Bringing the “Power” to Cerner’s PowerChart for Antimicrobial Stewardship

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The electronic medical record (EMR) has huge potential for facilitating antimicrobial stewardship efforts by directing providers to preferred antimicrobials. Cerner PowerChart currently holds the number 2 position in the EMR market. Although PowerChart has limited “out of the box” functionalities to optimize stewardship efforts, there are many potential utilities that can be developed to assist in stewardship practice. However, to harness the stewardship potential of the EMR system, significant hospital information technology resources are needed. Herein we describe the experiences of 3 large healthcare systems utilizing Cerner to facilitate prior authorization of antimicrobials, prospective audit and feedback of antimicrobials, and supplemental stewardship strategies.

Keywords. antibiotic stewardship; EMR; Cerner; PowerChart; CPOE.

Recently, Kullar et al discussed the role of the current electronic medical record (EMR) leader, Epic, in antimicrobial stewardship [1]. The authors described the use of EMR systems in stewardship efforts and the role of add-on systems such as Theradoc and Medmined that are provided by third-party vendors. Kullar et al also highlighted various tools, such as iVents and Navigator and Best Practice Alerts, provided by Epic to optimize Antimicrobial Stewardship programs [1]. Currently, Cerner (Kansas City, Missouri), maker of Cerner PowerChart, holds the number 2 position in the EMR market [2].

Early versions of the Cerner system provided little “out of the box” utility for antimicrobial stewardship, which created opportunities for third-party vendors [1]. These third-party vendor systems addressed some functionality limitations of Cerner with regard to stewardship. Over time, the potential utility of the Cerner software for antimicrobial stewardship has improved, although local information technology resources are required to unleash this utility. We describe utilization of Cerner for antimicrobial stewardship at 3 large healthcare systems, Northwestern Memorial Hospital (NMH), Detroit Medical Center (DMC), and University of Pittsburgh Medical Center (UPMC) to demonstrate capabilities of the platform that other institutions with Cerner EMR can utilize to facilitate stewardship efforts at their hospitals.

FACILITATING FORMULARY RESTRICTION AND PRIOR AUTHORIZATION

One of the 2 core strategies of antimicrobial stewardship is formulary restriction and preauthorization [3]. This strategy focuses on providers obtaining approval, prior to antimicrobial dispensation. Cerner provides excellent functionality to facilitate the preapproval process, as long as institutional information technology (IT) resources are available in terms of personnel and their time to build this functionality. Below we describe how 2 large healthcare facilities utilize this functionality.
Criteria Monitored Drugs

The DMC has successfully used the criteria-monitored drug (CMD) system (Figure 1) since 1987 [4]. The CMD process has 2 tiers of restriction for antimicrobials. The first is for agents that require infectious diseases approval and appropriate criteria for use prior to dispensing (eg, carbapenems, daptomycin, micafungin). For second-tier restricted agents (eg, fluoroquinolones), only clinical criteria, predefined by the Antimicrobial Subcommittee, are needed for the agent to be dispensed. For tier 2 antimicrobials, prescribers have the ability to override criteria.

This CMD process is facilitated in an automated format through computerized prescriber order-entry (CPOE). Currently, DMC utilizes an automated prompt when a restricted antimicrobial is ordered, requiring the prescriber to select one of the predefined criteria, or to select “Other—pharmacy to contact me” option prior to the routing of the order to pharmacy for verification. The verifying pharmacist determines whether or not criteria were met, and if applicable, whether infectious diseases approval was obtained and documented. The verifying pharmacist can then complete the documentation process, selecting 1 of 4 predetermined options (approved by monitoring service, attending physician override, changed on follow-up, and meets criteria) and document other pertinent information.

Cerner Special Instructions Approval

At UPMC, when a restricted antibiotic is ordered, a “pop-up” screen fires (Figure 2A), reminds the ordering physician of the level of prior authorization needed for the chosen antimicrobial, and provides directions on how to obtain the agent. Additionally, a specific field within the order itself can be used for recording an approval code documenting approval by the stewardship team. An order entry pharmacist subsequently verifies the order provided (Figure 2B). If the process is not followed, the pharmacist can page the provider to convey that the antimicrobial requires approval.

Whereas these processes at DMC and UPMC facilitate compliance with restriction policies, they are not without limitations. Ultimately, restriction is dependent upon the verifying pharmacist’s assessment of the medication order and/or the CMD form, as well as the amount and quality of documentation present. If the pharmacist fails to properly assess the necessary approval process components, the stewardship process can fail.

