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MAJOR ARTICLE

A Quality Initiative to Improve Postdischarge Care for Patients on Outpatient Parenteral Antimicrobial Therapy

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Background. Patients discharged from the hospital on outpatient parenteral antimicrobial therapy (OPAT) require close monitoring, including weekly blood tests and an early posthospital follow-up visit. However, because patients often receive OPAT in a separate healthcare system from where they received inpatient care, the OPAT plan often fails, with less than 75% of OPAT patients receiving the recommended laboratory monitoring. We sought to determine whether changing our inpatient OPAT documentation method would improve postdischarge care.

Methods. As a quality improvement initiative, we conducted 2 Plan-Do-Study-Act interventions on our OPAT documentation. Our first intervention was to create a standardized OPAT Progress Note, and our second was to turn that note into a SmartForm (Epic) with discrete fields for the key information. We examined the effects of these changes on the rate of completion of recommended laboratory monitoring, attendance at outpatient follow-up visits, and 30-day readmission rates.

Results. Changing our documentation to a standardized Progress Note and then to a SmartForm with discrete fields led to an increase in the proportion of patients with a serum creatinine checked within 10 days of discharge (from 63% to 71% to 73%) and who attended an infectious disease clinic visit within 3 weeks of discharge (from 21% to 36% to 47%). However, the rate of readmissions for OPAT-related problems did not change, nor did a composite outcome of 30-day mortality/unplanned readmission.

Conclusions. Changes in how and where care plans are documented in the inpatient medical record can have significant effects on patient care outcomes after discharge.

Keywords. care transitions; medical record documentation; outpatient parenteral antimicrobial therapy (OPAT); quality improvement.

An estimated 300 000 patients per year are discharged from the hospital on intravenous (IV) antimicrobials [1], and these patients on outpatient parenteral antimicrobial therapy (OPAT) are at significant risk for hospital readmission due to adverse drug-related events, line complications, or worsening infection [2–9]. To mitigate these OPAT risks, Infectious Disease Society of America (IDSA) guidelines recommend regular laboratory monitoring of patients on OPAT, with the results reviewed by an infectious disease (ID) specialist or another provider familiar with the patient's case and with OPAT [10]. An infectious disease consultant in the hospital typically evaluates the patient and prescribes an OPAT plan, which is then executed by the receiving home health company, infusion center, or care facility. The OPAT plan includes the type and duration of antimicrobial therapy, recommended laboratory monitoring, and scheduled follow-up visits in the infectious disease outpatient clinic. However, when the patients are discharged to skilled nursing facilities or home health companies outside of the discharging hospital's system, often the laboratory monitoring and outpatient follow-up plan is never realized. Indeed, prior studies have indicated that only approximately 50%–75% of patients receive the recommended laboratory monitoring, and those who are not monitored have a higher risk of readmission [5]. The situation may be worse for those patients discharged to skilled nursing facilities as opposed to home [5, 7].

As part of a continuous quality improvement project at our hospital, we have been monitoring outcomes for our patients on OPAT as we make incremental changes to the OPAT program. Because of differences in insurance, care needs, location, and preference, our patients receive OPAT from a wide variety of institutions and home health companies. We noted that for many, we did not receive the recommend laboratory tests nor did patients always come to their scheduled follow-up visits. In particular, we found that fewer than two thirds of patients had a serum creatinine (SCr) or white blood cell (WBC) count checked within 10 days of hospital discharge, and fewer than

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one quarter attended an outpatient ID visit within 3 weeks of discharge. We further found that key elements of the OPAT plan (antimicrobial end date, recommended laboratory monitoring, where to send the laboratory results) only made it into the discharge paperwork approximately half the time, even though the ID team documented those recommendations in the chart almost 100% of the time [11].

To improve upon these baseline outcomes, we assembled an OPAT quality improvement team consisting of an infectious disease physician, an infectious disease pharmacist, and a value/process engineer. Before the first intervention, this team contacted stakeholders (inpatient and outpatient infectious diseases physicians, inpatient case managers, inpatient primary team physicians, and home infusion pharmacists) to get their input on how to better communicate the OPAT plan at discharge. Based on those discussions, observations of the OPAT discharge process as it happened, and our baseline analysis indicating that the complete OPAT plan only made it into the discharge paperwork half the time, we elected to modify our documentation of the OPAT plan to make it easier to find and to incorporate into discharge instructions and other communications. Our aim was to determine whether changing our method of inpatient documentation would improve specific postdischarge outcomes for patients discharged on intravenous antibiotics: laboratory monitoring, attendance at ID clinic visits within 3 weeks of discharge, and hospital readmissions. In this study, we report our quality improvement interventions and their effects.

