Final Progress Report

Project title: Scaling E.Q.U.I.P.P.E.D. Clinical Decision Support

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STRUCTURED ABSTRACT

Purpose: We proposed to extend the implementation and evaluation of the EQUIPPED medication safety program 1) into a new electronic health record, Cerner, using traditional EQUIPPED implementation practices, and 2) to three new sites within one health system using a new hub-and-spoke implementation model – to further demonstrate program agility and effectiveness in reducing potentially inappropriate medications (PIMs) initiated in the Emergency Department at discharge for adults aged 65 and older.
Scope: Evaluation of EQUIPPED implementation at four healthcare system Emergency Department sites, one in the southeastern US (traditional model) and three in the eastern US (hub-and-spoke model). Study participants were physician attendings, physician assistants, nurse practitioners, and EQUIPPED site implementation teams.
Methods: We assessed program effectiveness through change in PIMs proportion (number of PIM prescriptions written for older adults at ED discharge/all prescriptions written for this population) from 12-months baseline through 12-months post implementation, using an interrupted time series design. We explored effect on health system utilization at the traditional site. A mixed-methods analysis of provider surveys, implementation team interviews and focus groups, meeting minutes, and individual prescriber interviews using the RE-AIM framework to assess factors associated with implementation is underway for completion in 2023.
Results: All sites successfully implemented EQUIPPED using two implementation models. Evaluation of monthly PIM prescribing proportions at both traditional and spread sites demonstrated a significant reduction in PIM prescribing in aggregate and for several medication classes. Healthcare utilization was non-significantly reduced post-implementation.
Key Words: Geriatrics, Emergency Medicine, Potentially Inappropriate Medication List, Patient Safety, Implementation Science.

PURPOSE

The purpose of this study was to achieve the following aims focused on medication management for older adults (≥65 years old) discharged from the Emergency Department (ED).

Specific Aim 1: Scale EQUIPPED CDS in two settings
1a. Adapt EQUIPPED CDS to a novel EHR system, Cerner/PowerChart EHR, through traditional EQUIPPED implementation methods.
1b. Accelerate local CDS implementation of existing Epic-based EQUIPPED CDS through implementation at 3 additional sites within a healthcare system that had previously implemented EQUIPPED. Under a new scale-up model, the previous site became the hub or coordinating site for implementation to three other satellite sites within the shared health system.
Specific Aim 2: Evaluate scale-up using the RE-AIM framework (Reach-Effectiveness-Adoption-Implementation-Maintenance):

a. Assess **reach** via education attendance, order set use, and provider feedback use
b. Evaluate **effectiveness** via change in PIM prescribing rates 12 months pre- and post- implementation
c. Assess **adoption** factors through interviews with clinicians with greatest and smallest prescribing change
d. Evaluate **implementation** through implementation team meeting minutes, team focus groups, and provider survey
e. Evaluate **maintenance** via sustainment of PIM prescribing rates one year post-implementation.

SCOPE

Background: Older adults are a vulnerable population at high risk for medication adverse drug events (ADEs), especially when they are discharged from the Emergency Department (ED). More than half of older adults discharged from the ED leave with a new prescription medication.[1,2] The risk of receiving a new potentially inappropriate medication (PIM) upon discharge from the ED ranges from 5.6%-13%.[2-7] Prescribing new medications for older patients outside the primary care setting increases chances for suboptimal prescribing as well as ADEs, both major reasons for repeat ED visits, hospitalization or death.[1-8] The emergency care of older adults is time and resource intensive and frequently complicated by patients' underlying chronic medical conditions and complex unmet social and physical needs[9]. One reason for suboptimal prescribing within the ED is inadequate time spent on geriatric training within the emergency medicine curriculum[10, 11]. Medication management (including prescribing appropriate drugs) has been identified as one of the core competencies called for in the 2010 Geriatric Competencies for Emergency Medicine[12] developed in response to a 2008 Institute of Medicine report calling for geriatric competence within medical specialties.[13] Other reasons for suboptimal prescribing include inadequate time within a busy ED to handle complex patients such as older adults with multiple chronic conditions[14]; and inadequate clinical decision support (CDS), which can lead to unintended consequences,[15] or CDS that does not function appropriately because it is not designed for a chaotic ED setting.[16]

EQUIPPED (Enhancing Quality of Prescribing Practices for Older Adults Discharged from the Emergency Department) is a quality improvement initiative designed to equip ED providers with the tools they need to reduce PIM prescribing for adults aged 65 years and older who are discharged from the ED to home with a prescription.[17] EQUIPPED's CDS bundle is comprised of: 1) didactic education for providers; 2) specialized geriatric pharmacy order sets and links to online educational content at point of prescribing; and 3) academic detailing including audit and feedback and peer benchmarking. EQUIPPED is informed by the Beers Criteria,[18] widely used by government agencies and supported by research in various settings[1,5,6] as a marker of prescribing quality. We aim to reduce PIMs in an ED to less than 5% of all prescription. Our team has demonstrated the ability to successfully adapt and implement EQUIPPED in 20 urban and rural Veterans Affairs (VA) Medical Centers using the Computerized Patient Record System electronic health record (EHR) and in 5 non-VA health systems using the EHR Epic,[19-22] with the first 4 sites reducing PIMs from 7.4%-11.9% of all medications at pre-implementation baseline to 4.5%-6.1% one year post-implementation.[19] Implementing EQUIPPED into Cerner/PowerChart for the first time widens the scope of applicability to at least 45% of the hospital EHR market outside the VA system.[23] Implementing in multiple EDs within the same health system extends EQUIPPED to a community hospital, increasing the diversity of providers and patients that are touched by the intervention. What we learn from the implementation evaluation will poise EQUIPPED for future dissemination.

Context: As a system-wide approach to increasing patient safety for older adults at the time of ED discharge, the EQUIPPED program fits into the Age-Friendly Health System Initiative established by the John A. Hartford Foundation and the Institute for Healthcare Improvement which includes medication as one of its four pillars of geriatric care.[24] Specifically EQUIPPED has been recognized as a means for EDs to receive Geriatric ED[25] accreditation.[21,26] Guidelines for geriatric EDs from professional societies representing geriatrics, nursing, and emergency medicine highlight the need to tailor pharmacy and ED-based interventions to the older adult population to improve prescribing quality and provide high quality ED care.[27] Providers often state that they have inadequate knowledge about principles of geriatric care and could benefit from point-of-care prescribing guidelines and newer decision-support tools.[28, 29] Electronic decision support tools and provider audit and feedback, two key components of EQUIPPED, are proven provider education tools that can be applied in the busy ED setting to improve the safety and quality of prescribing high-risk medications.[30, 31]

Settings: Our site sample included one "traditional" site, modelled after previous EQUIPPED implementation efforts, and three spread sites in a single health system using a new hub-and-spoke model. The traditional site adapted and implemented all program components itself with the help of the study team. In contrast, the spread sites can be conceived as spokes branching off of a hub that had previously implemented EQUIPPED; the hub had the experience and infrastructure in place to deliver education, order sets, and provider feedback reports to a local known champion who was asked to deliver the provider feedback reports to individual providers, speak up at regular ED meetings, and answer questions that arose. The hub-and-spoke sites also had access to knowledge and resources of the study team through biweekly meetings.

Traditional model site: The **traditional site** is an academic urban hospital in the southeast that has almost 50,000 ED visits annually and the highest geriatric patient mix in our sample, at 29%. The site used Cerner/PowerChart, an electronic health record into which EQUIPPED had never before been implemented. Local efforts to adapt EQUIPPED to this new EHR were led by Camille Vaughan, MD, MS, Section Chief for Geriatrics & Gerontology and Associate Professor of Medicine at Emory University School of Medicine, a geriatrician and clinical-investigator with expertise in the management of geriatric syndromes among older adults with multiple morbid conditions. Dr. Vaughan worked closely with the site champion, an ED physician (emergency medicine), in concert with a nurse practitioner and an ED pharmacist. Our data analysts and data visualizers determined how to extract data from the clinical data warehouse and prepare provider feedback reports using Tableau software. Provider feedback reports were delivered monthly by the site champion.

