From Pilot to Practice: A Trainee-Integrated Pharmacy Practice Model in Cardiology

Bethany A. Kalich, Jonathan D. Cicci, Shailly Shah, Brent N. Reed

OBJECTIVES Problems related to medication use portend poor outcomes, but resources for expanding clinical pharmacy services are limited. We conducted a pilot study in the area of cardiology to determine the impact and feasibility of a trainee-integrated pharmacy practice (TIPP) model comprised of pharmacy residents and a clinical pharmacist.

METHODS Coverage of 2 acute care and 1 intensive care team was distributed among 1 clinical pharmacist and 3 pharmacy residents. Patient care services included interdisciplinary rounds, order verification, medication reconciliation, counseling, clinical monitoring, and documentation. A pharmacy technician collected medication histories for newly admitted patients. Data related to medication reconciliation, clinical interventions, and time requirements were collected. Clinical services were compared to historical controls where data were available.

RESULTS Over the 18-day pilot study, the mean daily census consisted of 33.4 ± 5.3 patients. Admission medication reconciliation was performed on 8.1 patients per day, resulting in the discovery of 3.5 discrepancies per patient. Of 18 patients receiving anticoagulant therapy, 9 were counseled prior to discharge. Compared to historical controls, the number of patients receiving medication reconciliation and discharge counseling improved by 81% and 70%, respectively (both \( P < .05 \)). A total of 763 clinical interventions were recommended (42.4 per day), with many recognized in peer-reviewed literature as conferring improvements in clinical outcomes. Members of the model were active for a mean of 10–12 hours each day, with 6.3–7.2 hours corresponding to direct patient care.

LIMITATIONS This was a single-arm, observational pilot study.

CONCLUSION Implementation of a TIPP model significantly expanded clinical pharmacy services on an acute care cardiology service, but it required significant time commitments.

Despite efforts called for as part of health care reform, the ability of hospitals and health systems to expand services is limited by increasing costs and complexity of care. Problems related to medication use have emerged as an area of emphasis given their association with readmissions and adverse events. Although estimates vary, adverse events related to medications are associated with injury in up to 40% of hospitalized patients and in nearly 20% of patients following discharge [1, 2].

As a result of their unique expertise in this area, pharmacists are viewed as key players in efforts to improve these outcomes. Given limited resources for expanding clinical pharmacy services, trainee-integrated pharmacy practice (TIPP) models, which are analogous to the training paradigm for physicians, have been proposed as a strategy for meeting evolving demands while ensuring high-quality educational experiences for student and resident trainees [3]. In a TIPP model, trainees with varying levels of experience are structured in a way that facilitates sharing of clinical and educational roles, thereby enhancing the volume and scope of activities that can occur.

Given the often-complex medication regimens of patients with cardiovascular disease and these patients’ propensity for readmission, clinical oversight of medication therapy is crucial for ensuring optimal outcomes. Moreover, the growing accountability for medication-related outcomes called for by professional pharmacy organizations will require a greater degree of involvement in clinical decision making than what was expected in the past. However, there are limited resources for providing more comprehensive services, which may necessitate a team-based approach that incorporates residents, students, and technicians. To our knowledge, data on the implementation and impact of a TIPP model have not been previously reported in the literature. Thus we conducted a pilot study of a TIPP model in the area of cardiology to evaluate its feasibility (ie, time utilization) and effectiveness (ie, clinical interventions, rates of medication reconciliation, and discharge counseling).

Methods

At the 800-bed academic medical center where this study was conducted, coverage of the cardiology service consists of 1 full-time clinical pharmacist providing oversight for 3 teams: 1 in the cardiac intensive care unit (CICU) and 2 in the intermediate and acute care units. During the study period, a TIPP model was organized to coordinate pharmacy coverage across each team, thereby expanding coverage from 1 clinical pharmacist to 4 pharmacists (3 of whom were resident pharmacists) and effectively supporting the high volume and complexity of patient care on the cardiology service.
trainees) plus 1 technician. One pharmacy practice resident (PGY1) and 1 cardiology specialty resident (PGY2c) were assigned to 1 ward team (MDC1); the clinical pharmacist was assigned to the 2nd ward team (MDC2); and 1 critical care specialty resident (PGY2cc) was assigned to the CICU team. The clinical pharmacist was ultimately responsible for the MDC1 and CICU teams as preceptor for the residents. The individuals assigned to each team performed the following services: rounding with the team and making recommendations regarding the plan of care; verification of medication orders; medication reconciliation at admission and discharge; discharge counseling on high-risk medications, such as anticoagulants and dofetilide; and clinical monitoring (including documentation when required). The technician collected comprehensive medication histories for newly admitted patients, which included contacting community pharmacies, interviewing patients and family members, and obtaining records from outside facilities. Implementation of the TIPP model provided each cardiology care team with a dedicated pharmacist as well as a shared pharmacy technician to collect comprehensive medication histories for all 3 teams. No students had been assigned to the service; therefore they were not included in this pilot study.