METHODS

Context

Our hospital is a 750-bed academic medical center serving a large geographic area in the Mountain West region of the United States. Approximately 50 patients are discharged on prolonged courses of IV antimicrobials every month, with one quarter going to skilled nursing facilities and two thirds going home with home health.

At our institution, there is no formal OPAT service separate from the Infectious Disease team. For hospitalized patients expected to be discharged on IV antimicrobials, an ID consult is almost always obtained before discharge (the major exception being cystic fibrosis patients followed by the Pulmonary service). The inpatient ID team makes the OPAT plan and schedules the patient to follow up in the ID clinic after discharge, then alerts the ID physician the patient will be seeing in clinic. After discharge, it is the responsibility of the outpatient ID physician to monitor the patient's laboratory results and adjust therapy as needed; there is no dedicated OPAT nurse or pharmacist for the ID clinic.

Before our interventions, the ID team documented the OPAT plan in the Problem List section of the electronic medical record ([EMR] Epic, Verona, WI). We found that documenting the OPAT plan in the EMR Problem List created several challenges. First and foremost, not everyone involved in the patient's care knew to look at the Problem List to find the OPAT plan. Second, it was not easy for the primary inpatient teams to import (copy/paste) the OPAT plan from the Problem List into the discharge instructions. Third, whenever the OPAT plan was edited in the Problem List, it did not leave a record of prior versions of the plan, making it difficult to determine the treatment history for each patient.

Interventions

Over the course of 3 years, we conducted 2 Plan-Do-Study-Act (PDSA) interventions (ie, a PDSA time-series (AB) quality improvement study design) [12]. For our first intervention, we stopped documenting the OPAT plan in the Problem List and instead used a standardized Progress Note with "service type" OPAT (Supplementary Figure 1). Service type is a modifiable field for Progress Notes in our EMR. Making it a Progress Note made it easier to import (copy/paste) the OPAT plan into any discharge documentation, and labeling it as from the "OPAT Service" (as opposed to the Infectious Disease service) made it easier to find in the EMR. For our second intervention, we converted the standardized "OPAT Progress Note" into a SmartForm note. A SmartForm is a macro available in Epic that allows the creation of a progress note by entering data in discrete fields, or by choosing from various options in a list (Supplementary Figures 2 and 3). Our SmartForm improved upon the OPAT Progress Note in several ways: it included a prompt to label the note as being from the OPAT service; it encouraged the scheduling of 2 follow-up visits, 1 soon after discharge and 1 near the end of the planned antimicrobial course; and its discrete fields facilitated the collection of data about our OPAT documentation.

Measures and Study of the Interventions

Our outcomes of interest were as follows: the proportion of patients who had a SCr or WBC count checked within 10 days of hospital discharge; the proportion of patients completing an infectious disease clinic visit within 3 weeks of hospital discharge; OPAT-related readmissions within 30 days of hospital discharge; and a composite outcome of death or unplanned readmission within 30 days of hospital discharge. We created statistical process control charts (p-charts) for these 5 outcomes. We manually chart-reviewed each readmission to determine whether it was planned or unplanned, and whether the primary reason for readmission was "OPAT-related." We considered the following to be OPAT-related: adverse effects from the antimicrobials; complications from vascular access devices; worsening of the infection or recurrent infection at the same location; and OPAT administrative issues (eg, loss of insurance, loss of home).

Analysis

Our patient cohort consisted of patients discharged from November 20, 2017 to November 22, 2020 who met all of the following inclusion criteria: (1) seen by the infectious disease consult service during their hospital stay; (2) discharged on an intravenous antimicrobial; and (3) planned follow-up in the infectious disease clinic within 60 days of discharge. For patients who had multiple discharges within the study period that met inclusion criteria, only the first encounter was included. Patients were excluded from the analysis if they met any of the following exclusion criteria: (1) died before discharge; (2) discharged on hospice; (3) discharged to a long-term acute care hospital or an inpatient acute rehabilitation hospital; (4) transferred to an outside hospital or prison; or (5) left against medical advice. We divided the cohort into 3 groups: Preintervention, "Problem List" November 20, 2017–November 13, 2018; First Intervention, "Progress Note" November 14, 2018 to November 17, 2019; and Second Intervention, "SmartForm" November 18, 2019–November 22, 2020.

