BACKGROUND AND OBJECTIVES: Many patients recently discharged from an asthma admission do not fill discharge prescriptions. If unable to adhere to a discharge plan, patients with asthma are at risk for re-presentation to care. We sought to increase the proportion of patients discharged from an asthma admission in possession of their medications (meds in hand) from a baseline of 0% to >75%.

METHODS: A multidisciplinary improvement team performed 3 plan–do–study–act cycles over 2 years and, using a statistical process control chart, tracked the proportion of patients admitted with asthma discharged with meds in hand as the primary outcome. An exploratory, retrospective analysis of insurance data was conducted with a convenience sample of Medicaid-insured patients, comparing postdischarge utilization between patients discharged with meds in hand and usual care. Generalized estimating equations accounted for nonindependence in the data.

RESULTS: Changes to the discharge process culminated in the development of a discharge medication delivery service. Outpatient pharmacist delivery of discharge medications to patient rooms achieved the project aim of 75% of patients discharged with meds in hand. In a subset of patients for whom all insurance claims were available, those discharged with meds in hand had lower odds of all-cause re-presentation to the emergency department within 30 days of discharge, compared with patients discharged with usual care (odds ratio, 0.22; 95% confidence interval, 0.05–0.99).

CONCLUSIONS: Our initiative led to several discharge process improvements, including the creation of a medication delivery service that increased the proportion of patients discharged in possession of their medications and may have decreased unplanned visits after discharge.
patients. Although other US hospitals have attempted to ensure medication possession at discharge, descriptions of mechanisms that successfully achieve this goal are lacking.

At Boston Medical Center (BMC), patients were traditionally discharged with unfilled prescriptions, and many of these prescriptions remained unfilled. Phone call follow-up 48 hours after discharge with a convenience sample of 97 consecutive patients admitted with asthma in 2011 demonstrated that 37% had not filled their prescriptions. This proportion is consistent with the known low prescription filling rate after admission for an asthma exacerbation.

We became concerned that after an admission for asthma many children were unnecessarily suffering because of lack of medication possession, and therefore we initiated a quality improvement (QI) project in August 2011. Our specific aim was to increase the proportion of patients with asthma in possession of their newly prescribed medications at the time of discharge from a baseline of 0% to 75% within a year. We expected that medication possession would decrease posthospitalization morbidity, including unscheduled visits.

In this article we describe 3 change strategies designed to increase the proportion of patients discharged with meds in hand. After 2 years of intervention and data collection, we also performed an exploratory, retrospective analysis of the intervention’s impact on postdischarge utilization for a subset of our patients using insurance claims.

METHODS

Ethical Issues

Each intervention aimed to help patients obtain their prescribed medications before discharge and was available to all patients. Changes were considered “value-added,” with negligible risk of adverse effects. Families were not obligated to obtain medications according to the strategy under study at the time of their discharge. No external funding was obtained, and Boston University Medical Campus Institutional Review Board approval was granted before the retrospective study.

Setting

The pediatric ward is a single floor of BMC and manages ~1800 general pediatric admissions per year. The age of patients ranges from 4 days to 22 years. The patients are primarily urban minorities (97% nonwhite), and 71% are insured by Medicaid or a Medicaid managed care organization (MCO), characteristics associated with more severe asthma. The ward has 30 beds and is staffed by an attending, 2 residents, and 4 interns. Residents rotate in 4-week blocks. Medications prescribed after an asthma exacerbation routinely include a short-acting β agonist, an inhaled corticosteroid, and an oral steroid (prednisone or prednisolone, per practice guidelines).

Before this project, physicians routinely printed discharge prescriptions or sent them to the patient’s preferred pharmacy at discharge. No attempts were made to confirm medication pickup.

Planning the Intervention

Pediatric residents supervised by department leadership initiated this QI project. Physicians, nurses, and pharmacists made up the improvement team. A key driver diagram was developed (Fig 1). Using the Model for Improvement and plan–do–study–act cycles, the improvement team designed interventions to improve timely prescription writing, rapid medication preparation, and convenient medication disbursement.

Members of the improvement team oriented interns in person at the start of each block. Attending physicians and residents were informed of changes via e-mails. All interventions included a 45-minute interactive review of asthma management for interns, with an emphasis on discharge planning.