Hub and spoke model sites: The **hub site** is an academic urban hospital in the northeastern United States. Both hub and spoke sites use the Epic electronic health record. The hub site facilitated order set updating and implementation, data extraction, provider feedback report creation using Tableau software, and communication with the hub site champions and ED leadership. **Spoke site** champions received provider feedback reports from the hub site and sent them to each provider in the EQUIPPED cohort. The hub site had three site PIs at various phases of the project: initially Dr. Ula Hwang, then Associate Professor at the Icahn School of Medicine at Mount Sinai, Departments of Emergency Medicine and Brookdale Department of Geriatrics and Palliative Medicine, and a national recognized expert in the development of geriatric ED models of care. She was followed by Dr. Nicholas Genes, then Assistant Professor, Department of Emergency Medicine at the Icahn School of Medicine at Mount Sinai, with expertise in medical informatics. Finally, Dr. Lynne D. Richardson, MD, Professor or Emergency Medicine and Vice Chair for Academic, Research and Community Programs of the Department of Emergency Medicine, lead implementation.

Spread site 1: This academic site is a level 2 trauma center with 102,000 estimated patient visits of in a typical year, about 18,000 of which involve geriatric patients. About 40% of the ED patients are on Medicaid. Providers typically work about halftime at this site and halftime at spread site 2, though individual schedules vary. The two sites are about 60 urban blocks from each other.

Spread site 2: In a typical year this ED has an annual volume of almost 70,000 patient visits, about 13,000 of which involve geriatric patients. About 28% of its patients are on Medicaid. Providers typically work about halftime at this site and halftime at spread site 1, though individual schedules vary. The two sites are about 60 urban blocks from each other.

Spread site 3: This community-based ED represented a new type of hospital site for the program. Its ED has an estimated volume of about 11,700 geriatric patient visits annually and is growing. About 24% of its patients are on Medicaid.

Participants: Our target clinicians for EQUIPPED were all attending physicians and advanced practice providers (i.e., physician assistants, advance practice nurses) at the 4 hospitals. These clinicians were targeted since they are a more consistent and continuously present group of ED clinicians. Additionally, attending physicians and advanced practice providers are more reflective of staff employed by most EDs in the community setting. The target providers who were on staff at the start of the implementation year became our cohort; they were introduced to EQUIPPED and received group education, including training in how to access order sets, a 1:1 training session with their site champion, and monthly academic detailing and feedback with peer benchmarking for 12 months. We did not update our cohort with newly hired clinicians as time went on.

While each site had a targeted cohort of providers for the intervention, all providers in the ED (including moonlighters, *locum tenens*, residents, part-time providers, and new hires) had access to the order sets and may have been exposed to information about EQUIPPED through staff meetings or discussion with colleagues. Our effectiveness evaluation is inclusive of all prescribers, whether or not they were in our original cohort.

Prevalence: Previous evidence suggests the prevalence of PIM prescribing at ED discharge for older adults ranges typically from 5.6%-13%.[2-7] Common PIM drug classes prescribed in the ED for older adults being discharged include centrally-acting antihistamines, muscle relaxants, and benzodiazepines.

METHODS

Study Design: Prospective evaluation of the EQUIPPED medication safety program implemented at four sites.

Data Sources: Seven data sources were used to answer our evaluation questions.

1) Interviews with Implementation Teams: For the traditional site, a 90-minute group interview with the implementation team was conducted on July 22, 2020. All members of the implementation team were eligible to participate (N=12). We had 4 members representing: ED physician champion, ED clinical pharmacy specialist, EQUIPPED physician and project mentor, and project coordinator. The focus group was moderated by Dr. Kegler and her staff, experienced in focus group facilitation.[32-37] The evaluation team developed a discussion guide that contained open-ended questions that focus heavily on the implementation process as informed by the consolidated framework for implementation research (CFIR).[38] Due to the pandemic environment, the focus group data collection was adapted to be conducted over the Zoom video conferencing platform. At the hub and spoke sites, the focus group was redesigned as individual 20-minute interviews with members of the implementation teams at the hub site and each of the spoke sites. The interview guide was adjusted into hub and spoke versions. All implementation team members were invited (N=20) and 6 agreed to participate (2 from the hub site, 2 from two sites sharing an implementation team, and 2 from the third site). Due to the pandemic environments, these interviews were delayed and conducted in April 2021, also via the Zoom videoconferencing network. All interviews were recorded and then transcribed for analysis.

2) Interviews with ED providers: Midway through the post-implementation period, we conducted an interim analysis to identify providers at the hub-and-spoke scale-up satellite sites whose prescribing had changed the most or least to date and who also indicated in survey responses their willingness to be interviewed. Providers were invited to participate in a 20-minute interview conducted over Zoom and were recruited until 4 were interviewed at each of the three sites. Dr. Vandenberg and her staff conducted the interviews, using an interview guide that was adapted to each individual's survey responses. The interviews were transcribed and then analyzed qualitatively to identify facilitators and barriers to implementation dose and facilitators and barriers to behavior change.

3) Implementation Team Meeting Minutes: As part of the implementation process, implementation teams were formed at each site and met via teleconference. Similar to the VA and subsequent academic site implementation strategies, we had EQUIPPED leadership team (including site PIs, ED champions, and key site personnel) teleconference twice monthly to discuss site specific factors and strategize solutions through collaboration. The evaluation team analyzed agendas and minutes using qualitative methods to identify planning steps, timeline for implementation, and barriers encountered in each site. These were used to inform the evaluation interviews and understand our implementation fidelity measures.

4) Academic Detailing Staff Logs: Each site designated at least one individual to serve as an academic detailer to have one-on-one meetings with providers to share provider feedback on PIM prescriptions. These individuals maintained program records that document which providers have received the feedback and the date of the academic detailing meeting.

5) Provider Surveys on CFIR Constructs: Surveys were administered to characterize the implementation environment and identify predictors of implementation success. Data were collected in the 3rd quarter of the implementation year for each site. Providers surveyed had at least three months as an ED provider (attending MD, APRN, PA) with at least 3 ED shifts worked per month. Measures were adapted from a similar survey

developed and tested by Dr. Kegler and members of the Cancer Prevention and Control Research Network (CPCRN), a national network of academic, public health and community partners who work together to reduce the burden of cancer through dissemination and implementation research.[39] The CPCRN developed and tested psychometric properties of 16 out of 39 CFIR constructs and sub-constructs.

6) Organizational profiles: We asked that each site champion facilitate the collection of data from their site describing site characteristics during the implementation year.

7) Local Facility Corporate Data Warehouse: Data were extracted from the clinical data warehouse at each implementation site to calculate the proportion of PIMs prescribed to adults aged 65 and over and discharged from the ED. Data for the secondary outcomes related to healthcare utilization and contextual factors of ED visit flow (volume of patient encounters, age of encounters, and proportion discharged) were also extracted at the traditional site.

Interventions: The three core components of EQUIPPED are: a) provider education, b) EHR-based pharmacy quick order sets to facilitate provider order entry, and c) provider audit and feedback with peer benchmarking. Collectively these interventions are considered EQUIPPED CDS. The interventions were implemented differently according to the scale-up model used.

Traditional implementation: The traditional site implemented all EQUIPPED components itself, adapting EQUIPPED templates for the local ED culture and different EHR. Local clinical data warehouse extraction services wrote code to extract the prescriptions written to patients aged 65 and older who were discharged from the ED and to identify relevant ED providers to receive monthly PIMs reports. These services updated an evidence-based potentially inappropriate medications (PIMs) list, mapped the list to the site's formulary, with medical chart review spot-checking for confirmation. They refined the data extraction code to match our biostatisticians' parameters for the implementation evaluation after the post-implementation year. The clinical team identified drug classes to be mapped to the provider feedback forms that were concordant with the formulary and parlance within the local ED in conjunction with the Beers Criteria classes. The data extraction fed into an adapted Tableau provider feedback report for monthly distribution by the site champion to the ED provider cohort.