To assess for possible population changes and their effects upon our interventions, we gathered standard demographic data on all patients, including age, sex, race, primary language, Charlson comorbidity index, and insurance type. Other data collected included the following: primary service while hospitalized, OPAT antimicrobial (vancomycin, beta-lactam, other), OPAT location (home vs care facility), and whether a follow-up visit occurred with any service within 10 days of hospital discharge.

Data were summarized using counts and percentages, means and standard deviations, and medians and interquartile ranges as appropriate. Differences in categorical outcomes across intervention periods were assessed for statistical significance using χ^2, with an alpha of 0.05 for differences across the 3 groups and an alpha of 0.017 for pair-wise comparisons (Bonferroni correction due to comparing 3 pairs of time periods). Continuous data were assessed for significance across intervention phases via one-way analysis of variance or Mann-Whitney, followed by a Steel-Dwass test for the statistically significant non-parametric variables to identify differences between pairs. Logistic regression analysis to identify variables independently associated with the outcomes was performed by forward/backward stepwise selection based on effect likelihood ratios using alpha = 0.05 and Akaike's Information Criterion to assess model fit [13]. All statistical analyses were performed in JMP Pro version 16.0.0 (SAS Institute, Cary, NC). Standards for Quality Improvement Reporting Excellence (SQUIRE) 2.0 guidelines were used to construct the manuscript [14].

Ethical Considerations

As quality improvement work supplemented by retrospective chart review, our institutional review board determined this project to be exempt from formal review.

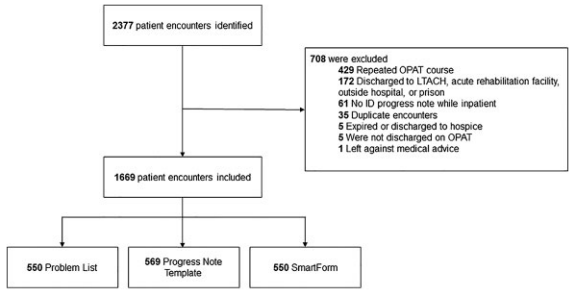

Figure 1. Flowchart diagram of patients included in our cohort. ID, Infectious Diseases; LTACH, long-term acute care hospital; OPAT, outpatient parenteral antimicrobial therapy.

RESULTS

We identified 2377 admissions over the period of our quality improvement project where the patient was (1) seen by the infectious disease consult service during their hospital stay, (2) scheduled to follow-up in the infectious disease clinic within 60 days of discharge, and (3) discharged on an intravenous antimicrobial. After manual chart review, 708 encounters were excluded (Figure 1) leaving 1669 patient encounters for inclusion: 550 during the Problem List phase (Preintervention), 569 from the first intervention (Progress Note), and 550 from the second intervention (SmartForm). Overall, the average age was 56 years and 60% were male (Table 1). In general, patient characteristics were similar across the 3 phases. However, during the SmartForm phase fewer patients were discharged on vancomycin (26% vs 37% preintervention, $P = .001$), and a greater proportion of patients were discharged to home health rather than to a skilled nursing facility (75% vs 59% preintervention, $P < .0001$).

Laboratory monitoring improved over the course of our interventions (Figure 2A and B). At baseline, 63% of patients had a SCr checked within 10 days of discharge, which improved to 73% with our interventions. We also saw improvements in attendance at ID follow-up visits within 21 days of discharge, from 21% in the preintervention phase to 47% in the SmartForm phase (Figure 2C). However, the rate of OPAT-related readmissions did not improve over the course of our 2 interventions, nor did the 30-day death/unplanned readmission rate (Figure 2D and E): both got slightly worse during the Progress Note phase then better again in the SmartForm phase. Only 14 patients died within 30 days of discharge (without being readmitted), so this outcome is driven by readmissions; 17 patients died after readmission.