**Measures of Effectiveness and Feasibility**

To assess the effectiveness of the services provided as part of the TIPP model, each pharmacist documented the following responsibilities on a daily basis: admission medication reconciliation; discrepancies discovered during admission medication reconciliation, categorized by type; discharge medication reconciliation; discharge counseling; and recommendations made during rounds, categorized by medication, type of recommendation, and whether or not the recommendation was accepted. For the purposes of this study, medication reconciliation was performed in accordance with the definition of the Centers for Medicare & Medicaid Services, which states that reconciliation is a comparison of the hospital medical record with an external list of medications obtained from the patient, family member, outside hospital, or other provider in order to create an accurate medication list (ie, name, dosage, frequency, and route) [4]. Admission medication reconciliation consisted of reviewing the comprehensive medication history report prepared by the technician, resolving discrepancies, and assessing the appropriateness of therapy. Discharge medication reconciliation consisted of preparing a finalized discharge medication list in the electronic medical record and coordinating with the prescriber regarding which therapies required prescriptions or refills.

The effectiveness of the TIPP model for facilitating medication reconciliation and medication counseling was assessed by comparing the rates of each activity during the TIPP pilot study with rates during a historical control period (ie, a month when no trainees were assigned to the cardiology service). We also collected data on clinical interventions that were accepted by the team and corresponded to core measures of The Joint Commission, guideline-directed medical therapy, or other standards of care [5-8]. These interventions were then assessed for their potential to improve patient outcomes by comparing them to rates described in peer-reviewed literature [8-20]. We then used these comparisons to estimate the potential benefit if the clinical pharmacy services provided by the pilot study were provided year-round.

To assess the feasibility of the TIPP model and determine how it might be limited in a practical setting by time and resource constraints, each pharmacist documented the time required to complete daily responsibilities, which included direct patient care, trainee education (eg, topic and patient discussion), administrative tasks, and other activities. Patient care responsibilities were further subdivided into the following categories: preparation for rounds, rounds, medication reconciliation, counseling, and follow-up. The time required to make clinical interventions and verify medication orders was included as part of the time required for rounding with the team.

No formal changes were made to the trainee education delivery model as part of the pilot study. Education consisted of daily patient discussion with the clinical pharmacist, 2 weekly 1.5-hour topic discussions, and a monthly journal club. As part of longitudinal program requirements, residents attended a weekly 1-hour seminar; PGY1 residents also attended a weekly 1.5-hour case conference. Although daily patient discussion constitutes oversight of patient care for teams on which the clinical pharmacist cannot round (because each team rounds simultaneously and residents round with their team independently), this activity was categorized as educational for the purposes of this pilot study.

The number of patients receiving medication reconciliation and anticoagulation counseling services as part of the TIPP model were compared to historical controls (ie, months when no trainees were assigned to the cardiology service). Descriptive statistics were compared by chi-square or Fisher exact test as appropriate. A P-value less than .05 was considered to be statistically significant. As a quality improvement initiative, the pilot study was considered by the biomedical institutional review board at our institution to be exempt from regulations for human subjects research.