Following a baseline data pull, the ED champion, pharmacist and nurse practitioner met with EQUIPPED leaders and selected 7 order set templates deemed to be most relevant and urgent for adaptation at this site, based on baseline data: 1) Chronic Obstructive Pulmonary Disease, 2) Anticoagulation for Deep Vein Thrombosis, 3) Hypertension, 4) Constipation, 5) Gastroesophageal Reflux Disease/Nausea, and 6) Musculoskeletal order sets. These order sets were then adapted to the local formulary and affordances of the PowerChart platform. Drafts of each order set were vetted by relevant generalist and specialist physicians, pharmacists, and ED directors across the site's health system. Order sets were first presented to and approved by the Formulary Stewardship Committee. The order sets were subsequently presented and approved at the Clinical Practice Council in November 2019; the CPC also approved any future changes to these order sets. The order sets were built within PowerChart and edited by the implementation team. They are named "ED Discharge Prescriptions > 65 years old" and appear under Orders for Signature in the PowerChart navigations pane. Geriatric prescribing edits were further inserted into an existing ED Antibiotics discharge order set, for a seventh "geriatricized" order set. The EQUIPPED order sets went live for providers on February 25, 2020.

The local site champion prepared a didactic lecture for presentation to the order set approval committees and to ED providers, using a slidedeck template but displaying the navigational path to the new orders sets, their contents, and local baseline PIM figures. Other educational strategies were the creation of a computer card indicating the Top 5 PIMs during the baseline period that was affixed to each of 24 ED computer stations and the offering of the iGeriatrics mobile application to access the American Geriatrics Society (AGS) Beers Criteria® for all providers. The champion further emailed individual provider feedback reports to provider colleagues as well as a group message indicating strong and weak areas of prescribing.

Hub-and-spoke model implementation: The hub site that had formerly implemented EQUIPPED from July 2017 through June 2018 and needed only to update the order sets according to the 2019 Beers Criteria and activate them at the satellite sites for the order sets to be available for providers to use. The hub site also provided a didactic lecture to hub-and-spoke sites 1 and 2 on October 15, 2019, and to site 3 on January 15, 2019, distributed slides to providers who could not attend those lectures, provided educational tips to the site champion, and offered providers iGeriatrics gift cards as was done at the traditional site. They further coordinated the creation of the monthly provider feedback reports in Tableau, using previously developed data extraction techniques. Therefore, the spoke sites were charged only with distributing the provider feedback reports monthly through its ED MD champions and presenting and answering questions about the program at staff meetings.

Measures: To assess the RE-AIM constructs, specific measures of interest included the following:
Reach: Attendance records from training sessions, EQUIPPED staff logs, provider survey assessments to determine the aggregate and individual dose of EQUIPPED received by ED providers.
Effectiveness: Change in the proportion of PIMs to all prescriptions in the ED to show what happened to monthly PIM prescription proportions prescribed to patients aged 65 years and older and discharged from the ED by MDs and advance practice providers from the baseline through the post-intervention periods. PIMs were defined according to the 2019 American Geriatrics Society® Beers Criteria. Supplies were excluded.
Adoption: Assessed through implementation team interviews and focus groups. In addition, 12 individual provider interviews at the hub-and-spoke sites are designed to provide insight into facilitators and barriers to dose and to behavior change.
Implementation: Attendance records from provider trainings, focus groups, implementation team notes and agendas provide information about how implementation was achieved and fidelity to the program.
Maintenance: Focus groups and sustainability of EHR changes over time.

Primary Outcome analysis:
The primary effectiveness outcome of interest was the monthly PIMs rate. Poisson regression was used to compare the percentage of PIMs prescribed in the 12 months before the first EQUiPPED intervention with 12 months after the completion of the EQUiPPED intervention (see Table 1). Rate ratios (RRs) and their respective 95% confidence intervals (CIs) were calculated to compare the pre-EQUIPPED and post periods.

Additionally, generalized linear models assuming a Poisson distribution for the monthly PIMs rates were fitted. The total number of prescriptions served as the offset term in the model, and a piecewise, nonlinear regression model was used to evaluate the pattern of PIMs prescriptions over time. All models contained three basic parameters accounting for the pre-intervention trend (pre-intervention slope), the change in level at the intervention point, and the difference in trend between the two periods (change in slope from pre-intervention). Correlograms were used to check for autocorrelation in the residuals using the Durbin Watson test. The standard errors were calculated based on the Newey-West method to account for the autocorrelation. Based on observed autocorrelation, the post intervention trend was adjusted by a 0-1 month lag depending on the institution. We conducted all analyses by using the statistical software R, version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria), and *p* values of .05 or less were considered statistically significant.

Secondary healthcare utilization outcomes – traditional site:
We were asked to do an exploratory analysis of the impact of PIM prescribing on health-care utilization post ED discharge. We conducted this analysis at the traditional site only. We defined four outcomes of interest (ED visit within 72 hours, ED visit within 30 days, inpatient admission within 72 hours, and inpatient admissions within 30 days) but created a combined variable due to the small number of health utilization outcomes. We used logistic regression to examine what happened to the odds of having a health outcome from pre- to post-intervention.

Secondary data analysis: Order set usage – traditional site: We were interested to know the degree to which order set usage alone influenced PIM prescribing. We identified the two conditions (ICD10 codes) associated with the majority of baseline PIMs, musculoskeletal pain for which alternative medications were offered to the PIMs through an order set and vertigo for which no order set was offered. We predicted that prescriptions for the muscle relaxant cyclobenzaprine and the benzodiazepine diazepam prescriptions would decline and that prescriptions for the muscle relaxant alternative baclofen would increase due to the influence of the guidance in the musculoskeletal order set. We predicted that prescriptions for the anticholinergic antihistamine meclizine would remain about the same due to the lack of an order set that suggested any alternative prescription guidance. All prescriptions associated with these ICD10 codes were extracted from the clinical data warehouse during the baseline, implementation and post-implementation periods (12 months each). Chi square analysis evaluated the proportion of all medications including PIMs over the study periods.

Facilitators and barriers to dose and to prescribing behavior change – spread sites only:
As part of an evaluation study of the association between the dose of EQUIPPED that was self-reported by individual provider survey respondents in our cohorts across 7 EQUIPPED sites and the target outcome of <5% PIMs, we conducted an interim analysis of provider prescribing at the spread sites 6 months post-implementation and identified providers whose prescribing had improved the most and the least. We then recruited 4 providers at each site who on the survey were agreeable to participate in a follow-up interview. The approximate 20-minute interviews were conducted over Zoom, recorded, transcribed, and analyzed thematically for facilitators and barriers to dose and to prescribing behavior change. These findings will inform a larger analysis underway on the survey-identified CFIR factors associated with provider dose and prescribing change.

Limitations:
The sample size to assess site-level factors influencing implementation was relatively small (n=4) as was the sample size of individual providers who completed our surveys (n=61). We therefore are combining survey data with those from a previous EQUIPPED study in order to examine these factors at the site and individual levels (7 sites, 150 providers). For the secondary outcomes concerning healthcare utilization at the traditional site, we were limited by access to data only at the hospital where the index visit took place rather than the other 9 hospitals and EDs that were in that healthcare system. Healthcare utilization recorded is therefore likely underestimated. In March 2020 the COVID-19 pandemic became the healthcare system's top priority and interrupted implementation completion at all sites. All four sites had to cease one-on-one provider feedback to introduce academic detailing through site champions due to the national emergency. Resumption of feedback and academic detailing occurred in May 2020 amid dynamic and stressful conditions. In the words of one of our EQUIPPED provider interviewees, "There was a firehose of information coming at us basically every week, like new protocols, changes in practices, best practices regarding managing COVID, which is mostly what we were seeing for a long period of time. So I think that at the time it was rolled out EQUIPPED was probably either eclipsed or rolled into just an abundance of outreach about a lot of things all at once." We appreciated the time and attention that our providers gave to the program under these conditions.

RESULTS
Principal Findings: EQUIPPED CDS to enable safe prescribing for older adults discharged from the ED can be spread across health systems with different EHRs using either a traditional implementation model (site adapt and implement all components themselves) or a new hub-and-spoke implementation model (spoke sites receive order sets, didactic education, and academic detailing reports from a hub site within the same health system that had previously implemented EQUIPPED; spoke site champions perform academic detailing). Overall PIM prescribing was significantly reduced at all four sites from baseline to post-intervention periods.

