Development of an inpatient operational pharmacy productivity model

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The accuracy of measuring inpatient pharmacy productivity using external benchmarking programs is limited. Separating inpatient and outpatient activities, as well as accounting for differences in the acuity of patients and workloads associated with special patient populations (e.g., emergency department patients), may be difficult. To address these limitations, benchmarking or productivity vendors may use metrics from the Centers for Medicare and Medicaid Services Case Mix Index (CMI) or the Action OI Pharmacy Intensity Score (PIS) (Truven Health Analytics, New York, NY).1

While these metrics help correct and account for patient differences, they do not fully account for department-level differences such as the breadth and scope of pharmacy technology, the structure of the pharmacy practice model, and state laws governing specific pharmacy activities. Technology examples include computerized prescriber order entry and the use of automated dispensing cabinets (ADCs) or robotics. Pharmacy model differences include the breadth of clinical services offered by a department and the emphasis placed on teaching and research.

Purpose. An innovative model for measuring the operational productivity of medication order management in inpatient settings is described.

Methods. Order verification within a computerized prescriber order-entry system was chosen as the pharmacy workload driver. To account for inherent variability in the tasks involved in processing different types of orders, pharmaceutical products were grouped by class, and each class was assigned a time standard, or “medication complexity weight” reflecting the intensity of pharmacist and technician activities (verification of drug indication, verification of appropriate dosing, adverse-event prevention and monitoring, medication preparation, product checking, product delivery, returns processing, nurse/provider education, and problem-order resolution). The resulting “weighted verifications” (WV) model allows productivity monitoring by job function (pharmacist versus technician) to guide hiring and staffing decisions. A 9-month historical sample of verified medication orders was analyzed using the WV model, and the calculations were compared with values derived from two established models—one based on the Case Mix Index (CMI) and the other based on the proprietary Pharmacy Intensity Score (PIS).

Results. Evaluation of Pearson correlation coefficients indicated that values calculated using the WV model were highly correlated with those derived from the CMI and PIS-based models (r = 0.845 and 0.886, respectively). Relative to the comparator models, the WV model yielded productivity data that correlated closely with values calculated using two validated workload management models. The model may be used as an alternative measure of pharmacy operational productivity.

Conclusion. The WV model yielded productivity data that correlated closely with values calculated using two validated workload management models. The model may be used as an alternative measure of pharmacy operational productivity.

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Most pharmacy productivity models measure either broad, non-specific metrics such as patient admissions or very basic activities such as the number of doses dispensed. An example is a commonly used pharmacy productivity metric, pharmacy adjusted admissions (PAA) divided by PIS (PAA/PIS) (Figure 1). This metric attempts to account for the pharmacy workload associated with the care of nonadmitted patients (i.e., those in the emergency department) and the acuity of admitted patients.

While the PIS allows for a more accurate pharmacy adjustment than the CMI, it is unable to account for the time required for management of medication order appropriateness. The PIS is a pharmacy resource-consumption metric; it is a nationally standardized weight of the average cost of medication use within a specific diagnosis-related group (DRG). While the total cost of the medications a patient receives may have some correlation to the total time required for a department to manage those medications (i.e., a higher overall cost is correlated to a higher number of medications), it only provides a portion of the total picture. Pharmacy formularies are rife with examples of low-cost, time-intensive medications (e.g., custom ophthalmic compounds, generically available medications requiring pharmacokinetic calculations for dosage adjustment). The productivity of any group is calculated as a function of “units produced” divided by hours worked. Since time is associated with the calculation of productivity, an optimal productivity model would incorporate the time required for these activities. The utility of a productivity model is dependent on the predictive ability of the model to assist in determining staffing appropriateness and hiring decisions.

As described by Rough et al. and Pawloski et al., productivity models have been developed using pharmacist interventions to track the activities of staff and correlate those data to staffing appropriateness. While it is essential to quantify the activities of staff, most intervention tracking systems require manual documentation and are only used to monitor the productivity of the staff members who report the interventions (i.e., pharmacists only). There is controversy regarding the predictive ability of manual intervention documentation, with experts divided as to whether staff typically overreport or underreport interventions. An optimal productivity model would incorporate the activities and monitor the productivity of all department staff through an automated reporting mechanism.

The study described here aimed to develop and validate a productivity model that measures the required hours for pharmacist and technician operational activities by assigning a time standard to instances of medication verification that incorporates important pharmacist and technician activities. We attempted to determine if this method could be used as an alternative to established workload management models.

