# Days of Therapy Avoided: A Novel Method for Measuring the Impact of an Antimicrobial Stewardship Program to Stop Antibiotics

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A proposed metric to quantify the impact of an antimicrobial stewardship program (ASP) is using changes in the antibiotic days of therapy (DOT) per 1000 patient-days, which is the total number of days any dose of an antibiotic is administered during a specified time period, standardized by the number of patient-days.[1] Although DOT is useful for comparing antibiotic use among hospitals or time periods, this metric is a composite result of an ASP's often multifaceted approach to improving antibiotic use. Thus, DOT provides a loose estimate of the direct impact of specific ASP activities and does not quantify the amount of antibiotics directly avoided or direct cost savings on the patient level. To ameliorate this, we reviewed our institution's ASP prospective audit and feedback (PAF) and applied a novel metric, days of therapy avoided (DOTA), to calculate the number of antibiotic days avoided that directly result from our ASP's actions targeting antibiotic stoppage. From DOTA, we also calculate attributable cost savings.

## METHODS

As approved by the institutional review board, this was a retrospective chart review of electronic records performed at Rochester General Hospital (RGH) in Rochester, New York, a 528-bed, acute-care, community teaching hospital. The RGH ASP began in 2012 with 1 infectious diseases physician and 2 infectious diseases pharmacists, who conducted daily verbal and/or written PAF progress notes within the electronic medical record. In 2013, the ASP team developed a database to document PAF activities. The variables and definitions used are summarized in the Table. When no planned length of therapy (LOT) was documented, an LOT range (based on national guidelines or, when unavailable, local practices) for the documented infection was assumed.[2-9] This database was used to collect records on patients who received written ASP recommendations for no infection (NI) or therapy complete (TC; Table) antibiotic stoppage between January 2013 and December 2016. Only written and accepted interventions (changes occurring within 48 hours of the ASP note) were included in the data set.

To quantify the direct impact of PAF, DOTA (Table) was calculated. Antibiotic costs avoided were calculated by multiplying the average wholesale price (AWP) per day (range: $0.44-$534; mean: $67.85) by DOTA. This calculation was done twice under 2 assumptions: that PAF led to the prevention of (1) 1 more day of antibiotic prescription and (2) the remainder of the documented or assumed LOT.

## RESULTS

Over 4 years, the ASP made 1594 interventions to stop antibiotics. Accepted interventions totaled 1151 (72%): 513 (44.5%) for NI and 638 (55.4%) for TC, involving 431 and 575 unique patients, respectively. Nearly half (45.8%) of the NI interventions targeted asymptomatic bacteriuria, whereas respiratory tract infections were the most common (42.2%) indication for the TC intervention.

Under the most conservative assumption that each accepted PAF recommendation avoided 1 day of unnecessary antibiotics, we estimated a total of 1151 DOTA; 690 (59.9%) were intravenous antibiotics. The average DOT on which the PAF note was written was 3.07 ± 1.69 for NI and 6.38 ± 2.73 for TC. A planned LOT was documented for only 36.7% of the courses. On the basis of documented or assumed LOT, we estimate that the NI and TC interventions led to between 1077 and 2826 DOTA and between 397 and 1598 DOTA, respectively. Potential fluoroquinolone DOTA ranged from 300 to 1126; for third- and fourth-generation cephalosporins, there were 314 to 1017 DOTA.

Using the conservative estimate of 1151 DOTA, the costs avoided totaled $16,700, which includes $10,700 for intravenous antibiotics. When the AWP per day of each antibiotic was applied to the remaining LOTs avoided, the maximum potential cost savings was $67,100. Additional cost savings may have been realized if indirect expenses, such as pharmacy preparation and nursing administration time or costs of medical supplies, were evaluated.

## CONCLUSION

We investigated DOTA as a measure of the direct patient-level and intervention-specific impact of an ASP's PAF. DOTA may be useful for ASPs with limited access to an electronic record or electronically generated DOT reports because DOTA and

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TABLE. **ASP Database, Variables, Standards, and Definitions**

| **Database Variables** |
|---|
| Antibiotic name and/or route |
| Infectious indication |
| DOT on which ASP note written |
| Planned DOT by primary team |
| **Planned LOT Standards if not Documented by Primary Team** |
| Uncomplicated urinary tract: 3-7 days |
| Skin and soft tissue: 7-14 days |
| Intraabdominal: 7-10 days |
| Respiratory tract: 5-10 days |
| Bloodstream: 10-14 days |
| Unknown and/or empiric: 3-10 days |
| Clostridium difficile: 10-14 days |
| **Definitions for Antibiotic Stoppage Indications Resulting from ASP Review** |
| NI: antibiotics prescribed but not clinically indicated |
| TC: antibiotics prescribed for a specific infectious cause, but documented planned LOT was longer than recommended by guidelines, and there were no objective signs of continued infection |
| **Definition for Antibiotics DOTA** |
| Difference between DOT on which the ASP recommendation was accepted subtracted from the planned, documented LOT or standard LOT range when not documented |

NOTE: Abbreviations: ASP, antibiotic stewardship program; DOTA, days of therapy avoided; LOT, length of therapy; NI, no infection; TC, therapy complete.

cost savings can be tracked manually and prospectively with each accepted intervention. DOTA can also help ASPs identify which clinical conditions are responsible for the most antibiotic overuse, and thus may benefit from the development of clinical treatment guidelines. We found that the highest yield areas for DOTA were targeting asymptomatic bacteriuria (NI) and respiratory infections (TC). In doing so, these have also succeeded in reducing high-risk, broad-spectrum antimicrobials, such as fluoroquinolones and advanced-generation cephalosporins. Further research is needed to assess if DOTA correlates with other ASP metrics and clinical outcomes; however, current evidence supports that reducing unnecessary antibiotic use is fundamental to reducing antibiotic resistance and adverse events.[10]

The limitations of measuring DOTA include time consumption, particularly if not collected prospectively. However, we make several conclusions. ASP PAF stopping antibiotics was well accepted and reduced antibiotic use. Second, calculating DOTA requires little technology and only knowledge of the planned LOT and drug costs. DOTA also identifies which infectious indications to focus PAF efforts on and gain the greatest impact. Overall, DOTA is a simple, useful, and promising measurement of the direct antibiotic and economic impacts of specific ASP PAF and warrants further investigation as an ASP metric.

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