Outcomes:
Site characteristics of the four implementation sites are described in Table 1. The traditional site was a Certified stroke center in the Southeastern urban United States that used the Cerner/PowerChart EHR. It had

47,955 encounters during the implementation year, 29% with geriatric patients and 56% with Black patients. The three spread sites belonged to a single health system in the Northeastern urban United States that used the Epic EHR. Their encounter volume ranged from 60,167 to 76,983 encounters during the implementation year, 19-21% with geriatric and 27-41% with Black patients. Spread site 3 represented the first non-academic community hospital to implement EQUIPPED.

PIM prescribing over time: The proportions of PIMs/medications prescribed are shown in Table 2. All sites achieved significant reduction of PIMs from baseline to post-implementation periods. However only one site (traditional) was able to reach the EQUIPPED goal of < 5% PIMs in the post-implementation period. PIM baseline proportions ranged from a low of 8.86% at the traditional site to a high of 16.16% at the community spread site. PIM proportions declined from 8.86% to 3.59% (p<.0001) at the traditional site, from 12.20% to 7.13% (p<.0001) at spread site 1, 11.30% to 7.48% (p=.045) at spread site 2, and 16.16% to 11.67% (p<.0001) at spread site 3 (the community hospital).

In addition to achieving an overall reduction of PIMs in the ED, all sites were able to significantly reduce prescribing for two of the medication classes most problematic to our demographic: skeletal muscle relaxants, which accounted for 22.5% to 37.8% of all PIMs prescribed at baseline, and benzodiazepines, which accounted for 8-15% of all PIMs. The two spread sites where non-steroidal anti-inflammatory drug PIMs (prescribed for greater than 29 days) were among the five most prescribed PIM classes (29.1% of PIMs for spread site 1 and 30.9% for spread site 2) achieved significant reductions in those PIMs as well (from 3.5% of all medications prescribed to 2% (p=.0004) for site 1 and from 3.5% to 2% (p=.0059)). However, other drug classes were recalcitrant. Only spread site 3 was able to significantly reduce anticholinergic antihistamines, which constituted 40.3% of all its PIMs, from 6.5% of all medications prescribed to 4.9% (p=.0183), and only spread site 2 was able to reduce its GI motility class, which constituted 2.68% of its PIMs, from .3% to 0% (p=.0246).

The time series analyses, which indicated that long-term change in the mean level significantly decreased over time for all four sites, are shown in figures 1-4. These figures show the observed PIMs rate over time and the overall slope (middle line) with a 95% confidence interval.

The interrupted time series analyses examined what happens before and after ‘interruptions’ such as intervention and post-intervention. Table 3 and Figure 5 show these changes at the traditional site. Non-significant incident rate ratios (IRR) of .996 and 1.15 are indicated for the baseline time period and the immediate change in the outcome from baseline to intervention, respectively. However, we do see a significant difference between the slope of the line before and after the intervention. This ‘trend change after baseline’ in Table 3 represents the sustained effect of the intervention with an estimated IRR of .961 (p=.0166). There is a significant decrease in the outcome in the last month of intervention and the first month of post-intervention as estimated by the ‘Level change after intervention’ in Table 3. As shown in both Table 3 and Figure 5, there is a statistically significant increase in the sustained effect during the post intervention period (as compared to the intervention period).

Table 4 and Figure 6 show these changes at spread site 1. The baseline estimates indicate non-significant incident rate ratios of .991 and 1.107 for the baseline time period and the immediate change in the outcome from baseline to intervention, respectively. However, we do see a significant difference between the slope of the line before and after the intervention. This trend change after baseline, called ‘Trend change during intervention period’ in Table 4 represents the effect of the intervention compared to baseline with an estimate IRR of .959 (p=.0496). There is not a significant decrease in the outcome in the last month of intervention and the first month of post-intervention as estimated by the ‘Level change after intervention’ in Table 4. Similarly, there is no significant decrease during the post intervention period (as compared to the intervention period).

Table 5 and Figure 7 show these changes at spread site 2. A significant decrease (estimate IRR of .963) is observed during baseline but not intervention (“Trend change (during intervention period)”). Table 5 and figure 7 show a significant increase (estimate IRR of 1.04) during post intervention (“Trend change (during post intervention period)”).

Finally, Table 6 and Figure 8 show these changes at spread site 3. Non-significant incident rate ratios of .989 and 1.168 for the baseline time period and the immediate change in the outcome from baseline to intervention, respectively. While the time during intervention decreased, the IRR estimate .963 has a confidence interval that includes 1 (i.e., no effect). In addition, there is not a significant decrease in the outcome between the last month of intervention and the first month of post-intervention as estimated by the 'Level change after intervention' in Table 6 (although this does not have much meaning in our study since intervention was long-lasting). Unfortunately, there is significant increase trend during the post intervention period (as compared to the intervention period) with a 1.08 estimated IRR.

Secondary healthcare utilization outcomes – Traditional site only: The number of index ED discharge encounters for patients aged 65 and older dropped from a total of 3577 during the baseline year to 2468 during the post-intervention period (i.e., COVID-19 era) and combined health care utilization dropped from 927 to 556, respectively. The logistic regression model indicating the probability of having a negative health outcome (re-presentation ED visit within 72 hours of the EQUIPPED index visit, re-presentation ED visit within 30 days, hospitalization within 72 hours, or hospitalization within 30 days) at the traditional site was 2.6% lower during the post-implementation period than it was during the baseline period (odds ratio 1.026 (CI - 0.96 - 1.10)), but the results did not reach statistical significance (p=0.48).

Secondary data analysis: Order set usage at traditional site only: Cyclobenzaprine and diazepam prescriptions for musculoskeletal pain declined significantly during and after the study period (p<0.0001) while meclizine prescriptions for vertigo remained constant (p=0.5848). Prescriptions for baclofen, a non-PIM alternative, offered in the musculoskeletal pain order set increased (p<.0001). Order set usage increased significantly post-implementation (p<.0001) using a Cochran-Mantel-Haenszel (CMH) Test.

Facilitators and barriers to order set usage – spread sites only:
The qualitative interviews with 12 providers at the spread sites indicated that facilitators to using EQUIPPED order set dose were needing a resource for resident teaching and finding order sets to be conveniently placed within the workflow. Barriers to EQUIPPED order set dose included preferring champion-provided feedback to order sets as clinical decision support, perceiving the order set use to require a change in workflow, finding competing priorities in the ED as a deterrent to using the order sets, lacking an engaged and interactive site champion at one of the sites, perceiving EQUIPPED to be imposed top-down on providers, and being a night attending and therefore not available for meetings at which EQUIPPED was discussed.

Discussion: EQUIPPED clinical decision support for medication safety was successfully scaled to a new electronic health system (Cerner/PowerChart) using the traditional model and to three sites within the same health system of an initial EQUIPPED site using a new hub-and-spoke implementation model. Statistically significant reductions in all PIM prescribing proportions, as well as in the problematic PIM classes skeletal muscle relaxants and benzodiazepines, were seen across all of the sites from the 12-month baseline to the 12-month post-implementation period. However, the PIM prescribing goal of < 5% for the entire ED was reached by only one site, the traditional site. This site began the study with the considerably better PIM proportion of 8.86% at baseline vs. 12.20%, 11.30%, and 16.16% for spoke sites 1-3, respectively. Given the scope of the PIM problem at baseline, the relative reduction of 42%, 34%, and 28% at these spread sites, respectively, nevertheless appears impressive.

The hub-and-spoke model did not appear to offer a clear advantage over the traditional on-site model in terms of speed or quality of implementation. Although each of the two models was implemented independently by different teams, each ended up taking a complete year to implement. The hub-and-spoke model was a relatively "light touch" approach to implementation, with local sites needing only to deliver academic feedback to all providers in the cohort (rather than, for example, also preparing the reports). However, communication challenges introduced by decentralizing some tasks across the hub and spokes may have slowed delivery. In addition, both models in their respective major metropolitan EDs were interrupted in March 2020 by the

COVID-19 pandemic, and this world emergency continued to preoccupy the ED throughout the rest of the study. Our implementation analysis to understand factors related to implementation success and downstream effects on PIM prescribing is on track to be completed in 2023.