**Background**

The Ohio State University Wexner Medical Center (OSUWMC) is a 1250-bed academic medical center located in Columbus, Ohio. The department of pharmacy at OSUWMC distributes medications through a primarily decentralized distribution model, with approximately 87% of eligible doses dispensed from ADCs.

**Productivity background.** Most departments consist of both “fixed” and “variable” staff positions. Fixed staff positions are those with workloads not directly affected by the variable-workload driver. These positions typically include administrative and support staff (e.g., directors, drug information pharmacists, medication safety pharmacists, informatics pharmacists, pharmacy residents). Although residents and other trainees provide patient care and contribute to variable activities these positions have historically been designated as fixed positions by our organization due to the educational nature of the responsibilities and because the diverse and frequently changing rotational responsibilities would require frequent model maintenance. Variable staff positions are those with work directly related to the variable-workload driver (e.g., patient care pharmacists, technicians). It is important to note that every variable position entails both variable and fixed activities. Fixed activities of variable staff are those activities that are required by the employer but do not correlate to the variable-workload driver (e.g., staff meetings, competency examinations, cleaning for compliance with United States Pharmacopeia chapter 797 requirements for compounded sterile preparations, cycle counts). When calculating the productivity of a department, all positions are incorporated, although the variable portion of the activities of variable staff positions drives the variability of the productivity model.
Pharmacist and technician workload classification. At the time the study was conducted, the practice model at OSUWMC was a mixed generalist–specialist model. Unit-based clinical generalist pharmacists verified medication orders, provided drug information support to nurses and physicians, and had limited direct patient interaction (several clinical generalists had patient care rounding duties). Other activities included student precepting for advanced pharmacy practice experience (APPE) hospital rotations and medication dose and product checking in the central pharmacy, satellite pharmacies, and the i.v. compounding area. Clinical generalist pharmacists typically had postgraduate year 1 residency training, with many holding a board certification in their usual area of practice. The job functions of clinical specialist pharmacists included attending patient care rounds, precepting APPE students and residents, and performing hospital and department quality-improvement activities. Clinical specialist pharmacists had postgraduate year 2 or equivalent training and held a board certification in their respective areas of practice. Pharmacy technician activities consisted primarily of preparation and distribution of medications, as well as supporting the activities of the clinical pharmacy generalists. These support activities included resolution of problems with medication orders, answering nursing questions, and processing medication returns (at OSUWMC, all pharmacy technicians are certified by the Pharmacy Technician Certification Board). Historically, clinical specialist pharmacist positions were considered to be fixed positions while those of pharmacy generalists and pharmacy technicians were viewed as variable positions. For study integrity, we decided that clinical specialist pharmacists would continue to be considered fixed staff (a variable staffing model for clinical specialist pharmacists was identified as an area for future research).

Historical pharmacy productivity system. At the time of the study, pharmacy productivity at OSUWMC had traditionally been measured using the metric PAA/CMI; this model has several inherent limitations. First, the accuracy of using the CMI to estimate pharmacy acuity is limited. The CMI is a broad hospital-level index of patient complexity, and the direct translatability of CMI values to pharmacy workload is controversial. (The literature suggests that the PIS is a better pharmacy acuity indicator, but it has significant limitations when used as a pharmacy workload indicator, as described above.) Second, the significant time delay involved in analyzing information using the PAA/CMI model was seen as a major limitation. Admissions, revenue, and CMI data were obtained from the finance department and external vendors—often with a reporting delay of several weeks to a month. It was clear that access to real-time workload data would give pharmacy leaders the ability to make more impactful decisions on how best to staff the department to provide optimal patient care. The CMI (and PIS) is calculated from the DRGs of patients admitted to the hospital. For DRG assignment to occur, the patient must be discharged from the hospital and the bill coded. Internal OSUWMC data suggest that only about 85% of admissions are coded within 10 days after the service date. Another limitation of the CMI, or any DRG-dependent acuity measure, is the dependence on proper physician documentation and coding of the patient visit.

Methods

Establishing the workload driver. An expert panel of generalist pharmacists, pharmacy residents, and pharmacy administrators was convened to establish the variable-workload driver for clinical generalist pharmacists and pharmacy technicians. A review of the department’s workflow by this expert panel determined that potential primary workload indicators included the following: admissions, patient days, doses dispensed, medication order verifications, and clinical pharmacy interventions. Medication order verifications were selected as the primary workload driver for clinical generalist pharmacists because this was their primary daily responsibility. The primary workload driver for pharmacy technicians was established as doses dispensed. In addition to frequent meetings with the pharmacy expert panel, the authors met with representatives of the OSUWMC management engineering staff and hospital administration at regular intervals to ensure model “buy-in” from the productivity experts in the organization.