After controlling for potential confounders, the odds of having a creatinine level checked within 10 days of discharge were higher for the Progress Note (odds ratio [OR], 1.46; 95% confidence interval [CI], 1.12–1.91) and SmartForm (OR, 1.41; 95% CI, 1.08–1.86) phases compared with the preintervention

Table 1. Demographics of the Patient Population

Characteristic	Problem List ($n = 550$)	Progress Note ($n = 569$)	SmartForm ($n = 550$)	P Value[a]
Age, mean (SD)	56 (16)	57 (15)	56 (16)	.60
Male sex, *n* (%)	341 (62)	350 (62)	318 (58)	.30
White race, *n* (%)	459 (83)	467 (82)	467 (85)	.44
Hispanic ethnicity, *n* (%)	56 (10)	54 (9)	48 (9)	.71
Charlson comorbidity index, median (IQR)	3 (1–7)	3 (1–6)	3 (1–6)	.43
Hospital length of stay, days, median (IQR)	5.9 (3.9–9.0)	6.4 (4.0–10.5)	6.3 (4.1–10.9)	**.03**[b]
Discharged to Home Health, *n* (%)	326 (59)	368 (65)	410 (75)	**<.0001**[b,c]
Primary payor, *n* (%)				.21
Medicare	257 (47)	247 (43)	236 (43)	
Commercial	183 (33)	203 (36)	193 (35)	
Medicaid	68 (12)	90 (16)	90 (16)	
Other	42 (8)	29 (5)	31 (6)	
English as primary language, *n* (%)	525 (95)	545 (96)	535 (97)	.23
OPAT antimicrobial, *n* (%)				
Beta-lactam	371 (67)	406 (71)	420 (76)	**.004**[b]
Vancomycin	201 (37)	183 (32)	144 (26)	**.001**[b]
Any outpatient follow-up visit completed within 10 days, *n* (%)	305 (55)	348 (61)	338 (61)	.07
Primary hospital service, *n* (%)				.21
Internal medicine	201 (37)	188 (33)	219 (40)	
Orthopedics	140 (25)	127 (22)	115 (21)	
hematology/BMT or oncology	47 (9)	51 (9)	50 (9)	
Neurosurgery	31 (6)	25 (4)	31 (6)	
Cardiology/Cardiothoracic Surgery	42 (8)	47 (8)	40 (7)	
Plastic Surgery	17 (3)	24 (4)	18 (3)	

Abbreviations: BMT, bone marrow transplant; IQR, interquartile range; OPAT, outpatient parenteral antimicrobial therapy; SD, standard deviation.

[a]*P* value reported is for any difference across the 3 phases.

[b]Statistically significant difference between SmartForm and Problem List phases.

[c]Statistically significant difference between SmartForm and Progress Note phases.

Problem List phase (Supplementary Table 1). Other variables significantly associated with having a creatinine checked within 10 days of discharge included the following: being discharged to a home health service rather than to a skilled nursing facility; having private insurance; and a shorter hospital length of stay before discharge. Multivariable analysis of having a WBC checked within 10 days of discharge gave similar results; in addition, being a hematology-oncology patient was positively associated with having a WBC checked within 10 days of hospital discharge compared with internal medicine patients (Supplementary Table 2).

We found that being in the Progress Note or SmartForm phase was associated with increased attendance at an ID clinic visit within 21 days of hospital discharge, even controlling for potential confounders (Supplementary Table 3). The odds of attending an early ID visit were twice as high for patients in the Progress Note phase compared with preintervention (OR, 2.14; 95% CI, 1.62–2.81) and more than 3 times as high for patients in the SmartForm phase (OR, 3.50; 95% CI, 2.67–4.59). Other factors associated with attending an early ID clinic visit were a lower Charlson comorbidity index and being discharged from the orthopedic service.

In contrast to our laboratory monitoring and clinic follow-up outcomes, multivariable analysis did not show that our interventions had a consistent impact on OPAT-related readmissions, nor on our composite outcome of 30-day mortality/unplanned readmission (Supplementary Tables 4 and 5). There were 173 OPAT-related readmissions, comprising 10% of the cohort. The most common reason for OPAT-related readmission was worsening or recurrent infection (68% of patients with OPAT-related readmissions), followed by antimicrobial side effect (24%), vascular access problem (11%), and OPAT-administrative problem (7%). Fourteen patients were admitted for more than 1 OPAT-related problem. The variables independently associated with OPAT-related readmissions on multivariable analysis included Charlson comorbidity index (OR, 1.06 per point; 95% CI, 1.01–1.11), beta-lactam treatment (OR, 0.66; 95% CI, .47–.92), and the Progress Note intervention phase (OR, 1.51 compared with Problem List phase; 95% CI, 1.04–2.20).

