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Enhancement of Antimicrobial Stewardship with TheraDoc Clinical Decision Support Software

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Abstract

Even as the rate of antibiotic-resistant infections is on the rise, the number of new antimicrobial drugs approved in the United States continues to decrease. Current efforts to guard the quality of patient care by combating the increase of drug–resistant organisms focus on development of institutional antimicrobial stewardship programs (ASP). Clinical Decision Support Software (CDSS) has been shown to positively impact the provision of antimicrobial stewardship. These systems are capable of helping identify a number of clinical interventions including, but not limited to, IV to PO conversions, drug-bug mismatch, redundant therapy, and unnecessary double coverage of pathogens. This article describes how Detroit Medical Center enhanced its current ASP to provide better patient care, and achieve cost and personnel time savings by implementing the TheraDoc® Clinical Decision Support Software. In addition, the authors describe how this software program can identify target areas for improvement as well as help identify patients most likely to benefit from intervention in institutions without formal stewardship programs or with limited resources.

Introduction

Infections caused by antibiotic-resistant bacteria continue to challenge healthcare professionals as growing resistance among both gram-positive and gram-negative pathogens is observed.[1] Data from the Centers for Disease Control and Prevention (CDC) show rapidly increasing rates of infection due to methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *E. faecium* (VRE), and fluoroquinolone-resistant *P. aeruginosa*.[2] More people now die of MRSA infection in US hospitals than of HIV/AIDS and tuberculosis combined.[3] In addition, increasing rates of extended-spectrum beta lactamase (ESBL)-producing pathogens, carbapenem-resistant acinetobacter (CRAB) and carbapenem-resistant (CRE) enterobacteriaceae are posed to be even greater threats as mortality rates of CRE and CRAB are estimated to exceed 30 percent.[4,5] To further compound this problem, the number of new antibacterial drugs approved for marketing in the United States continues to decrease[6] (Figure 1).

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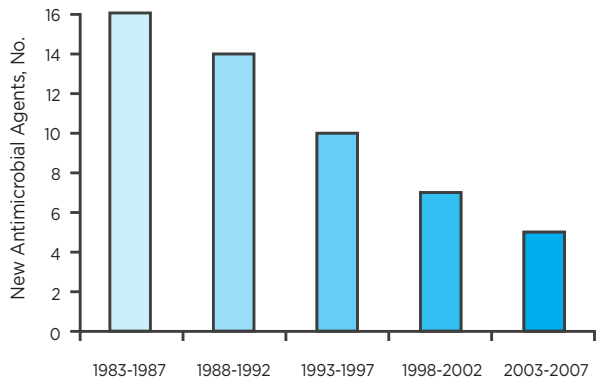
Figure 1

New Antibacterial Agents Approved in the US, 1983–2007, per 5-Year Period[6,7,8]



Given the dramatic reduction in development of new antimicrobial agents, current efforts to combat the increase of drug-resistant organisms focus on development of institutional antimicrobial stewardship programs (ASP).[9] In 2007, The Infectious Diseases Society of America (IDSA) published guidelines in conjunction with the Society for Healthcare Epidemiology of America to outline antimicrobial stewardship practices.[10] As a result of the awareness generated by organizational thought leaders, antimicrobial stewardship programs are increasingly recognized as important quality initiatives for health care institutions.[11]

A core strategy for the provision of antimicrobial stewardship is a prospective audit with intervention and feedback.[9] This approach is labor intensive and requires a dedicated person to proactively evaluate patients receiving antimicrobial therapy, identify possible interventions, and address concerns with the medical staff in a timely fashion. Multiple studies have shown that a prospective audit with immediate feedback can decrease the utilization of broad spectrum antimicrobials as well as decrease the length of therapy.[9,12-15] Recent enhancements in Clinical Decision Support Software (CDSS) have been shown to aid health care professionals in identifying patients in an expedited manner.[9]

CDSS Systems are capable of helping identify opportunities for a number of clinical interventions including, but not limited to, IV to PO conversions, drug-bug mismatch, redundant therapy, and unnecessary double coverage of pathogens.[9] For infection prevention professionals, the system provides a variety of information regarding multidrug resistant organisms (MDROs), allowing for rapid identification of patients who are infected and/or colonized so that they can be appropriately placed on contact isolation precautions. To increase productivity and documentation of many stewardship activities[9], most CDSS programs allow for documentation of interventions directly in the system, which permits easy analysis of the impact of the facility's ASP.