Defining the workload driver. The expert panel also defined the types of activities and the corresponding time standards for the designated workload drivers (i.e., medication order verifications and doses dispensed). Order verification times were determined using the geometric mean of values from a time-to-verify report from the electronic medical record (EMR); these data were adjusted based on staff observations and medication incorporation into order sets. The time standards were then validated through the use of a frontline pharmacist work group. Verification of order-discontinuation time standards was determined using the same methodology. Also considered in calculating the workload standard was the time associated with pharmacists’ cognitive review of medication order appropriateness. The expert panel determined that the various complexities of medications should be taken into account by weighting medications according to pharmaceutical class. For example, chemotherapy was associated with a longer time standard than a stool softener, based on the relative amount of time
and effort required to assure proper dose and protocol compliance. Other activities that were incorporated into the overall verification weight included verification of medication preparation (the product check), verification of medication order discontinuation, and communication with nurses for problem-order resolution. Nursing communication and problem-order resolution time standards for pharmacists and technicians were determined using student observations. For each of the pharmaceutical classes, historical nursing medication requests were used to determine the frequency multiplier for each verification.

To determine the time standards for technician product preparation and pharmacist product checks, historical dispenses were analyzed. The historical average numbers of dispenses per verification in all pharmaceutical classes were used to calculate related activities. Additionally, the type of dispense was analyzed to incorporate time differences in product preparation and product check associated with dispensing an i.v. product versus an oral tablet or capsule. Time standards were determined using student observations, and the appropriate i.v.-to-oral proportion was applied to calculate the time standard for each pharmaceutical class. Finally, the historical proportion of returned medications per verification was incorporated with time studies to determine the time standard for technician product-return processing. The respective time standards for each pharmaceutical class were summed to determine the relative value unit (RVU) for pharmacists and technicians for each class. An RVU is a weight applied to an activity to demonstrate its value (in terms of time) in relation to the values of other activities.

**Establishing pharmaceutical class groupings.** Ninety-six pharmaceutical class groupings from the EMR (Epic Systems Corporation, Verona, WI) permitted us to evaluate the differences between medication classes. The medical record permitted us to evaluate medications in 96 distinct pharmaceutical classes. This breakdown was granular enough to allow for important and meaningful comparisons (e.g., cephalosporins versus aminoglycosides versus a general antiinfective class) while still allowing for model development feasibility. Each pharmaceutical class was assigned an RVU for both pharmacists and technicians based on the properties of the medications in the class, as described above. Standardized reports from the EMR, developed by the OSUWMC pharmacy information technology team, allowed for this detailed analysis.

**Model calculation.** For reporting feasibility, technician dispensing volumes were calculated using year-average dispenses per verification for each pharmaceutical class. After each pay period, the total number of verifications in each pharmaceutical class was calculated from an automated EMR report and multiplied by the respective RVU to determine the produced units of service (UOS), or relative workload, for pharmacists and technicians. The UOS were combined with the defined fixed activities and compared with actual work hours during the same period to determine period productivity.

The productivity model described above will henceforth be referred to as the weighted verifications (WV) model.

**Model validation.** Productivity values calculated via the WV model were compared with values derived from two other accepted productivity models: the PAA/CMI model and the PAA/PIS model (Figure 1). Model validation was conducted using the Pearson correlation coefficient. Alpha was set at a level of significance of 0.05. All data analysis for model development and calculation was conducted using Microsoft Excel (Microsoft Corporation, Redmond, WA), while comparative statistics were analyzed using SPSS, version 19 (IBM Corporation, Armonk, NY).

**Results**

The data derived from the comparison of department productivity using the WV model, the PAA/CMI model, and the PAA/PIS model are shown in Figure 2. The consistency displayed in the graph was confirmed through statistical analysis, which indicated significant correlation of data derived from the WV model to data derived from both comparator models (0.845 and 0.886, respectively) (Table 1). Additionally, the WV model demonstrated the least amount of period-to-period variability, with a

| Table 1. Correlation of Productivity Calculations via Weighted Verifications (WV) Model Versus Comparator Models*

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<th>WV Model</th>
<th>PAA/CMI Model</th>
<th>PAA/PIS Model</th>
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<tbody>
<tr>
<td>Mean ± S.D. calculated productivity (%)</td>
<td>102.6 ± 3.9</td>
<td>101.5 ± 5.1</td>
<td>101.6 ± 7.5</td>
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<tr>
<td>Pearson r for correlation to WV model</td>
<td>. . b</td>
<td>0.845 (p &lt; 0.05)</td>
<td>0.886 (p &lt; 0.05)</td>
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*PAA = pharmacy adjusted admissions, CMI = Case Mix Index, PIS = Pharmacy Intensity Score.