FACILITATING PROSPECTIVE AUDIT AND FEEDBACK

Prospective audit of antimicrobial use with intervention and feedback is the other core stewardship strategy [3], and focuses on real-time follow-up by the stewardship team with the provision of recommendations to the prescribers. Although Cerner offers some utility with regards to prospective audit and feedback (see below), its capabilities are limited. Third-party vendors offer more effective processes to identify patients for whom targeted interventions are appropriate (eg, patients who have organism–drug mismatches, patients on broad-spectrum antibiotics with isolates susceptible to narrower-spectrum therapies). Utilization of Cerner alone for prospective audit and feedback may result in inefficiencies (eg, stewardship personnel spending time on patients for whom intervention is not needed) and might not identify patients who could most benefit from stewardship intervention.

InfoView Reports for Patient Identification

With institutional IT support, InfoView reports can be created listing each patient who is receiving antimicrobial therapy, and the number of days of therapy received (Figure 3A). Unfortunately, this information does not help to identify which patients require intervention (ie, does not evaluate the appropriateness of prescribed antimicrobials). However, when institutions do not have electronic data capture systems to identify patients...
Figure 2. A, Facilitating prior authorization with the Cerner special instructions approval. B, Pharmacy verifies approval obtained.
for interventions, this Cerner functionality can serve as a starting point for identification of patients for intervention. InfoView reports can also be designed to identify all patients on an intravenous formulation of antimicrobials that possess excellent bioavailability and who are taking other medications orally (Figure 3B), facilitating intravenous to oral conversion. This can be important “low-hanging fruit” for newer stewardship programs, or those programs with limited personnel resources. The active list antibiotic report took 30–40 hours to build, whereas the intravenous to oral report took between 8 and 16 hours.

mPage Capabilities
Cerner mPages are essentially web pages supported by EMR data. They utilize common web technologies (HTML and JavaScript) to create a customizable view that can be tailored to an institution’s need. At DMC, an antimicrobial stewardship mPage, “Stew View” (Figure 4), focuses on the information that stewardship or infectious diseases personnel need to make informed antimicrobial-related decisions. Once a patient is identified, all antimicrobial orders for the current admission, antimicrobials administered within the previous 90 days, culture data from the current admission as well as for the previous

Figure 3.  A, Patients in the hospital currently on antibiotics. B, Intravenous to oral eligible patients.
year, serology data, serum drug concentrations (vancomycin, aminoglycosides), and relevant laboratory values, vital signs, heights, and weights are displayed. Importantly, this display includes all antimicrobials ordered, and not only those administered. The electronic medication administration record would need to be referenced to review doses administered. This focused display allows stewardship personnel to quickly scan relevant parts of the medical record to facilitate antimicrobial drug and dose optimization. Although this functionality is robust, it requires significant IT resources. In addition to the planning...
phase, building Stew View took an estimated 160–320 IT hours. Furthermore, it is useful only after the stewardship team has identified a patient for intervention.

**FACILITATING SUPPLEMENTARY STEWARDSHIP METHODS**

The Infectious Diseases Society of America guidelines recommend a series of supplementary techniques to enhance the institutional stewardship program [3], including education, guideline, and pathway utilization, de-escalation, and dose optimization. These supplementary techniques are perhaps where Cerner offers its best functionality.

**Antibiotic Indications**

One impressive feature within Cerner that cannot be met with third-party vendors is the ability to capture antibiotic indications within the system (Figure 5). At Northwestern, problems tracking compliance with surgical care improvement project indicators provided the impetus for development of a comprehensive, real-time antibiotic indication documentation requirement within the Cerner medication ordering process. A list of 51 antibiotic indications was created by the Antimicrobial Subcommittee as a drop-down field. An indication was required to be completed during CPOE by the ordering physician. Indications are organized by organ system and/or defined by common clinical syndromes such as genitourinary (GU)—pyelonephritis and GU-prostatitis. There is also an “other” option that allows the clinician to free text an indication for infrequent scenarios. This method provides an easy-to-navigate list, where indications for all antimicrobial orders are documented. These data provided facilitate audits for appropriate empiric antibiotic choice and duration of therapy by antibiotic indication. The indication is not modified during the course of therapy. Shortly