**Results**

**Patients**

The pilot study was conducted Monday through Friday each week during February 2013, for a total of 18 days. The clinical specialist and PGY2c resident were present for 18 days; the PGY2cc resident was present for 17 days; and the PGY1 resident was present for 15 days. During the pilot study, the overall average daily census was 33.4 ± 5.3 patients, with an average daily census of 10.6 ± 3.2 patients, 13.2 ± 4.0 patients, and 9.6 ± 1.5 patients on the MDC1, MDC2, and CICU units, respectively.
**Medication Reconciliation**

Admission medication reconciliation was performed for all 145 patients admitted to the service during the TIPP pilot month (14 of whom were new to the system); this corresponded to an average of 8.1 patients per day. Compared to a historical control period, when 33 of 178 patients received admission medication reconciliation, the TIPP model reduced the risk of patients not receiving this service by 81% (relative risk [RR] = 0.19; 95% confidence interval [CI], 0.14–0.25; \( P < .0001 \)). The average amount of time required to perform admission medication reconciliation was 10.9 ± 7.7 minutes per patient; this value only represents the time needed for resolution of discrepancies, not the time spent by the technician to prepare a medication history report. This service resulted in the discovery of 512 discrepancies, for an average of 3.5 ± 3.0 discrepancies per patient. The types of discrepancies found are illustrated in Figure 1.

Discharge medication reconciliation was performed for 109 patients; this corresponded to an average of 6.0 patients per day. The average amount of time required for discharge medication reconciliation was 8.0 ± 6.5 minutes per patient. Based on the average census, the amount of time required to perform admission and discharge medication reconciliation for the entire service was about 2.2 hours per day.

**Medication Counseling**

During the 18-day pilot study, 9 of 18 patients (50%) received counseling on anticoagulation therapy prior to discharge. Compared to the historical control period, when 4 of 27 patients received anticoagulation counseling, the TIPP model reduced the risk of patients not receiving counseling by 70% (RR = 0.30; 95% CI, 0.11–0.82; \( P = .02 \)). For dofetilide, 6 of 6 patients (100%) received counseling prior to discharge, which was similar to the rate observed during the control period. The average time spent counseling patients on these and other medications was 0.2 ± 0.3 hours per day, 0.3 ± 0.6 hours per day, 0.1 ± 0.2 hours per day, and 0.2 ± 0.2 hours per day for the PGY1 resident, PGY2_{CV} resident, PGY2_{CC} resident, and clinical specialist, respectively.

**Clinical Interventions**

Over the course of the pilot study, 763 total interventions were recommended, for an average of 42.4 per day; of these, 720 interventions (94.4%) were accepted by the team. The type and category of interventions are depicted in Figures 2 and 3. The majority of interventions involved optimizing medication dose or frequency; another substantial percentage of interventions involved initiating therapy or discontinuing inappropriate therapy. The majority of interventions (64%) involved cardiovascular medications, and a substantial percentage (14%) involved anti-infective therapy. Of the 720 accepted interventions, 55 (7.6%), 96 (13.3%), and 45 (6.3%) are recognized in the literature as conferring improvements in all-cause mortality, major adverse cardiovascular events, and hospitalizations, respectively.

**Time Utilization**

The average total amount of time spent participating in the TIPP model each day was 10.9 ± 1.6 hours, 11.5 ± 1.0 hours, 10.9 ± 2.1 hours, and 9.8 ± 2.1 hours for the PGY1 resident, PGY2_{CV} resident, PGY2_{CC} resident, and clinical specialist, respectively. A breakdown of how these hours were spent is included in Tables 1 and 2. Of this time, an average of 6.3–7.2 hours was spent performing patient care activities.
Discussion

Implementing a TIPP model considerably expanded patient care on the cardiology service. Admission medication reconciliation was performed on all patients admitted Monday through Friday; previously this service had only been provided for targeted patients (i.e., 1–2 patients per day). Finding an average of 3.5 discrepancies per patient was concerning, which we feel underscores the value of this service, as decisions made during hospitalization depend largely on preadmission medication therapies. More than 90% of patients were a part of our health system, indicating that current strategies for maintaining an accurate medication list are suboptimal. Performing medication reconciliation at discharge is not part of our current practice model, so it is likely that the TIPP model significantly improved the accuracy of these lists, given the number of discrepancies identified and the integral involvement of pharmacists in the discharge process.

The amount of time needed for medication reconciliation was considerable. Based on our average census, this service would require over 2 hours per day, which is not sustainable for an individual clinical pharmacist in the current practice model. Moreover, this estimate does not include the time required for the technician to perform a comprehensive medication history. With average days ranging between 10–12 hours during the pilot study, medication reconciliation was difficult to sustain even with assistance from residents. However, this service could become more viable with minor modifications, such as the incorporation of students, technologies for streamlining the process, or a validated system for identifying which patients (if not all) would be most likely to benefit from medication reconciliation. It is worth noting that our model benefited considerably from the services of a dedicated medication history technician, a resource that had been allocated to the cardiology service prior to conducting this pilot study.