We did not find a significant difference in healthcare utilization following the index visits in the baseline vs. the post-implementation periods. However, this null finding is likely due to the many limitations of our data, including confining the analysis of hospitalizations and ED visits to the original index site. A future exploratory analysis could be refined by controlling for age and health conditions at presentation and also to capture ED revisits and hospitalizations at all hospitals and EDs within one health system.

Conclusions: The EQUIPPED CDS can be successfully and effectively implemented using two implementation models. Evaluation of monthly PIM prescribing proportions at both traditional and spread sites using the hub-and-spoke model demonstrated a significant reduction in PIM prescribing. All sites were also able to significantly reduce prescribing of skeletal muscle relaxants and benzodiazepines. Evaluation of site and provider-level factors implementing EQUIPPED implementation is on track for completion in 2023.

Significance: It is feasible to scale EQUIPPED clinical decision support to multiple electronic health record systems and with a hub-and-spoke as well as a traditional implementation model. The fact that EQUIPPED was successfully implemented in the midst of the major COVID-19 challenge emphasizes how feasible the project is in the busy, dynamic, and unpredictable ED clinical setting.

Implications: The adaptation of EQUIPPED to Cerner/PowerChart may enable scale-up within the VA system as it transitions from the Computerized Patient Health Record System to Cerner. A hub-and-spoke model frees the local implementation site to concentrate on provider academic detailing through a site champion and may allow large health systems to scale up the EQUIPPED medication safety program.

Table 1: Emergency Department site characteristics during the intervention year (July 2020-June 2021)

Domain	Traditional Site 1	Spread Site 1	Spread Site 2	Spread Site 3
Location	Southeastern urban United States		Northeastern urban United States	
Medical system type	Academic	Academic	Academic	Community
Complexity level	Certified stroke center	Level 2 trauma center	Certified stroke center	Certified stroke center
Patient population	47,955 encounters	76,983 encounters	60,167 encounters	62,105 encounters
Sex	58% female	51% female	46% female	50% female
Race	56% Black	41% Black	27% Black	17% Black
Insurance	34% public	64% public	52% public	41% public
% Aged 65+	29% geriatric	21% geriatric	19% geriatric	20% geriatric
% Aged 65+ discharged	22.5% geriatric discharged	54% geriatric discharged	57% geriatric discharged	58% geriatric discharged
Provider population (size and makeup)	33 attendings 36 residents yearly 8 Physician assistants 21 Nurse practitioners 0 pharmacists 0 geriatric pharmacist	43 attendings 60 residents 9 physician assistants 0 nurse practitioners 1 pharmacist 0 geriatric pharmacist	42 attendings 60 residents 9 physician assistants 0 nurse practitioners 1 pharmacist 0 geriatric pharmacist	15 attendings 0 residents 12 physician assistants 0 nurse practitioners 0 pharmacist 0 geriatric pharmacist
Electronic health record	Cerner/PowerChart		Epic	
Discharge order sets prior to EQUIPPED	Discharge antibiotics for common infections		0 discharge order sets	
EQUIPPED order sets implemented	Infections – Antibiotics geriatricized Cardiology - Antihypertensive Constipation Chronic Obstructive Pulmonary Disease Gastroesophageal reflux disease/Nausea Musculoskeletal Pain		Infections Cardiology Dermatology Diabetes Mellitus Gastrointestinal Gynecology/Urology Neurology/Pain Rheumatology Pulmonary	

Table 2. Pre-post PIM prescribing and specific PIM drug classes

	% of all PIMs at baseline	Pre-EQUIPPED (%) (95% CI for a*ll medications*)*	Post-EQUIPPED (%) (95% CI for *all medications*)*	Pre- to Post change p-value**
Traditional: Site 1				
All PIMs	100	8.86 (8.12-9.60)	3.59 (3.59-9.60)	< 0.0001
Skeletal Muscle Relaxant	37.8 (33.6-42.2)	3.34 (2.89-3.84)	.85 (.59-1.18)	<.0001
Anticholinergic Antihistamine	20.8 (17.3-24.6)	1.8 (1.5-2.2)	1.4 (1.1-1.8)	.1272
Benzodiazepine	15 (12.03-18.34)	1.3 (1.05-1.65)	.33 (.18-.56)	<.0001
Anticholinergic Antispasmodic	10.2 (7.72-13.13)	.9 (.67-1.18)	.74 (.5-1.06)	.473
GI Motility	8 (5.82-10.73)	.7 (.51-.96)	.4 (.22-.63)	.0562
Spread: Site 1				
All PIMs	100	12.20 (11.20-13.19)	7.13 (6.14-8.14)	< .0001
Anticholinergic Antihistamine	32.3 (28.3-36.5)	3.9 (3.4-4.5)	3.4 (2.7-4.1)	.2578
Non-Steroidal Anti-Inflammatory Drugs	29.1 (25.2-33.2)	3.5 (3.0-4.1)	2.0 (1.5-2.6)	.0004
Skeletal Muscle Relaxant	27.1 (23.3-31.2)	3.3 (2.8-3.9)	1.1 (.8-1.6)	<.0001
Benzodiazepine	8.7 (6.46 -11.51)	1.1 (0.77-1.4)	.3 (0.17-0.66)	.0021
GI Motility	1.2 (0.52-0.02)	.1 (0.06-0.31)	.1 (0.01-0.27)	.7186
Spread: Site 2				
All PIMs	100	11.30 (10.14-12.56)	7.48 (6.35-8.78)	.04466
Anticholinergic Antihistamine	32.2 (26.99-37.72)	3.6 (2.96-4.42)	3.9 (3.08-4.90)	.7068
Non-Steroidal Anti-Inflammatory Drugs	30.9 (25.77-36.37)	3.5 (2.83-4.25)	2.0 (1.46-2.78)	.0059
Skeletal Muscle Relaxant	22.5 (18.03-27.61)	2.5 (1.98-3.21)	0.77 (0.45-1.27)	<.0001
Benzodiazepine	9.4 (6.41-13.15)	1.1 (0.72-1.52)	.33 (0.14-0.72)	.0098
GI Motility	2.68 (1.19-5.09)	.3 (.13-.59)	0	.0246
Spread: Site 3				
All PIMs	100	16.16 (14.91-17.40)	11.67 (10.30-13.04)	<.0001
Skeletal Muscle Relaxant	33.3 (29.41-37.48)	5.4 (4.64-6.18)	3.2 (2.51-4.05)	.0003
Anticholinergic Antihistamine	40.4 (36.27- 44.62)	6.5 (5.70- 7.39)	4.9 (4.05- 5.92)	.0183
Benzodiazepine	8.0 (5.85-10.50)	1.3 (0.94-1.72)	.33 (0.15-0.67)	.0006
GI Motility	8.0 (5.85-10.50)	1.3 (0.94-1.72)	.76 (0.46-1.21)	.0897
Non-Steroidal Anti-Inflammatory Drugs	5.6 (3.81-7.80)	0.9 (0.61-1.27)	.95 (0.60-1.45)	.9613

*percentages for specific PIM classes represent the % of that class among all medications prescribed

**p-value represents general time series model assuming a Poisson distribution

Figure 1: General Time Series Analyses of Trend PIM rate – Traditional Site (Poisson distribution)