Figure 5. Antibiotic indication field.
after implementation, the investigators evaluated the accuracy of entered indications by auditing a representative sample of antimicrobial orders in a single month. The audit demonstrated 100% accuracy of documentation for surgical prophylaxis orders and 86% accuracy for empiric orders [5]. Practitioners at NMH are comfortable utilizing the indication data to audit antimicrobial utilization, which allows the stewardship team to identify problem areas with regards to appropriate utilization of empiric and prophylactic antimicrobial utilization. The indication data have little impact on de-escalation. It took approximately 40 IT hours to design and implement this feature. Systemwide education geared toward providers about the rationale for adding these indications and directions for completing the indication process also takes multidisciplinary collaboration. At our institutions, sessions targeted to the internal medicine, emergency medicine, and surgical groups focused on clinical indication education and process, and information.

**Order Sets and PowerPlans**

Integrated disease-specific order sets are well-characterized tools to achieve consistency in practice for common infections such as community-acquired and ventilator-associated pneumonia and *Clostridium difficile* infection [6–8]. These order sets can also be made to be flexible and thus also useful for uncommon scenarios or indications. The advantage of CPOE (vs paper) systems is that order sets can be customized to the needs of the creating institution.

**Ethanol Lock Order Set**

At UPMC an order set was developed for ethanol lock therapy, which involves instilling an ethanol solution into an intravenous catheter and allowing it to dwell for a period of time to prevent catheter-related bloodstream infections [9]. Ethanol lock therapy has been increasingly recommended and prescribed at UPMC. Each time a prescriber wished to use this therapy, significant stewardship resources were devoted to assure that...
processes were appropriately performed. To facilitate these orders, a CPOE ethanol lock order set was developed with dose, volume, route (affected catheter), dwell time, and special concerns (such as the need to verify catheter compatibility with ethanol) autopopulated in the form. Since CPOE queries for ethanol lock have been directed to this order set, compliance has been excellent. Similar order sets have also been implemented for antibiotic lock therapies.

**Improving Consistency With Inhaled Antimicrobials Through Order Sets**

Given the large cystic fibrosis and lung transplant patient population at UPMC, there is significant use of aerosolized antibiotics and antifungals. However, given the sparse literature on aerosolized antibiotic indications and dosage, patients with similar indications might be prescribed discrepant dosages, with resultant confusion among clinicians and extra work for pharmacy in terms of preparation. As such, drug-specific aerosolized antibiotic order sets were created which standardize dosages as well as clinical indications.

**Phased PowerPlans**

The utility of order sets has been demonstrated previously, and historically, preprinted order sets were utilized prior to CPOE. However, within Cerner, the employment of the “phased PowerPlan” has many characteristics that differ from a typical order set. A PowerPlan, unlike a historical order set, is designed with single or multiple stages (or “phases”). Each of these phases can be designed to enter a “planned” status. In this planned status, orders within the phase are signed and ready to be executed; however, the orders do not appear in their respective departments (pharmacy, lab, etc) or generate nursing tasks until the plan is “initiated.” Plans can be initiated by preidentified healthcare personnel (ie, a nurse, pharmacist, physician assistant, or physician). This system allows for strategic application in areas where flexibility in start times of antimicrobials is desired.

To streamline a complicated process at DMC, phased PowerPlans have been utilized for roughly 2 years for penicillin desensitization. Prescribers begin by searching the order catalog for the appropriate desensitization plan (eg, “Penicillin Desensitization”), as they would for any other order. Once the appropriate desensitization plan is chosen, the physician is prompted for an estimated start time. It is important to note that this is only an estimated start time, and the entire plan can be “rescheduled” at any point before the plan is fully initiated. Once the plan is signed, the first phase begins. During the first phase of the PowerPlan, a notification that desensitization is taking place is routed to pharmacy, initiating the communication process between prescriber, nursing, and pharmacy. It is important to note that the PowerPlan itself has no communication orders to discuss these specific steps to be undertaken, but rather it facilitates communication, which occurs usually in the form of a phone call or face-to-face discussion, between the involved parties. Also, once the plan is initiated, the second phase of the plan moves into a “planned” status. In this second phase, all the appropriate timings and doses of penicillin are predefined (ie, the 14-dose desensitization schedule at 15-minute intervals). After clarification that the estimated start time is deemed to be appropriate, the pharmacist, nurse, or physician then initiates the second phase of the plan. Once initiated, the orders from the second phase are activated and routed to the necessary healthcare personnel (ie, nursing, pharmacy, etc). Timing of all doses and orders are automatically calculated relative to the estimated start time of the initial dose. If the start time is not feasible (eg, due to a 1:1 nursing to patient ratio not being available), the plan will remain in the planned stage until the second phase is initiated. Once this phase of the plan is initiated, all of the subsequent start times will be automatically calculated and updated. Because timing delays can compromise the entire desensitization process, PowerPlans have the ability to significantly improve patient care. Additionally, in standardizing the desensitization process, significant stewardship resources (time) do not need to be spent reinventing the wheel every time the process is needed for patient care. Since implementation of the PowerPlan for desensitization, the stewardship team has targeted other areas where ordering and timing of antibiotic administrations is complex. We are currently targeting perioperative antimicrobial prescribing where start times for procedures are dynamic and contingent on multiple factors.