The number of patients being counseled on anticoagulant medications prior to discharge also improved during the pilot study. Although we did not meet the 90% threshold established by our institution in order to comply with The Joint Commission’s National Patient Safety Goal 03.05.01, our findings indicate the potential utility of using a TIPP model to improve these rates. Given the ability of students to perform discharge counseling, their integration into a TIPP model could further contribute to this process, while residents perform activities that require more advanced degrees of training. Because our model produced a 3-fold improvement in counseling rates, strategically implementing TIPP models in areas that remain a focus for national quality measures should be strongly considered.

Having at least a PGY2-level trainee assigned to each team also contributed significantly to patient care. The recommendation acceptance rate of nearly 95% demonstrates that members of the TIPP model were able to build credibility with their teams. In the non-TIPP model, the clinical pharmacist rounds with only 1 of 3 teams each day, and the remaining patients are followed peripherally through profile review and follow-up discussion with providers. This process often delays or impedes medication optimization because the pharmacist is absent during discussions of each

### Table 1.
Daily Time Utilization

| Participant | Patient care* (hours) | Education* (hours) | Administrative* (hours) | Other* (hours) |
|-------------|-----------------------|--------------------|-------------------------|---------------|
| PGY1 resident | 6.9 ± 1.1             | 2.5 ± 1.0          | 1.4 ± 1.0               | 0.1 ± 0.3     |
| PGY2, resident | 7.3 ± 1.4             | 1.8 ± 1.0          | 2.3 ± 1.9               | 0.1 ± 0.3     |
| PGY2, resident | 6.2 ± 0.9             | 2.1 ± 0.8          | 2.3 ± 1.5               | 0.3 ± 0.1     |
| Clinical specialist | 7.1 ± 1.7             | 1.4 ± 0.7          | 1.0 ± 1.0               | 0.3 ± 0.2     |

Note. PGY1, pharmacy practice resident; PGY2, critical care specialty resident; PGY2, cardiology specialty resident.

All values are represented as mean ± standard deviation.

*Patient care consists of preparation for rounds, interdisciplinary rounds, order processing, medication reconciliation, patient counseling, and clinical follow-up care.

*Education consists of participating in patient and topic discussion.

*Examples of administrative work include attending meetings and classes, proctoring exams, serving as teaching assistants, and assisting with interviews.

*Other time consists of work breaks.

### Table 2.
Daily Patient Care Activities

| Participant | Preparation* (hours) | Rounds* (hours) | Medication reconciliation (hours) | Counseling (hours) | Follow-up* (hours) |
|-------------|----------------------|----------------|----------------------------------|-------------------|-------------------|
| PGY1 resident | 1.9 ± 0.3            | 2.4 ± 0.6      | 1.5 ± 0.6                        | 0.2 ± 0.3         | 0.9 ± 0.5         |
| PGY2, resident | 1.2 ± 0.2            | 2.6 ± 0.7      | 1.5 ± 0.6                        | 0.3 ± 0.6         | 1.7 ± 0.9         |
| PGY2, resident | 1.0 ± 0.4            | 3.4 ± 0.5      | 0.3 ± 0.3                        | 0.1 ± 0.2         | 1.4 ± 0.5         |
| Clinical specialist | 0.8 ± 0.4             | 3.2 ± 1.5      | 1.0 ± 0.4                        | 0.2 ± 0.2         | 1.9 ± 0.7         |

Note. PGY1, pharmacy practice resident; PGY2, critical care specialty resident; PGY2, cardiology specialty resident.

All values are represented as mean ± standard deviation.

*Preparation included time spent preparing for interdisciplinary rounds, while follow-up constituted those activities to optimize medication therapies after rounds (e.g., following up on serum drug concentrations and other laboratories, medication titration, and clinical documentation).

*During interdisciplinary rounds, members of the TIPP model also performed various clinical and operational duties, such as medication order verification, profile review and documentation, and troubleshooting medication distribution issues.
patient’s condition, progress, and goals of care, or patients are discharged prior to the resolution of medication-related problems. Moreover, resident physicians are often reluctant to implement changes without further discussion with a more senior member of the team.