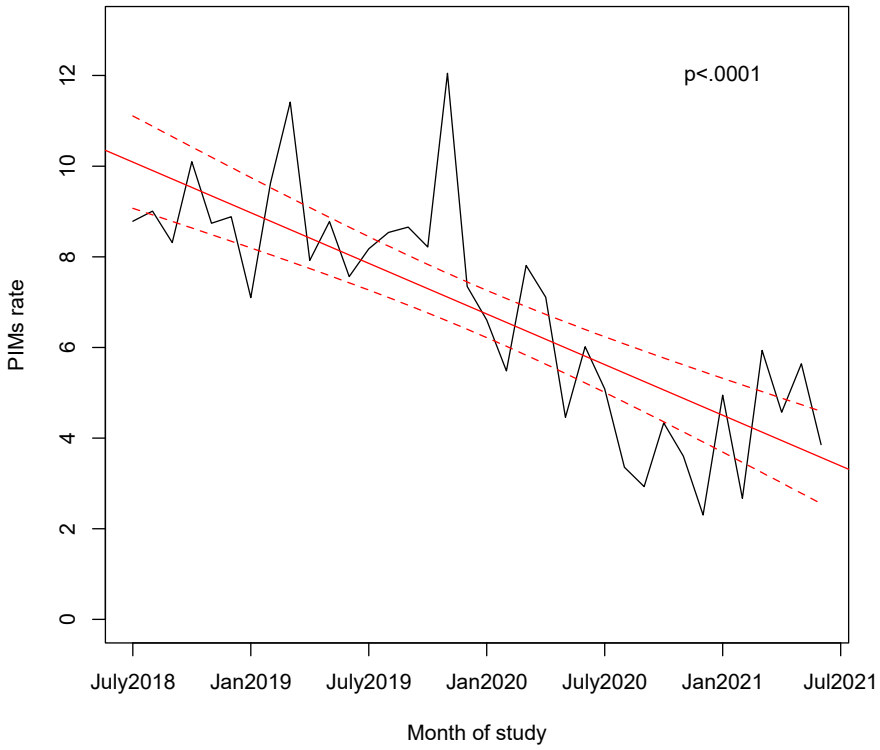

Figure 2: General Time Series Analyses of Trend PIM rate – Spread Site 1 (Poisson distribution)

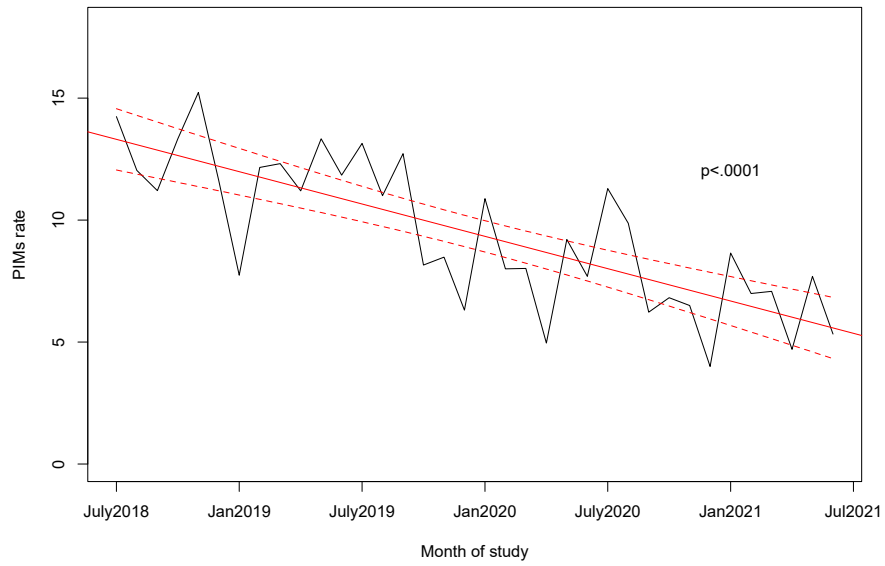

Figure 3: General Time Series Analyses of Trend PIM rate – Spread Site 2 (Poisson distribution)

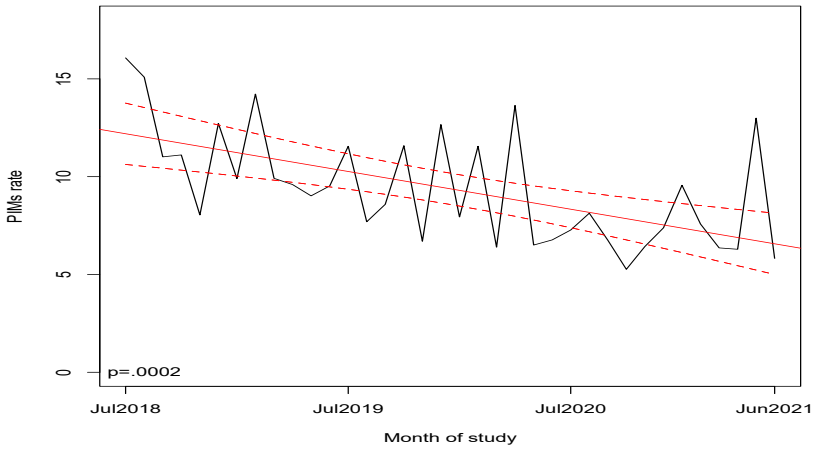

Figure 4: General Time Series Analyses of Trend PIM rate – Spread Site 3 (Poisson distribution)

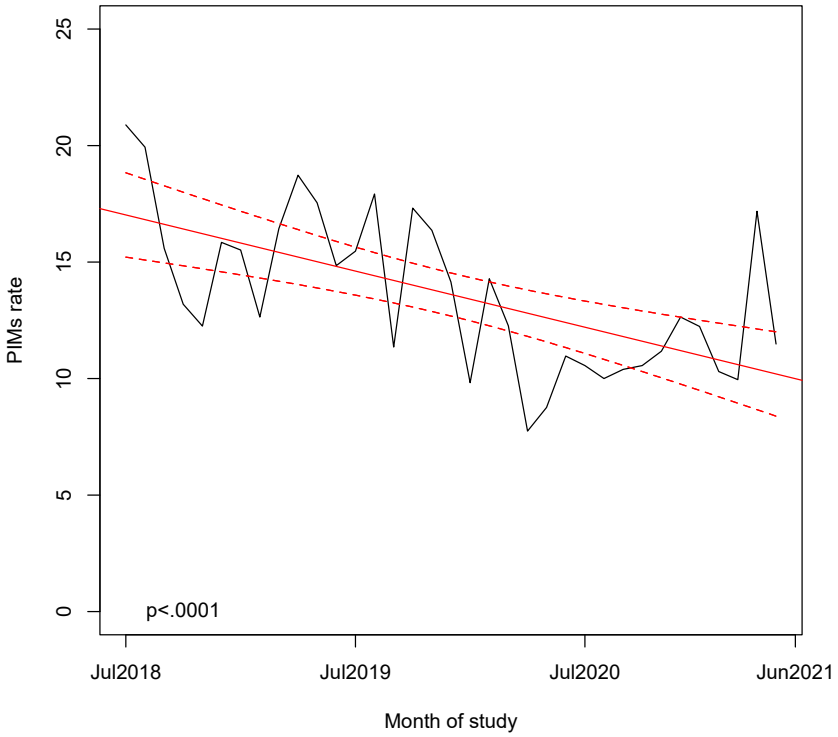

Table 3. Interrupted time series estimates (baseline vs. intervention vs. post-intervention) – Traditional site

Variable	Exponentiated estimate (95% CI)	P value
Time (Pre-trend)	0.996 (0.98- 1.01)	0.557
Level change after baseline	1.147 (.954,1.379)	0.1436
Trend change (during intervention period)	0.961 (.929,.993)	0.0166
Level change after intervention	0.631 (.456,.873)	0.0055
Trend change (during post intervention period)	1.066 (1.03,1.104)	.0003

Figure 5. Interrupted time series of baseline vs. intervention vs. post-intervention – Traditional site

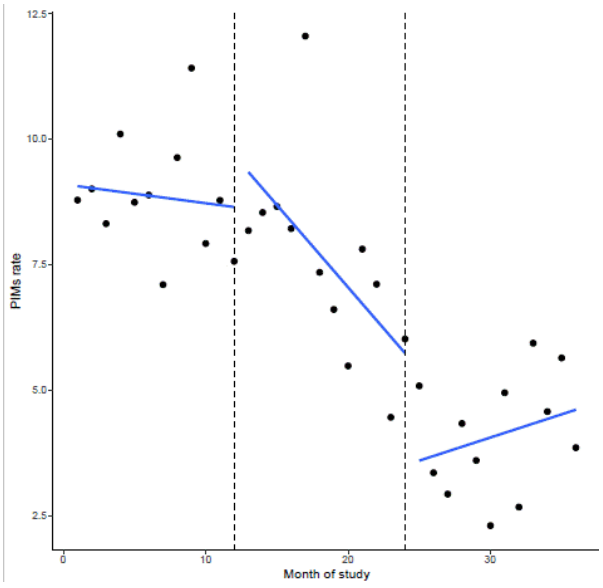

Table 4. Interrupted time series estimates (baseline vs. intervention vs. post-intervention) – Spread site 1

