency department, and dental practices. Under a data use agreement, health-systems securely share de-identified, masked data extracted from their electronic medical records with the CHARM project. These data are used to generate a health-system specific dashboard, which is then made available to clinicians within each health-system. New data is transferred to CHARM on a monthly or quarterly basis to update the dashboards in a timely manner. Partnering health-systems use their personal dashboards to identify and track outpatient antimicrobial use, identify stewardship needs and track the progress of interventions. Using aggregate data from all partnering health-systems, CHARM publishes a statewide dashboard for Michigan and a national dashboard. These aggregate dashboards can be used by partnering health-systems for benchmarking purposes.

Linking Prescription and Diagnosis:

The data extraction process for CHARM starts by identifying an antibiotic prescribing episode. This point serves an anchor for collection of other data elements. If the antimicrobial prescription is linked to a diagnosis International Classification of Diseases, Tenth Revision (ICD-10) code in the electronic health record (EHR), this diagnosis is used as the purpose of the prescription. If the antimicrobial is not directly linked to a diagnosis, all diagnoses listed on outpatient visits conducted on the date that the antibiotic was prescribed are examined to determine a likely diagnosis. It is common for outpatient clinic visits to be associated with multiple ICD-10 codes. In these situations, CHARM utilizes a validated tier system to identify the diagnosis that is most likely associated with the antibiotic prescription.

CHARM's ICD-10 tier system has 3 levels. A tier 1 diagnosis virtually always requires antibiotics (e.g. infectious pyelonephritis). A tier 2 diagnosis sometimes requires antibiotics (e.g. acute sinusitis). A tier 3 diagnosis never requires antibiotics (e.g. hypertension). CHARM links the antimicrobial prescription to the lowest tier diagnosis that is associated with the outpatient visit. If there are multiple diagnoses in the lowest tier recorded on the prescription date, CHARM links the antimicrobial to each of those diagnoses.

International Classification of Diseases, 10th Revision (ICD-10) Codes

The following list ICD-10 codes were utilized for this manuscript:

Diagnosis	**ICD-10 Codes**
Acute Cystitis	N02.2, N02.8, N02.9, N30.00, N30.01, N30.20, N30.21, N30.30, N30.80, N30.81, N30.90, N30.91, N31.1, N31.2, N31.8, N31.9, N32.0, N39.41, N39.42, O23.10, O23.11, O23.12, O23.13, O26.892, O26.893, O26.899, O86.22, O99.89, O99.891, R30.0, R30.1, R30.9, R33.8, R33.9, R35.0, R35.1, R35.8, R35.89, R39.15
Acute Sinusitis	J01.00, J01.01, J01.10, J01.11, J01.20, J01.21, J01.30, J01.31, J01.40, J01.41, J01.80, J01.81, J01.90, J01.91
Acute Pharyngitis	J02.0, J02.8, J02.9, J03.00, J03.01, J03.80, J03.90, J03.91, J04.0, J04.10, J04.2, J04.30, J04.31, J35.1, J35.2, J35.3, J35.8, J35.9, J36, J36.0, J39.0, J39.1, J39.2, R07.0, J03.81
Cellulitis	A46, A46.0, H60.10, H60.11, H60.12, H60.13, L03.011, L03.012, L03.019, L03.031, L03.032, L03.039, L03.111, L03.112, L03.113, L03.114, L03.115, L03.116, L03.119, L03.122, L03.124, L03.126, L03.129, L03.211, L03.212, L03.213, L03.221, L03.311, L03.312, L03.313, L03.314, L03.315, L03.316, L03.317, L03.319, L03.811, L03.818, L03.891, L03.90, L08.1, L30.3, P38.1, P38.9
Otitis Media	H65.00, H65.01, H65.02, H65.03, H65.04, H65.05, H65.06, H65.07, H65.111, H65.112, H65.113, H65.114, H65.115, H65.116, H65.119, H65.191, H65.192, H65.193, H65.194, H65.195, H65.196, H65.197, H65.199, H65.20, H65.21, H65.22, H65.23, H65.31, H65.32, H65.33, H65.411, H65.412, H65.413, H65.491, H65.492, H65.493, H65.499, H65.90, H65.91, H65.92, H65.93, H66.001, H66.002, H66.003, H66.004, H66.005, H66.006, H66.007, H66.009, H66.011, H66.012, H66.013, H66.014, H66.015, H66.016, H66.017, H66.019, H66.11, H66.12, H66.13, H66.21, H66.3X1, H66.3X2, H66.3X3, H66.3X9, H66.41, H66.42, H66.43, H66.90, H66.91, H66.92, H66.93, H67.1, H67.2, H67.3, H67.9, H68.002, H68.003, H68.011, H68.013, H68.101, H68.102, H68.103, H68.109, H69.02, H69.80, H69.81, H69.82, H69.83, H69.90, H69.91, H69.92, H69.93, H72.90, H72.91, H72.92, H72.93, H73.001, H73.002, H73.011, H73.012, H73.013, H73.019, H73.11, H73.12, H73.13, H73.20, H73.21, H73.22, H73.891, H73.892, H73.893, H73.90, H73.91, H73.92, H73.93, H74.01, H92.01, H92.02, H92.03, H92.09, H92.10, H92.11, H92.12, H92.13, H92.20, H92.21, H92.22, H92.23, , H93.8X1, H93.8X2, H93.8X3, H93.8X9, H93.90, H93.91, H93.92, H93.93