*Not applicable.
standard deviation of 3.9%. The division of activities during development of the WV model allowed for evaluation of productivity by job function (pharmacist versus technician). Data on productivity by job function are displayed in Figure 3. Additionally, the WV model permitted day-of-week and time-of-day analyses of productivity; such subanalyses are not possible with either of the comparator models.

**Discussion**

The methodology used to develop the WV model was shown to be comparable to the established PAA/CMI and PAA/PIS models. The use of WV allowed for more complete, timely, and usable data. The incorporation and weighting of each major job activity of both pharmacists and technicians allowed for more meaningful evaluation of productivity. Additionally, the timeliness of data allowed for staffing modifications as necessitated by patient demand.

Comparator models use financial resource-consumption metrics and make the assumption that these metrics correlate to the actual time required by pharmacy personnel to care for a patient. Using verifications directly from the medical record can allow for real-time reporting of pharmacy workload, as opposed to a several-week lag with the use of a DRG-adjusted metric. The benefits of monitoring workloads in real time and using workload predictors have been previously described, and Krogh et al. \(^4\) showed that these methods can be used to guide flexible staffing as indicated. However, in their flexible staffing model, Krogh et al. \(^4\) used patient census as a surrogate marker of pharmacy workload. Incorporation of a real-time workload monitoring system, such as the WV model, could allow for direct analysis of workload and appropriate staffing modifications.

The ability to monitor productivity by job function (technician versus pharmacist) was not possible previously and has proved beneficial in helping to direct hiring or staff flexing to the correct job function when the productivity model displays a variance. Some institutions may scrutinize the overall number of staff FTEs more closely than salary dollars; in these instances, managers may elect to hire pharmacists over technicians when positions are approved. The position-specific analysis of productivity using the WV model can ensure that numbers of positions are adjusted according to the workload variance.

At OSUWMC, the detailed information contained in the WV model has allowed us to adjust work hours and level of service to meet patient demand. It was determined through use of the WV model that patient demand from the surgical intensive care unit required extended hours of the satellite pharmacy. Staffing has been shifted to cover this satellite pharmacy for additional hours. At the same time, the review of WV model–derived data indicated that staffing could be adjusted in the cancer hospital on second shifts and weekends and resources redeployed to first shifts, where patient demand was higher.
As with any productivity model, the WV model has limitations. It requires significantly greater effort to develop, implement, and maintain than other established comparator models. The WV model was developed through a series of stakeholder meetings and data analysis over an 8-week period. We were able to use 34 weeks of historical data to develop and validate the WV model. Additionally, the direct external applicability of this model is unknown. We believe that the medication complexity weights are generalizable to other institutions; however, an institution implementing this model would have to perform a practice-model and medication-use process evaluation to determine which other resource-intensive tasks require weighting. Significant differences or changes in the practice model, technology, law, or physical hospital space may require modifications to these weights.

Overall, the WV model has been successfully implemented and used in monitoring the productivity of the OSUWMC pharmacy department and has assisted in the position-directed hiring and modification of staffing patterns to reflect workloads. As previously mentioned, the clinical specialist pharmacists were excluded from this model. This was done for two primary reasons: (1) the WV model consists of many “operational” metrics (e.g., order verification, medication dispensing) that very closely correspond to the job functions of a clinical pharmacy generalist or pharmacy technician, and (2) clinical specialist pharmacists were considered fixed staff in the previously used productivity model at OSUWMC, and excluding them from the WV model allowed for a more accurate comparison during the validation stage of model development. Developing a variable productivity model for the clinical specialist pharmacists was the second-phase goal of this project. Such a model has subsequently been developed, validated, and implemented.

Any productivity model captures only a portion of the overall department performance. Pharmacy leaders should always have other metrics to demonstrate the department’s impact, including but not limited to benchmarking data and quality metrics. At its heart, any productivity model should ideally be designed to encourage responsible use of labor resources while providing an optimal level of patient care.

**Conclusion**

The WV model yielded productivity data that correlated closely with values calculated using two validated workload management models. The model may be used as an alternative measure of pharmacy operational productivity.

**References**