Variable	Exponentiated estimate (95% CI)	P value
Time (Pre-trend)	.991 (.973-1.009)	0.4777
Level change after baseline	1.08 (0.836- 1.405)	0.5386
Trend change (during intervention period)	.959 (0.919- 0.9998)	0.0496
Level change after intervention	1.36 (0.917- 2.0)	0.1254
Trend change (during post intervention period)	1.01 (0.958- 1.07)	0.7005

Figure 6. Interrupted time series of baseline vs. intervention vs. post-intervention – Spread site 1

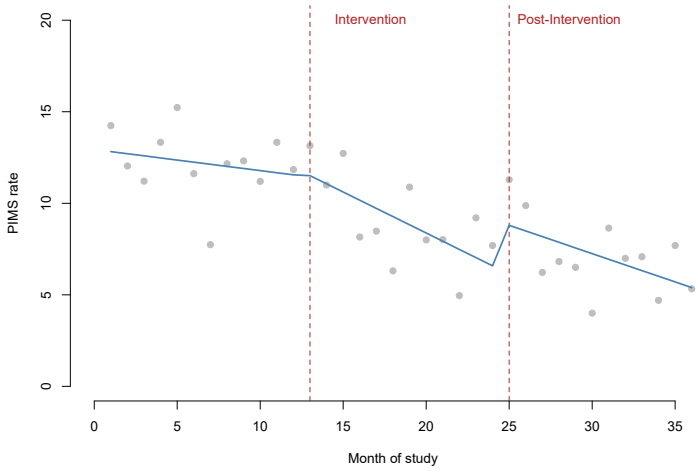

Table 5. Interrupted time series estimates (baseline vs. intervention vs. post-intervention) – Spread site 2

Variable	Exponentiated estimate (95% CI)	P value
Time (Pre-trend)	0.963 (0.950- 0.977)	<.0001
Level change after baseline	1.141 (1.009- 1.289)	0.0349
Trend change (during intervention period)	1.020 (0.997- 1.044)	0.0851
Level change after intervention	0.780 (0.657- 0.925)	0.0043
Trend change (during post intervention period)	1.036 (1.012- 1.060)	0.0028

Figure 7. Interrupted time series of baseline vs. intervention vs. post-intervention – Spread site 2

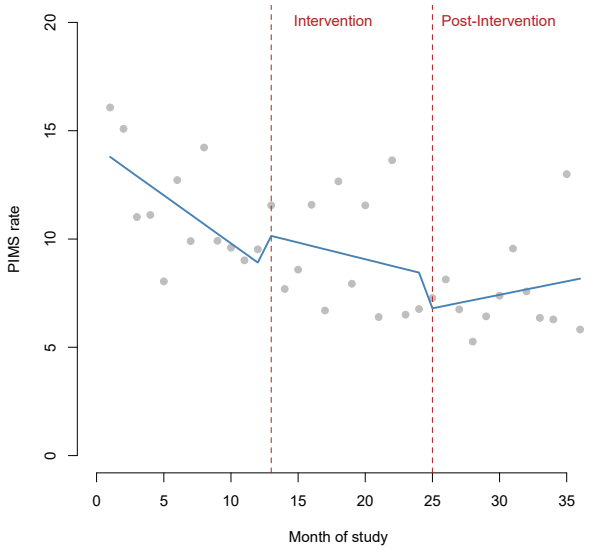

Table 6. Interrupted time series estimates (baseline vs. intervention vs. post-intervention) – Spread site 3

Variable	Exponentiated estimate (95% CI)	P value
Time (Pre-trend)	0.989 (0.966- 1.014)	0.38674
Level change after baseline	1.168 (0.908- 1.50)	0.22461
Trend change (during intervention period)	0.963 (0.926- 1.002)	0.06225
Level change after intervention	0.980 (0.680- 1.404)	0.91249
Trend change (during post intervention period)	1.079 (1.026- 1.134)	0.00309

Figure 8. Interrupted time series of baseline vs. intervention vs. post-intervention – Spread site 3

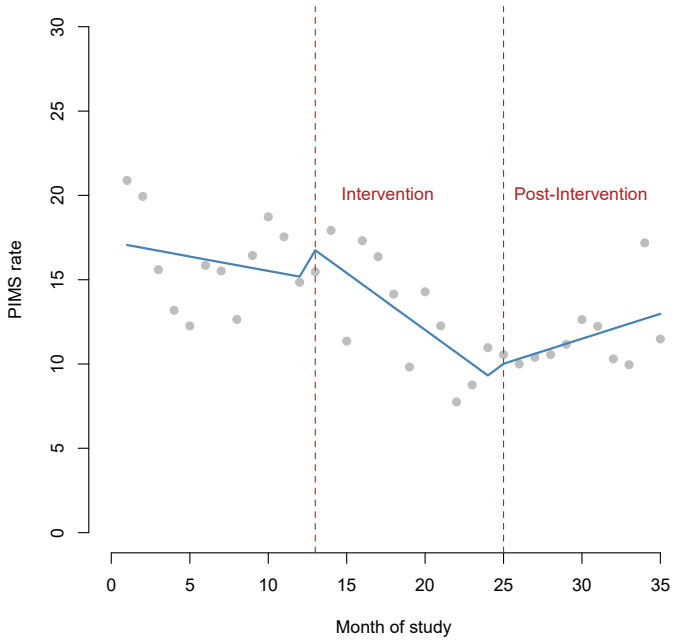

Table 7. Site prescriptions decline during the COVID-19 pandemic

Site	Baseline July 2018-June 2019	Intervention July 2019-June 2020	Post-Intervention July 2020-June 2021
Traditional – Site 1	5660	5272	3901
Spread – Site 1	4152	3692	2590
Spread – Site 2	2638	2507	1818
Spread – Site 3	3350	3003	2156

LIST OF PUBLICATIONS and PRODUCTS

Das S, Seitz R, Francois C, Leong T, Vaughan C, Vandenberg A. Association of ED provider order set usage with potentially inappropriate medications written during and after implementing a medication safety program. Journal of the American Geriatrics Society 2022;70(S1): S75-76. [Poster presentation at AGS Annual Scientific Meeting, May 2021, Orlando, FL, and abstract publication.]

Kegler MC, Rana S, Vandenberg AE, Hastings SN, Hwang U, Eucker SA, Vaughan CP. Use of the consolidated framework for implementation research in a mixed methods evaluation of the EQUIPPED medication safety program in four academic health system emergency departments. Front Health Serv 2022:2:1053489. doi: 10.3389/frhs.2022.1053489.