Identifying Concordant Antimicrobial Choice

Once the antimicrobial is linked with a diagnosis, CHARM evaluates whether that antimicrobial choice is concordant. To determine concordance of antimicrobial choice, CHARM uses FDA approvals, published guidelines from expert organizations such as the Infectious Diseases Society of American (IDSA), and the Center for Disease Control and Prevention (CDC) guidance. Treatment recommendations from sources such as the John Hopkins Antibiotic Guide and the Sanford Guide are also used to determine concordance. Within CHARM, there is a table that lists all infectious diagnoses that CHARM evaluates. Along each of these diagnoses is a list of antimicrobials that are recommended for treatment in an associated guideline. Along these antimicrobials that are recommended dosing regimens that are turned into recommended therapeutic ranges (RTR), which is further described in the "Identify Concordant Antimicrobial Dosing" section. If the prescribed antimicrobial is listed in the table of the associated ICD-10 code, it is categorized as guideline concordant.

Identifying Concordant Antimicrobial Dosing

If antimicrobial choice is determined to be concordant for the disease state for which it was prescribed, CHARM then assesses concordance of the dosing regimen prescribed. Dosing concordance is not determined for discordant antibiotic choice. The basis for the dosing concordance evaluation comes from using FDA approvals, published guidelines from expert organizations such as the IDSA and the CDC guidance. Treatment recommendations from sources such the John Hopkins Antibiotic Guide and the Sanford Guide are also used to determine concordance. If a societal guideline states an antimicrobial is concordant but does not provide recommended dosing, LexiComp is utilized to identify concordant dosing.

Within CHARM, there is a table that lists all infectious diagnoses that CHARM evaluates. Along each of these diagnoses is a list of antimicrobials that are recommended for treatment in an associated guideline. Along with these antimicrobials are recommended dosing regimens that are turned into recommended therapeutic ranges (RTR). If the prescribed therapeutic regimen (PTR) falls within the RTR, it is categorized as concordant. An example is listed below:

Lexicomp recommends that when cephalexin is prescribed to treat impetigo, it should be prescribed 250-500 mg four times a day for seven days. To determine if a given prescription is concordant, CHARM turns this recommendation into a range based on the total milligram exposure a patient can receive. This is accomplished by identifying the lowest and highest milligram exposure a patient can receive. In this example, CHARM multiplies the lowest dose, lowest frequency, and lowest duration of therapy to receive the low end of the range (250 mg x 4 times a day x 7 days = 7,000 mg). It then repeats this process for the highest possible exposure (500 mg x 4 times a day x 7 days = 14,000 mg). These numbers together make up the endpoints of the recommended therapeutic range (RTR).

Next, CHARM identifies the total milligram exposure in the actual antimicrobial prescription. This is referred to as the Prescribed Therapeutic Regimen (PTR). If the PTR falls within the RTR, the prescription is said to have concordant dosing. Continuing the previous example, let's say cephalexin 500 mg four times a day for ten days is prescribed for impetigo. This would equate to

a PTR of 20,000 mg (500 mg x 4 days a day x 10 days). In this situation the PTR (20,000 mg) falls outside of the RTR (7,000-14,000 mg). So, this prescription would be considered to not have concordant dosing.