Order sets and PowerPlans offer the ability to both ensure compliance with stewardship recommendations and allow flexibility for prescribing practices, but there are significant limitations. First and foremost is the significant time commitment needed for both the development of the order sets and PowerPlans, as well as for education regarding how the process works for all involved parties (eg, nursing, physicians, and pharmacy). In addition to the time for education, the development of order sets and PowerPlans can take anywhere from 2–3 hours to 80–100 hours to design, depending on the degree of complexity and the number of different providers who need to be involved. The desensitization protocol described above took approximately 80 hours to build, due to the complexities pertaining to the various dilutions needed for the 14-dose protocol. Unfortunately, despite education, it can be difficult to convince providers to consistently use order sets, particularly if they have already developed their own processes for managing common clinical scenarios.

**Dose Range Check**

A safety feature that is included in the standard Cerner application is the dose range check. This function uses predefined dose
ranges to inform the prescriber and verifying pharmacist, in the form of a pop-up window, if an entered dose is out of range. The pharmacist, after investigation, can either suppress the alert or contact the prescriber and recommend an alternative dose. The main limitation with this check is that the Cerner dose ranges may conflict with local dosing guidelines, resulting in confusion among prescribers, who may act on an alert, and verifying pharmacists, who are educated to dose per institutional guidelines. However, the ranges are modifiable for any drug and take a minimal amount of time (5–10 minutes per drug) to change.

**Promoting Education Through Toolbars**

A number of potential tools exist that enable the stewardship team to assist in both provider education and the dissemination of clinical pathways. An example of these tools are the toolbar links (Figure 6) such as the “print on demand” function, which at UPMC links to the institution’s annual *Guide to Antimicrobial Chemotherapy*. Although this pocket guide is printed and distributed annually to all providers, this real-time automated functionality provides information redundancy. It also serves as a passive mechanism for drug and dose selection, as the guide provides a comprehensive resource regarding formulary agents, institution-endorsed first-line and alternative agents by indication, antibiogram data, and dosing across the renal function spectrum. Even if individual institutions do not have a similar comprehensive resource like the aforementioned guide, this functionality can still provide a link to any document or series of documents deemed relevant to antimicrobial stewardship including guidelines, pathways, or antibiogram data.

**Summary and Limitations**

Cerner has made significant advancements in its functionality to promote institutional stewardship. Unfortunately, at the present time, little of this functionality is readily available in an “out of the box” format, and significant information technology investments from the individual institution are required to harness much of the functionality. Cerner does not currently employ dedicated stewardship personnel, although the company has described an interest in focusing more toward antimicrobial stewardship in the future. On the plus side, the functionality described in this manuscript allows an institution to create any logic they want, provided the resources are available. Additionally, these processes only function in the classical scenario of a prescriber entering an order in the EMR and a pharmacist subsequently checking the order. Increasingly, pharmacists rounding with medical teams are placing orders themselves directly into the “pharmacy side” of the EMR system, potentially bypassing stewardship mechanisms. From a stewardship prospective, the biggest limitation of the current Cerner functionality is that it fails to effectively identify appropriate patients for antimicrobial-related follow-up and interventions.

As rates of multidrug-resistant organisms continue to rise in both the hospital and the community, so will the need for empiric broad-spectrum therapy. For these reasons, the success of stewardship is largely driven by prospective audit and feedback to identify opportunities for antimicrobial de-escalation and discontinuation. Until Cerner prioritizes development of functionality to identify patients in “real time” who can benefit from review and intervention by stewardship personnel, the need for third-party vendors outside of the Cerner system will continue.

**Note**

*Potential conflicts of interest.* All authors: No reported conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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