As expected, the majority of recommendations surrounded the optimization of cardiovascular medications. However, nearly half of recommendations related to a range of other therapeutic areas, illustrating the complexity of caring for this patient population. Many recommendations involved management of high-risk medications such as anticoagulants (classified under cardiovascular medications), which constituted 9.2% of all interventions, and insulin (classified under endocrine medications), which constituted 3% of all interventions.

To our knowledge, this is the first TIPP model to quantify its potential impact on long-term clinical outcomes. Beyond recommending interventions to optimize therapy during hospitalization, those involved in the TIPP model recommended changes that are recognized in national practice guidelines and peer-reviewed literature as conferring improvements in long-term clinical outcomes. Of the interventions made during this pilot study, only 55 (7.6%), 96 (13.3%), and 45 (6.3%) were associated with improvements in mortality, major adverse cardiovascular events, and hospitalizations, respectively, but a considerable impact could be made if these services were provided year-round.

Using select interventions from the pilot study and evidence from the peer-reviewed literature, we estimated the potential impact of extending these services year-round; these data are documented in Table 3. As an example, initiation of an aldosterone antagonist in patients with New York Heart Association Class II–IV heart failure is associated with reductions in all-cause mortality and heart failure hospitalizations. Based on a number needed to treat of 34 and 16 for these 2 endpoints, respectively, if the rate of interventions made during this pilot study were sustained year-round, it would potentially yield 3.2 lives saved and 7.3 heart failure hospitalizations prevented, and this difference could emerge in as little as 21 months. In the case of heart failure hospitalizations, this intervention would yield a potential savings of $58,999 (about $33,713 annually).

The potential impact of the TIPP model thus warrants discussion of sustainability, as well as consideration of how this study might influence the implementation of such models in the future. Based on the data collected from this pilot study, average work-hours per day for each pharmacy team member ranged from 10–12 hours, which represents time spent performing the activities of the pilot study as well as responsibilities that pulled members away from patient care. Importantly, these numbers do not account for the additional time commitments required for longitudinal responsibilities such as research. In order to make the TIPP model successful over the long term, efforts should be made to address these challenges; we provide several suggestions below based on our experience.

First, decisions should be made regarding which services are worthwhile to provide in future models. During our pilot study, we performed activities expected to improve outcomes based on evidence from the literature. Recently, the Pharmacist Intervention for Low Literacy in Cardiovascular Disease (PILL-CVD) trial demonstrated that a combination of activities performed at discharge did not confer benefit in high-risk patients with acute coronary syndrome or heart failure [9]. Thus we chose to emphasize activities associated with improvements in outcomes: rounding in the intensive care unit [10]; rounding with a cardiology medicine service [11]; collaborative management of anticoagulation [12]; blood pressure [13], dyslipidemia [14], and other cardiovascular risk factors [15]; and improvement of medication adherence among high-risk patients [16]. Although evidence to support admission medication reconciliation is lacking in the literature (and it did not confer improvement as part of the services performed in PILL-CVD), we felt it was critically important for making decisions related to the aforementioned activities. Undoubtedly, the prioritization of these activities impacted our ability to perform other functions traditionally expected of pharmacy personnel. Although previous pilot studies have shown that more activities can be performed as part of a TIPP model, we believe the current study differs in that it shows the potential value of these services. However, we did not investigate whether these services are cost-effective from a time or resource standpoint.

Second, this model quantifies the degree to which members of the TIPP model were required to attend to administrative or other responsibilities. On average, each resident spent 1.5–2.5 hours per day performing administrative duties, which ranged significantly in variety; in total, this constituted about 6 total hours of time lost from the model per day. For a TIPP model to be successful over the long term, hospital leaders should consider whether pharmacists’ administrative responsibilities can be minimized, or whether strategies can be arranged to compensate for off-service time. The expectation that pharmacy residents engage in a significant number of administrative activities is a major distinction from medical residencies. In many cases, pharmacy residents are considered “value-added” coverage (ie, patient care would continue in their absence). This differs significantly from models utilized in medicine, where alternative coverage is arranged when residents are absent, rather than residents’ responsibilities reverting to the attending physician.

Third, studies have not yet investigated how this and other TIPP model experiences impact the quality of experiential education. Although less time was available for traditional educational activities, our goal was to use practical experiences to reinforce instructional objectives. Given the growing number of activities expected of pharmacists in the contemporary health care environment, experiential education models that rely heavily on extended discussions are
unsustainable. Future analyses should evaluate how the current model impacts both the education and the attitudes of the trainees involved.