Several articles have been published discussing the utility of CDSS in the performance of antimicrobial stewardship activities.[9] One study demonstrated a decreased duration of diarrhea and rates of *C. difficile*, personnel time associated with monitoring antimicrobial therapy, and antimicrobial expenditures when utilizing a CDSS as compared to standard of care for their institution.[16] Another study determined that 71% of evaluated patients were receiving redundant antibiotic combination therapy. Intervention and subsequent discontinuation of redundant therapy resulted in annualized savings of $60,000 and approximately 3,500 antibiotic days.[17]

Case Study

Detroit Medical Center (DMC) has had a longstanding ASP consisting of the establishment of guidelines and pathways, developing and enforcing restriction policies for certain antimicrobials, targeting opportunities for de-escalating antimicrobials, as well as intervening on culture reports. While this was an effective sound program, it was largely limited in the scope of impact that it could make. Stewardship pharmacists were tasked with determining the most optimal interventions by reviewing daily antibiotic list printouts, and/or static culture reports that printed out overnight. While this led to many effective interventions, it did not optimize the full potential of the ASP because it did not allow the stewardship team to focus on patients who would benefit most from the interventions.

In 2010, the DMC implemented a CDSS, TheraDoc, as its primary means of stewardship. The more robust, real time data obtained from this system allowed the stewardship team to better achieve the primary goal for stewardship - optimizing outcomes for patients with an infectious diseases process. While stewardship pharmacists still complete the tasks comprising DMC's original ASP, a shift in daily activities has taken place which has enhanced their focus on improving patient care.

Guideline and Pathway Compliance

At DMC, guidelines and pathways for infectious disease processes are developed through the antimicrobial subcommittee of the Pharmacy and Therapeutics (P & T) committee. With the implementation of TheraDoc, patients who are not on first-line therapies can be easily located, allowing these guidelines and pathways to be efficiently targeted. For example, the subcommittee recommended cefoxitin as first line therapy for intra-abdominal infections to optimize outcomes while minimizing third generation cephalosporin and fluoroquinolone usage, with the goal of decreasing extended-spectrum beta lactamase (ESBL) production. TheraDoc's EZ-Alerts Assistant™ helped identify patients on specific antibiotics or combinations that may be more appropriately treated with cefoxitin alone compared to patients on alternative regimens including ceftriaxone plus metronidazole, ciprofloxacin plus metronidazole, moxifloxacin, and ampicillin/sulbactam.

Time to Appropriate Therapy

Another advantage of TheraDoc is its ability to email or page information such as culture and laboratory results, and new antibiotic orders as soon as it is made available by the clinical microbiology laboratory. With TheraDoc, any relevant laboratory or medication data contained in the patient chart can be communicated to any practitioner in real time. These data can then be sent to the practitioner to help them decide if a patient warrants closer examination or a change in therapy.

At DMC, this real time reporting process has been 'practice-changing' and potentially life-saving. When deciding where to utilize real-time paging alerts, the DMC has targeted multiple disease states with two main characteristics: 1) implementation of rapid, appropriate empiric therapy has been proven in the literature to save lives and 2) there is a high likelihood that at the time of the culture result, the patient is not receiving optimal antibiotic therapy. For example, when a blood culture result comes back positive (or has an update, such as organism speciation or susceptibility information) for a Gram-negative bacilli or yeast, a page is sent immediately to the infectious disease (ID) pharmacist. The pharmacist then, in real time, can assess the patient and make therapeutic adjustments and/or recommendations as necessary. This decreases the time to appropriate therapy, and helps improve patient outcomes.

The email functionality is used at DMC for information that is desired in real time but is not considered crucial or life-threatening, such as restricted antibiotic starts or positive non-blood cultures with target organisms (methicillin-resistant *Staphylococcus aureus*, etc).

Optimizing Therapy for Difficult to Treat Pathogens

The infectious disease clinicians at DMC regularly encounter difficult-to-treat pathogens. Through the efforts of the antibiotic subcommittee, they have developed many pathogen-specific treatment algorithms that, in accordance with stewardship principles, focus on not only optimal drug selection, but also the optimal dose. Prior to the implementation of TheraDoc, no timely and effective method existed that could immediately identify patients with infections due to MRSA, *Acinetobacter*, ESBL, or *Pseudomonas* infections. Prior to TheraDoc, reports were only run once a day, possibly delaying optimization of antimicrobial treatment by 24 hours or more. Now with TheraDoc, this kind of information is emailed to the clinicians right away enabling the pharmacists to once again place patients on optimal therapy more rapidly. This is another example of how the use of TheraDoc promotes improved compliance with guidelines designed to optimize therapy for specific organisms/disease states.

De-escalation and Discontinuation Opportunities

After implementation of TheraDoc, the ID pharmacists have used therapeutic antibiotic monitoring (TAM) alerts configured by the hospital to identify opportunities to impact patient care that would have been undiscoverable using a nonautomated system.