Cycle 1

The first change focused on the intern–patient interaction before discharge. At the start of their rotation, interns were directed to write discharge prescriptions at least

![FIGURE 1](http://www.pediatrics.aappublications.org/content/134/5/e1503/F1.large.jpg)
≥1 day before the day of discharge. Interns were also instructed to recommend that parents pick up those medications before discharge from a branch of their pharmacy or the hospital outpatient pharmacy. Supervisors were encouraged to discuss discharge medications on rounds after admission, a change from discussing home medications on the day of discharge.

In end-of-rotation interviews with a member of the improvement team, most residents endorsed feeling uncomfortable writing discharge prescriptions before the day of discharge because of a concern that plans could change. Residents also had difficulty asking families to leave the hospital to retrieve medications and reported that many parents who lived further from the hospital were reluctant to walk to an unfamiliar pharmacy.

**Cycle 2**

The second test of change therefore focused on allowing residents to write day-of-discharge prescriptions and facilitating medication pickup for families in the hospital-owned pharmacy. In partnership with pharmacy leaders, the improvement team created an expedited preparation process for pediatric patients with asthma. When faxed to pharmacy, a uniquely designed fax cover sheet, followed by printed and signed prescriptions, served as a visual cue to pharmacists to prioritize the preparation of those prescriptions. Medications were then held at a designated “pediatric discharge” pickup window, allowing parents to bypass the regular pharmacy line. Medication preparation was completed in <1 hour from fax receipt, and parents could obtain medications without leaving the hospital. For families not routinely using the hospital pharmacy, refills were given with postdated paper prescriptions.

Studying the second cycle of change yielded important information for continued improvement. Residents noted that many parents were uncomfortable leaving their sick child’s room and preferred to pick up medications after discharge.

**Cycle 3**

The last test of change introduced an in-room delivery service for discharge medications by the hospital-owned outpatient pharmacy. If parents agreed to have medications delivered, residents identified prescriptions intended for delivery with the fax cover sheet. After rapidly preparing the medications, pharmacists awaited notification from the patient’s nurse that a parent was present before delivering the medications to the patient’s room. A workflow diagram for this delivery service is seen in Fig 2. Copayments were collected in the room either in cash or with a mobile credit payment system purchased by the pharmacy. Unlike traditional pharmacy pickup, the delivery service allows the patient, parent, nurse, and pharmacist to be together in the patient’s hospital room for teaching with the actual medications available for demonstration.

**Planning the Study of the Intervention**

The outcome of interest, the proportion of patients with asthma discharged in possession of their medications (meds in hand) is a process measure not captured by the medical record. Monitoring the outcome required novel techniques. A unit assistant reviewed each day’s patient list for patients >2 years old with an asthma-related indication for admission, such as “asthma,” “status asthmaticus,” “wheeze,” or “respiratory distress.” After confirming a diagnosis of asthma with the medical team, the unit assistant determined the length of stay from admission and discharge order times. Length of stay was a balancing measure, given the intervention’s potential to delay discharge.

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**FIGURE 2**

Workflow diagram of the most successful intervention: delivery of discharge medications from the hospital-owned outpatient pharmacy to patients on the ward before discharge.
The proportion of patients with asthma leaving with meds in hand was calculated after each 4-week resident rotation. In cycle 1, residents were asked to indicate which patients were discharged with meds in hand. In cycles 2 and 3, weekly pharmacy reports of patients who had picked up medications or to whom medications had been delivered were cross-referenced with the list of eligible patients to determine the proportion.

**Utilization Assessment**

Patient outcomes were not initially measured as part of this QI project. After project completion, a cohort of patients insured by a Medicaid MCO willing to share data for research purposes was identified. This MCO insures 25% of the patient population at BMC and is probably representative of the majority of BMC’s patient population, nearly three-quarters of whom are insured by Medicaid or a Medicaid MCO.

Insurance claims provide the most complete picture of an individual’s healthcare utilization in a city where hospital shopping is facilitated by an abundance of hospitals in close proximity.