Finally, the long-term sustainability of a TIPP model is dependent on the month-to-month consistency of resident (and potentially student) coverage. We have demonstrated in the current model that comprehensive clinical pharmacy services, which may soon be expected as part of standards promulgated by professional and regulatory bodies, are possible in a TIPP model but remain unsustainable in its absence. Although these services could be provided with additional full-time clinicians, the current economic climate generally precludes this option. Dedicated resident coverage would result in significant changes to the structure of the learning experience at many institutions (eg, omission of an orientation month, scheduling research months at different times in the year), but we feel this pilot study demonstrates the potential benefits of such a change.

We recognize there are significant limitations associated with the single-arm, observational nature of this analysis. However, given the limited data that exists in this area, we feel this pilot study helps to identify endpoints worth studying in future investigations. Furthermore, we believe this analysis demonstrates that cardiology is an ideal environment for studying and/or implementing a TIPP model throughout the year and should therefore be considered a requisite experience for trainees.

Cardiovascular disease remains the leading killer of Americans [17], making it an area of emphasis for numerous national patient safety and quality measures. Due to the complexities of health care delivery in this area and the diverse needs of cardiology patients, many of which transcend the acute care setting, we believe this study demonstrates that oversight by a team of pharmacy professionals is necessary for ensuring optimal medication-related outcomes. We believe that a TIPP model, similar to the one conducted during this pilot study, accomplishes this goal in a way that seamlessly integrates practice and education.

**Conclusion**

Implementation of a TIPP model significantly expanded clinical pharmacy services on an acute care cardiology service, but it required significant time commitments from team members. Strategies to ensure long-term sustainability of TIPP models, as well as studies of how they might impact clinical and educational outcomes, are warranted. Given the improvements we observed in the present study, future research should strongly consider areas of emphasis for safety and quality measures, such as cardiovascular disease. NCMJ

**Table 3. Select Interventions and Potential Improvements in Clinical Outcomes**

| Intervention | Interventions extrapolated over a year (n) | Support from clinical trial(s) | Trial duration (months) | Trial outcome | NNT | Potential events prevented due to intervention | Potential costs avoideda (if available) |
|--------------|------------------------------------------|--------------------------------|------------------------|--------------|-----|-----------------------------------------------|---------------------------------------|
| Achieving target dose of an ACE inhibitor or ARB in HF | 82.4 | ATLAS [18] HEAAL [19] | 45.7 | All-cause hospitalizations | 8 | 10.3 | — |
| Initiation of an evidence-based beta blocker in patients with HF | 151.1 | COMET [20] MERIT-HF [21] | 58 | All-cause mortality | 17 | 8.9 | — |
| Initiation of an aldosterone antagonist in patients with NYHA Class II–IV HF | 109.9 | EMPHASIS [22] RALES [23] | 21 | All-cause mortality | 34 | 3.2 | — |
| Initiation of an ACE inhibitor or ARB in high-risk patients with vascular disease | 164.8 | HOPE [24] EUROPA [25] GISSI-3 [26] ISIS-4 [27] ONTARGET [28] | 54 | All-cause mortality | 56 | 2.9 | — |
| Achieving target dose of a beta blocker in HF | 109.9 | MOCHA [29] | 6 | All-cause mortality | 20 | 5.5 | — |
| Initiation or change to high-potency statin in patients with ACS | 206.1 | PROVE IT [30] | 24 | Revascularization | 40 | 5.2 | $214,895 |
| | | | | Recurrent angina requiring rehospitalization | 77 | 2.7 | $25,912 |

Note. ACE, angiotensin converting enzyme; ACS, acute coronary syndrome; ARB, angiotensin receptor blocker; CV, cardiovascular; HF, heart failure; MI, myocardial infarction; NNT, number needed to treat; NYHA, New York Heart Association.

Trials in bold represent those for which the outcome data was calculated.

aData are based on average total covered charge of associated diagnosis-related groups (DRG) for our institution (most conservative values used) multiplied by projected total events prevented.
Brent N. Reed, PharmD assistant professor, Department of Pharmacy Practice, Johns Hopkins Bayview Medical Center, Baltimore, Maryland.

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