At DMC, the ID pharmacist uses a TAM mismatch alert which identifies 'bug-drug' mismatches. This alert is generated when a patient has a culture positive with an organism that their current antimicrobial regimen does not have activity against. The pharmacist then assesses the patient to determine if an intervention is necessary or if the culture result represents only colonization. Prior to the implementation of TheraDoc culture reports were not linked to patients' antimicrobial therapy information. The current method utilized in TheraDoc allows clinicians to focus their efforts on patients who are most likely to require intervention, rather than assessing every patient with a positive culture.

Another feature of the TAM mismatch alert is its ability to identify 'de-escalation' opportunities. At DMC, carbapenems, cefepime, piperacillin/tazobactam, and ceftriaxone have been selected as target antimicrobials, where optimization of use is a priority. The system works by alerting the ID pharmacist when any patient who is currently on one of these agents has a culture positive for an organism which is susceptible to a narrower spectrum agent, thereby identifying opportunities for de-escalation. This alert is a valuable resource for clinicians as it allows a prospective audit of restricted antimicrobials, once again allowing the clinician to focus on the patients who are most likely to benefit from analysis and intervention.

A 'no-positive culture' TAM Alert® identifies all patients who have been on antibiotics for 72 hours, but have not had any positive cultures. For these patients, the ID pharmacist investigates the case and sees if infection is suspected despite culture results (i.e., review cultures, labs, and diagnostics) and when appropriate, might recommend discontinuation or de-escalation of antibiotic therapy.

Implementing TheraDoc in Institutions without an Established ASP

While TheraDoc has had a significant impact at institutions like DMC which already had an established stewardship program, the ability of TheraDoc to help initiate a program at other institutions, no matter the size, is notable. Using TheraDoc to help clinicians develop antibiograms, conduct medication use evaluations and identify patients for interventions are areas where immediate impact can be attained.

Antibiograms

Some smaller institutions do not have the capability to run different types of antibiograms to determine where the resistance issues lie. TheraDoc provides the ability to create simple and easy antibiograms for any institution or any floor within that institution. Through development of antibiograms, an institution can identify resistance problems. Once resistance patterns have been identified, empiric therapy guidelines specific to the institution can be developed for various disease states. Information derived from the antibiogram may also justify the development of antibiotic restrictions. For example, an institution may develop guidelines for the treatment of urinary tract infections (UTIs). Although many institutions typically use ciprofloxacin for therapy, by running a quick antibiogram, the institution may learn that *E coli* susceptibilities to ciprofloxacin are relatively low (e.g. 70%), whereas susceptibilities to ceftriaxone might exceed 95%. Such a finding might warrant a change in empiric treatment recommendations and result in improving patient outcomes by improving time to appropriate therapy.

Medication Use Evaluation

Medication Use Evaluation (MUE) is a performance improvement method that focuses on evaluating and improving medication-use processes with the goal of improving patient outcomes.[18] An important MUE that can be implemented when beginning a ASP is the identification of patients receiving broad spectrum agents. This enables the ID pharmacist to assess appropriateness and determine potential areas for intervention. TheraDoc helps in identifying patients who received a specific antibiotic and its length of therapy, allowing institutions to identify patients and analyze usage. Additionally, using the alert system when broad spectrum agents are started enables the ID Pharmacist to execute a prospective MUE rather than the traditional retrospective MUE. In conducting this MUE, an institution can determine antimicrobial usage that is inappropriate or unnecessary and estimate a financial impact that could be gained by improving prescribing practices. For example, if the MUE identified opportunities for decreasing fifty percent of linezolid usage in an institution that spends $70,000 annually on linezolid, the institution would potentially realize a $35,000 per year cost containment.

Identifying Patients for Intervention

One of the biggest barriers to implementation of ASP at smaller, resource-limited institutions is a lack of personnel able to dedicate time to review static antimicrobial lists or positive culture reports. Therefore, person hours might be wasted in reviewing a large number of patients in an attempt to find the few for whom an intervention would be necessary. Using some of the alerts mentioned previously, the entire institution can be "screened" in order to identify patients who are most likely to be able to benefit from intervention. In particular an institution can quickly focus on serious infections where time to appropriate therapy is extremely important clinically. This can be done by reviewing all sterile site cultures (blood, respiratory, CNS) and intervening where necessary. Additionally, broad spectrum (and expensive) antimicrobial use can be limited by utilizing the TAM alerts as previously described to target de-escalation and discontinuation opportunities

Summary

For institutions with an established ASP such as DMC, implementing the TheraDoc Clinical Decision Support Software enhances the current program and results in better patient care, cost savings and personnel time savings. Additionally, for institutions without formal stewardship programs or with limited resources, this software can be used to effectively identify target areas for improvement as well as help identify patients most likely to benefit from intervention.

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