Patients included in the analyzed cohort may have been admitted during any cycle of the QI project, and therefore were eligible for meds in hand, but may have been discharged with meds in hand or usual care. Assignment to meds in hand or usual care was not randomized.

**Methods of Evaluation and Analysis**

**Quality Improvement**

A Shewhart control chart (p-chart) was maintained from August 2011 to July 2013. This statistical process control chart tracked the proportion of patients discharged with meds in hand by 4-week intervals across all 3 cycles of intervention. Length of stay was tracked similarly. Charts were updated in accordance with standard QI guidelines.

**RESULTS**

**Quality Improvement**

The proportion of patients discharged with meds in hand by 4-week interval was plotted in a p-chart (Fig 3). At baseline, no patients were discharged with meds in hand. The outcome of interest was achieved in 40%, 59%, and 75% of eligible patients in cycles 1, 2, and 3, respectively. In addition to achieving the highest proportion of patients leaving in possession of their medications, the third test of change (the delivery service) also had the least block-to-block process variation. The balancing measure “mean length of stay” did not deviate throughout all 3 cycles of improvement by more than an hour from the baseline mean of 62 hours.

The centerline from 2012Block3 to 2012Block13 was recalculated because of a shift in which 10 of 11 data points were above the previous mean during that interval. Contributing to the shifted mean is a point of special cause variation (2012Block7) with poor performance below the previous mean. This block spanned the winter holiday period, where diminished staffing and pharmacy closures greatly limited the team’s capacity to implement the intervention. Therefore, this point was ignored in determining that a shift had occurred.

**Utilization Assessment**

A cohort of 102 children insured by the same Medicaid MCO were identified. Of these patients, 89 were admitted once, and 13 had multiple admissions during the 2-year study period. A total of 124 admissions to BMC were attributed to the 102 patients, with each admission representing a new opportunity to receive meds in hand.

Of the 124 admissions analyzed, 77 were discharged with meds in hand, and 47 needed to pick up their new medications at the pharmacy. The characteristics of those receiving meds in hand and those receiving usual care were largely similar (Table 1), although the proportion of Hispanic or Latino patients receiving meds in hand was statistically significantly larger than the proportion receiving usual care.
Twelve patients in the sample re-presented to an ED within 30 days of discharge. Patients discharged with meds in hand had statistically significantly lower odds of returning to the ED within 30 days compared with those receiving usual care (OR = 0.22; 95% CI, 0.05–0.99). There were no statistically significant differences in the odds of presentation to a primary care shortly after discharge (OR = 0.81; 95% CI, 0.38–1.71) or readmission within 30 days of discharge (OR = 0.41; 95% CI, 0.08–2.10).

Of the 47 admissions discharged without meds in hand in the subset analyzed, 12 (26%) had not filled a steroid prescription by 10 days after discharge. Patients receiving meds in hand filled controller medications after discharge at similar rates to patients receiving usual care (RR = 0.98; 95% CI, 0.69–1.41). However, significantly higher rates of rescue medication filling were seen in patients discharged in possession of their medications (RR = 1.49; 95% CI, 1.10–2.02).

DISCUSSION

A discharge medication delivery service created in partnership with the hospital-owned outpatient pharmacy was most successful at ensuring that a high proportion of patients were discharged in possession of their prescribed outpatient medications. Though uncommon, delivering outpatient medications to patients before discharge is not novel and has been used in concert with other interventions. However, to our knowledge this report is the first to detail specific strategies to reliably discharge patients with meds in hand.

To address poor medication fill rates after discharge, our interventions increased medication possession at discharge. Medication possession is a necessary but not sufficient component of adherence. Although this study was not designed to detect adherence, families may feel more comfortable administering medications after receiving teaching from and having questions answered by their inpatient nurse, using the same medications and equipment they will use at home. Families who observe doctors, nurses, and pharmacists prioritizing discharge medications during the discharge process may be more likely...
to emphasize the outpatient regimen after discharge.

A similar service may not function as efficiently elsewhere. Site-specific characteristics of patients, hospitals, and pharmacies may influence the success of similar initiatives. The creation of the Meds-in-Hand service at BMC would not have been possible without the help of our collaborative and innovative pharmacy staff.