DISCUSSION

Summary

For patients discharged on IV antimicrobials (OPAT), standardizing the documentation of the OPAT plan and placing it as an identifiable progress note in the EMR led to improved

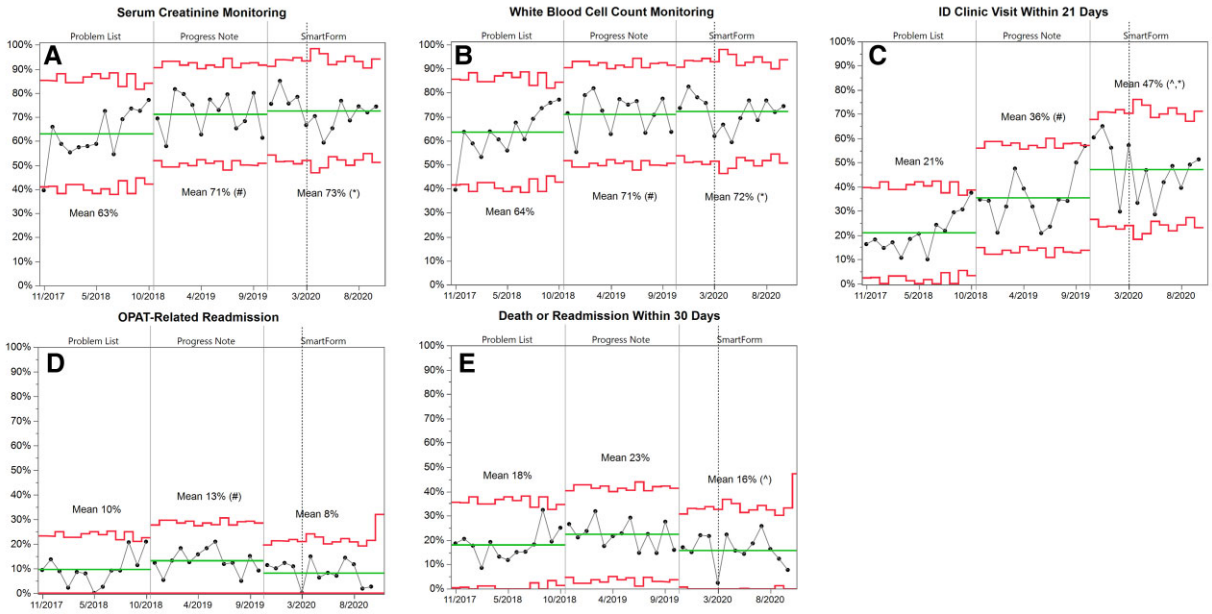

Figure 2. P-charts for the proportion of patients who (A) had a serum creatinine obtained within 10 days of discharge, (B) had a white blood cell count obtained within 10 days of discharge, (C) had an Infectious Diseases clinic visit completed within 21 days of discharge, (D) were readmitted for an outpatient parenteral antimicrobial therapy (OPAT)-related reason within 30 days of discharge, and (E) died or had an unplanned readmission within 30 days of discharge over the course of the interventions. The center line (mean, green) and surrounding upper and lower control limits (red) are plotted for each intervention time period. Data are grouped into 4-week increments based on date of patient discharge. A vertical dashed reference line at March 9, 2020 marks the onset of changes due to COVID-19 at our medical center, primarily a shift from in-person to telehealth visits. *, Statistically significant difference between the Problem List and SmartForm phases. #, Statistically significant difference between the Progress Note and Problem List phases. ^, Statistically significant difference between the SmartForm and Progress Note phases.

laboratory monitoring and outpatient follow-up. However, it did not lead to a reduction in readmissions. Throughout all time periods, the rate of OPAT-related readmission remained at approximately 10%, and the rate of unplanned readmission or death within 30 days was approximately 20%, similar to other studies of OPAT [2, 4, 15].