Kennedy, M., Hwang, U. and Han, J. H., Delirium in the Emergency Department: Moving From Tool-Based Research to System-Wide Change, J Am Geriatr Soc, 68 (5), 2020, 956-958

References

1. Gruneir A, Silver MJ, Rochon PA. Emergency department use by older adults: a literature review on trends, appropriateness, and consequences of unmet health care needs. *Med Care Res Rev* 2011; 68(2): 131-55.
2. Hustey FM, Wallis N, Miller J. Inappropriate prescribing in an older ED population. *Am J Emerg Med* 2007; 25(7): 804-7.
3. Gaddis GM, Holt TR, Woods M. Drug interactions in at-risk emergency department patients. *Acad Emerg Med* 2002; 9(11): 1162-7.
4. Hastings SN, Schmader KE, Sloane RJ, et al. Quality of pharmacotherapy and outcomes for older veterans discharged from the emergency department. *J Am Geriatr Soc* 2008; 56(5): 875-80.
5. Beers MH, Storrie M, Lee G. Potential adverse drug interactions in the emergency room. An issue in the quality of care. *Ann Intern Med* 1990; 112(1): 61-4.
6. Chin MH, Wang LC, Jin L, et al. Appropriateness of medication selection for older persons in an urban academic emergency department. *Acad Emerg Med* 1999; 6(12): 1232-42.
7. Nixdorff N, Hustey FM, Brady AK, Vaji K, Leonard M, Messinger-Rapport BJ. Potentially inappropriate medications and adverse drug effects in elders in the ED. *Am J Emerg Med* 2008; 26(6): 697-700.
8. Hastings SN, Sloane RJ, Goldberg KC, Oddone EZ, Schmader KE. The quality of pharmacotherapy in older veterans discharged from the emergency department or urgent care clinic. *J Am Geriatr Soc* 2007; 55(9): 1339-48.
9. Wilber ST, Gerson LW, Terrell KM, et al. Geriatric emergency medicine and the 2006 Institute of Medicine reports from the Committee on the Future of Emergency Care in the U.S. health system. *Acad Emerg Med* 2006; 13(12): 1345-51.
10. Carpenter CR. Emergency physician geriatric education: an update of the 1992 Geriatric Task Force Survey. Has anything changed? *Annals of Emergency Medicine* 2008; 52(4, Supplement): S156.
11. M MR. Geriatric emergency medicine: A survey of practicing emergency physicians. *Annals of Emergency Medicine* 1992; 21(7): 796-801.
12. Hogan TM, Losman ED, Carpenter CR, et al. Development of geriatric competencies for emergency medicine residents using an expert consensus process. *Acad Emerg Med* 2010; 17(3): 316-24.
13. Fineberg HV. Retooling for an aging America. *Medscape J Med* 2008; 10(8): 188.
14. Hwang U, Morrison RS. The geriatric emergency department. *J Am Geriatr Soc* 2007; 55(11): 1873-6.
15. Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. *J Am Med Inform Assoc* 2006; 13(5): 547-56.
16. Handler JA, Feied CF, Coonan K, et al. Computerized physician order entry and online decision support. *Acad Emerg Med* 2004; 11(11): 1135-41.
17. Stevens MB, Hastings SN, Powers J, et al. Enhancing the Quality of Prescribing Practices for Older Veterans Discharged from the Emergency Department (EQUiPPED): Preliminary Results from Enhancing Quality of Prescribing Practices for Older Veterans Discharged from the Emergency Department, a Novel Multicomponent Interdisciplinary Quality Improvement Initiative. *J Am Geriatr Soc* 2015; 63(5): 1025-9.

18. The American Geriatrics Society Beers Criteria Update Expert Panel. American Geriatrics Society 2019 updated Beers criteria for potentially inappropriate medication use in older adults. *J Am Geriatr Soc* 2019;67:674–94. doi: 10.1111/jgs.15767.
19. Stevens M, Hastings SN, Markland AD, et al. Enhancing Quality of Provider Practices for Older Adults in the Emergency Department (EQUiPPED). *J Am Geriatr Soc* 2017; 65(7): 1609-14. Vaughan CP, Hwang U, Vandenberg AE, Leong T, Wu D, Stevens MB, Clevenger C, Eucker S, Genes N, Huang W, Ikpe-Ekpo E, Nassisi D, Previl L, Rodriguez S, Sanon M, Schlientz D, Vigliotti D, Hastings NC. Early prescribing outcomes after exporting the EQUIPPED medication safety improvement programme. BMJ Open Quality 2021;10:e001369. doi:10.1136/bmjoq-2021-001369.
20. Vaughan Vaughan CP, Hwang U, Vandenberg AE, et al. Early prescribing outcomes after exporting the EQUIPPED medication safety improvement programme. BMJ Open Quality 2021;10:e001369. doi:10.1136/bmjoq-2021-001369\.
21. Vandenberg AE, Kegler M, Hastings SN, Hwang U, Wu D, Stevens MB, Cleavenger C, Eucker S, Genes N, Huang W, Ikpe-Ekpo E, Nassisi D, Previll L, Rodroguez S, Sanon M, Schlientz D, Vigliotti D, Vaughan CP. Sequential implementation of the EQUIPPED geriatric medication safety program as a learning health system. International Journal for Quality in Health Care, 2020, 470–476. doi: 10.1093/intqhc/mzaa077
22. Goldberg EM, Lin TR, Cunha CB, Mujahid N, Davoodi NM, Vaughan CP. Enhancing the quality of prescribing practices for older adults discharged from the emergency department in Rhode Island. Journal of the American Geriatrics Society 2022;1-10.
23. The Office of the National Coordinator for Health Information Technology. 2015 Edition market readiness for hospitals and clinicians. 2018. https://dashboard.healthit.gov/quickstats/pages/2015-edition-market-readiness-hospitals-clinicians.php (accessed October 6, 2022).
24. Fulmer T, Mate KS, Berman A. The Age-Friendly Health System Initiative. J Am Geriatr Soc 66:22–24, 2018.
25. Hwang U and Morrison RS. The Geriatric Emergency Department. J Am Geriatr Soc 55:1873–1876, 2007.
26. Shadyab AH, Castillo EM, Chan TC, Tolia VM. Developing and Implementing a Geriatric Emergency Department (GED): Overview and Characteristics of GED Visits. J Emerg Med 2021; 61:131-139.
27. Carpenter CR, Bromley M, Caterino JM, et al. Optimal Older Adult Emergency Care: Introducing Multidisciplinary Geriatric Emergency Department Guidelines from the American College of Emergency Physicians, American Geriatrics Society, Emergency Nurses Association, and Society for Academic Emergency Medicine. *J Am Geriatr Soc.* 2014;62(7):1360-1363.
28. McNamara RM, Rousseau E, Sanders AB. Geriatric emergency medicine: A survey of practicing emergency physicians. *Ann Emerg Med.* 1992;21(7):796-801.
29. Carpenter CR, Lewis LM, Caterino JM, Wilber ST, Scheatzle MD, Fiorello AB. Emergency Physician Geriatric Education: An Update of the 1992 Geriatric Task Force Survey. Has Anything Changed? (abstract). *Ann Emerg Med.* 2008;52(4, Supplement):S156.
30. Terrell KM, Perkins AJ, Dexter PR, Hui SL, Callahan CM, Miller DK. Computerized Decision Support to Reduce Potentially Inappropriate Prescribing to Older Emergency Department Patients: A Randomized, Controlled Trial. *J Am Geriatr Soc.* 2009;57(8):1388-1394.
31. Educational outreach visits: effects on professional practice and health care outcomes. 2007.
32. Kegler MC, Cleaver V, Kingsley B. The social context of experimenting with cigarettes: American Indian "start stories". *Am J Health Promot.* 2000;15(2):89-92.
33. Kegler MC, Bird S, Kyle-Moon K, S. R. Understanding teen pregnancy from the perspective of young adolescents in Oklahoma City. *Health Promot Pract.* 2001;2(3):242-254.
34. Kegler MC, McCormick L, Crawford M, Allen P, Spigner C, Ureda J. An exploration of family influences on smoking among ethnically diverse adolescents. *Health Educ Behav.* 2002;29(4):473-490.
35. Kegler MC, Young KH, Marshall L, Bui D, Rodine S. Positive youth development linked with prevention in a Vietnamese American community: Successes, challenges, and lessons learned. *J Adolesc Health.* 2005;37(3, Supplement):S69-S79.

36. Kegler MC, Norton BL, Aronson R. Achieving organizational change: findings from case studies of 20 California healthy cities and communities coalitions. *Health Promot Int.* 2008;23(2):109-118.
37. Kegler MC, Rigler J, Honeycutt S. How does community context influence coalitions in the formation stage? a multiple case study based on the Community Coalition Action Theory. *BMC Public Health.* 2010;10:90-100.
38. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci.* 2009;4:50-64.
39. Fernández ME, Melvin CL, Leeman J, et al. The Cancer Prevention and Control Research Network: an interactive systems approach to advancing cancer control implementation research and practice. *Cancer Epidemiol Biomarkers Prev.* 2014;23(11):2512-2521.