The operational costs of a discharge delivery service are nonnegligible, although it is possible that the service captures revenue-generating prescriptions for the hospital's pharmacy that otherwise would have been filled elsewhere. Since the completion of this project, the delivery service has been expanded to all pediatric patients at BMC and continues to thrive. Cost analyses are ongoing.

The exploratory analysis of insurance claims for a subset of patients admitted during the QI project revealed important findings about the potential clinical impact of meds in hand. These results suggest decreased postdischarge utilization of the ED by patients discharged with meds in hand. A likely mechanism for reducing utilization in patients receiving usual care is timely filling of oral steroid prescriptions. Kenyon et al4 showed a significant readmission hazard reduction for patients who fill an oral steroid prescription within 3 days of discharge. In the cohort analyzed here, a high proportion of patients not receiving meds in hand did not fill an oral steroid prescription.

An intervention that can be administered by the inpatient team to decrease postdischarge morbidity should be highly valued by hospital teams. Few previous efforts undertaken by inpatient teams to ensure postdischarge adherence have proven successful. Even hospital performance quality standards such as the routine use of a home management plan of care, detailed in the Children’s Asthma Care Process Measure Set,14 do not appear to affect subsequent ED utilization or short-term readmission.15,16

In the cohort analyzed, patients discharged with meds in hand filled significantly more rescue medications after discharge than patients discharged with usual care. Potential explanations for this higher rate include greater asthma symptoms, frequent and appropriate administration of a short-acting β agonist in the days after discharge, or greater preparation for future exacerbations. The latter 2 reasons may be more likely given that patients discharged with meds in hand had lower rates of ED use in our study.

Filling rescue medications frequently can lower a patient’s asthma medication ratio (defined as controller fills divided by the sum of controller and rescue medications fills), which is known to be associated with increased ED visits.17 However, such an effect was not seen in our data. Patients discharged with meds in hand had rates of filling controller medications that were no different from those of patients discharged with usual care, suggesting that the service does not disrupt a family’s ability to refill medications, a theoretical risk of the intervention.

Our results should be viewed in light of several important limitations. The sample used in the postdischarge utilization analysis was a nonrandomized convenience sample whose racial distribution was unbalanced. Two years of data were abstracted, increasing the likelihood of an unmeasured process change influencing outcomes. Allocations to the meds-in-hand group versus usual care in this retrospective study were nonrandom for many reasons, including patient or family preference, time of discharge (eg, an

<table>
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evening discharge after pharmacy closure), and competing obligations of the medical team. Additional study with randomization is needed to more definitively determine the influence of meds in hand on patient outcomes.

In addition, the sample analyzed was limited to claims from 1 payer, and the similarities of the cohort analyzed and the BMC patient population could not be compared. However, 71% of all BMC patients are Medicaid eligible. Although an institutional chart review would increase cohort size, it would decrease the accuracy of the utilization assessment, because chart review does not capture utilization at other institutions or pharmacies. Although insurance claims can provide a complete picture of utilization, we were unable to know the reason for ED visitation, readmission, or outpatient visits because of data sharing agreements. Finally, true utilization may be underestimated as a result of out-of-pocket payments or insurance plan changes (not tracked in this study).

This QI project aimed to increase the proportion of patients discharged with meds in hand and was most effective after the creation of a bedside medication delivery service provided by the hospital-owned outpatient pharmacy. Other strategies may be even more successful at increasing the proportion of families discharged with meds in hand, and improvement work is ongoing. Although more evidence on the impact of being discharged in possession of discharge medications is needed, a service that provides admitted patients with their outpatient medications before they leave the hospital has many potential benefits. Additional areas of exploration could include how the Meds-in-Hand service affects the patient experience, hospital finances, and clinical outcomes for other medical conditions.

ACKNOWLEDGMENTS

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ABBREVIATIONS

BMC: Boston Medical Center  
CI: confidence interval  
ED: emergency department  
MCO: managed care organization  
OR: odds ratio  
QI: quality improvement  
RR: rate ratio

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Increasing Medication Possession at Discharge for Patients With Asthma: The Meds-in-Hand Project
Jonathan Hatoun, Megan Bair-Merritt, Howard Cabral and James Moses
Pediatrics originally published online February 24, 2016;

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