Interpretation

Prior studies have shown an association of both appropriate laboratory monitoring and early infectious disease clinic follow-up with reduced readmission rates [5, 15, 16]. Therefore, we would have expected to see a decrease in readmission rates with our interventions, because they improved both of those outcomes. However, our interventions were not associated with a consistent decrease in readmissions. There are several possible explanations for this discrepancy. First, the improvements in laboratory monitoring and outpatient follow-up may not have been large enough to have an appreciable effect on readmissions. Second, previous work at our center suggests that laboratory monitoring during beta-lactam OPAT minimally affects patient outcomes, and most of our patients were on beta-lactams [17]. Third, our analysis shows that comorbidities are strong predictors of readmission for OPAT patients, and any effect of the OPAT note may be minimal in comparison. Our finding that the readmission rate was highest during the Progress Note phase may be due to unmeasured confounders, but looking at the overall pattern (Figure 2D and E), we suspect that it reflects normal variation, and that the statistically significant difference between the Progress Note and other phases is not clinically meaningful.

It is striking how much impact we had simply by changing the location of a care plan within the medical record. The content of the OPAT plan as documented in the Problem List was essentially the same as that documented in the templated Progress Note, yet our interventions were associated with an increased likelihood of having a SCr checked within 10 days of discharge. Given the toxicities associated with IV antimicrobials, and prior studies indicating that many of them occur within 2 weeks of hospital discharge [3], this improved laboratory monitoring has the potential to increase early detection of adverse drug effects, thus reducing their severity. In addition, the proportion of patients coming to early ID clinic follow-up visits increased, which has been associated with improved patient outcomes [15, 16]. We attribute these improvements to increased inclusion of the OPAT plan in the discharge paperwork; proving that link will be the subject of future investigations.

Discharge documentation that outlines the posthospital care plan is important for all patients, not just those on IV antimicrobials. For example, studies have found that many discharge

summaries fail to include adequate information for the receiving care facility or primary care physician, often missing a clear care plan, appropriate physical therapy precautions, or the responsible clinician for outpatient follow-up [18–21]. In addition to increasing frustration on the part of the receiving clinicians, these omissions are associated with increased risk for readmission [21]. Improving the hospital to posthospital care transition is a key component for improving patient safety [18, 19].

Limitations

One limitation in interpreting our data is that external, uncontrolled factors may have affected our outcomes. In particular, the control charts (Figure 2) suggest that some of our outcomes were starting to improve before our first intervention. A possible explanation is that our preliminary discussions about OPAT heightened the inpatient teams' awareness of OPAT, and this led them to improve discharge documentation and instructions before the official start date of our first intervention.

There are several limitations to the broader applicability of our findings. First, our interventions were created specifically for our ID consult workflow and EMR, and, as such, these may not be relevant elsewhere. Second, we did not monitor the quality of the documentation of the OPAT plan in any of the time periods. However, our EMR (Epic) is widely used, and in general our ID physicians include the relevant information in their OPAT notes [11]. Another limitation is that some of our variables are inextricably linked, complicating analysis and interpretation. For example, because Medicare does not pay for home IV antimicrobials, Medicare patients are almost always discharged to a skilled nursing facility rather than home with home health.

It is difficult to ignore that the coronavirus disease 2019 (COVID-19) pandemic occurred during the SmartForm phase. Our ID clinic substantially increased the proportion of patients seen by telehealth, from essentially zero in February 2020 to approximately 50% in May 2020. We had fewer no-show visits with telehealth, because patients no longer had to travel to their appointment. In addition, during this period, more patients were discharged to home rather than to a care facility due to COVID concerns associated with these facilities.

CONCLUSIONS

This project used a large patient cohort to demonstrate that improving inpatient documentation of the OPAT plan improves the postdischarge monitoring of these patients, by improving the proportion of patients who have appropriate laboratory monitoring and who attend an early ID follow-up visit. Although we were not able to show an effect of our interventions on hospital readmissions, improving these intermediate measures is a step in the right direction. Future work should focus on identifying which aspects of OPAT care are most effective in reducing morbidity and mortality in this high-risk patient population.

In conclusion, changes in how and where care plans are documented in the EMR can have significant downstream effects on patient care outcomes. It is therefore of particular importance at care transitions to find the optimal documentation method.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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