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# Enhancing a Geriatric Emergency Department Care Coordination Intervention Using Automated Health Information Exchange-Based Clinical Event Notifications

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## Abstract

**Purpose:** In a health care system where patients often have numerous providers and multiple chronic medical conditions, interoperability of health information technology (HIT) is of paramount importance. Regional health information organizations (RHIO) often provide a health information exchange (HIE) as a solution, which gives stakeholders access to clinical data that they otherwise would not otherwise have. A secondary use of preexisting HIE infrastructure is clinical event notification (CEN) services, which send automated notifications to stakeholders. This paper describes the development and implementation of a CEN service enabled by a RHIO in the New York metropolitan area to improve care coordination for patients enrolled in a geriatric emergency department care coordination program.

**Innovation:** This operational CEN system incorporates several innovations that to our knowledge have not been implemented previously. They include the near real-time notifications and the delivery of notifications via multiple pathways: electronic health record (EHR) “in-baskets,” email, text message to internet protocol-based “zone” phones, and automated encounter entry into the EHR. Based on these alerts the geriatric care coordination team contacts the facility where the patient is being seen and offers additional information or assistance with disposition planning with the goal of decreasing potentially avoidable admissions and duplicate testing.

**Findings:** During the nearly one-year study period, the CEN program enrolled 5722 patients and sent 497 unique notifications regarding 206 patients. Of these notifications, 219 (44%) were for emergency department (ED) visits; 121 (55%) of those notifications were received during normal business hours when the care coordination team was available to contact the ED where the patient was receiving care. Hospital admissions resulted from 45% of ED visits 17.8% of these admissions lasted 48 hours or less, suggesting some might potentially be avoidable.

**Conclusions and Discussion:** This study demonstrates the potential of CEN systems to improve care coordination by notifying providers of the occurrence of specific events. Although it could not directly be demonstrated here, we believe that widespread use of CEN systems have potential to reduce potentially avoidable admissions and duplicate testing, likely leading to decreased costs.

## Acknowledgements

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## Keywords

care coordination, health information exchange, notifications

## Disciplines

Emergency Medicine | Geriatrics | Health Information Technology

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## Introduction

Health information technology (HIT) has the potential to transform healthcare delivery by improving efficiency, safety and quality of care.<sup>1</sup> However, a key requisite for HIT to deliver on this promise is its ability to electronically exchange and use health data across vendor platforms and institutional boundaries through interoperability. Interoperability is important because many patients, especially those with chronic diseases and multiple comorbidities, may receive care from multiple providers, including primary care physicians, specialty physicians, home care providers and others.<sup>2</sup> Inadequate care coordination among these providers has been

identified as a source of duplicate testing and medical errors.<sup>2</sup> Therefore, interoperable HIT systems are likely to improve care for these patients by providing clinicians and other stakeholders with up-to-date patient information from across the spectrum of care.<sup>3</sup> For example, when a patient presents to the emergency department (ED) of a hospital not affiliated with any of the patient's providers, an interoperable HIT system would allow that hospital to have immediate access to the patient's medical records, recent laboratory tests, radiology reports, and a medication list, even if the patient were unaccompanied or could not provide details of his or her personal medical history. Furthermore, physician use of these systems decreases single day admissions and seven-day readmissions.<sup>4</sup>

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Regional health information organizations (RHIO) provide a governance structure to enable building health information exchange (HIE) networks by otherwise competing provider organizations. These HIE networks aggregate clinical data from multiple organizations, making it available to stakeholders in a given geographic region. RHIOs now provide, often for the first time in their region, real-time community-wide clinical data that may more accurately reflect the way in which patients access healthcare across multiple provider organizations.<sup>5</sup> Initial research suggests that RHIOs create cost savings by reducing potentially avoidable admissions, and duplicate tests and procedures.<sup>6-8</sup>

Clinical event notification (CEN) services are a logical next step toward fully utilizing the potential of HIE.<sup>9-11</sup> These notifications can be implemented in many ways, but in their most generic form will notify a given recipient (e.g., a provider) when a predetermined set of conditions occurs (i.e., an event) for a specific patient or group of patients. One example is to notify a care manager or primary care provider (PCP) anytime one of his or her patients visits an ED anywhere across the HIE. In this scenario, ideally, the notifications would arrive in real-time so the recipient can contact the provider at the other institution and offer assistance by providing additional clinical information or assisting with disposition planning. This kind of CEN-empowered care coordination could then help reduce some potentially avoidable admissions and unnecessary duplicate testing. In one study of such a system, PCPs who received notifications regarding their patient's presentation to an ED felt that the notifications provided useful information they may not have received otherwise.<sup>12</sup> The importance of this type of notification service and information sharing is further emphasized in geriatric populations where patients are more likely to have polypharmacy, and functional and cognitive impairments such as dementia—the latter with potential to limit a patient's ability to provide practitioners with a detailed medical history.<sup>13</sup>

This type of notification service works best when a majority of providers in a given region who participate in a patient's care also participate in HIE. Inevitably, HIE-based notifications increase provider-to-provider interactions. For instance, in the example given above, PCPs or care managers may contact the ED physician to provide additional clinical information and assist with arranging outpatient follow-up if the patient is discharged. Increasing these types of interactions may create a greater atmosphere of community participation by spurring on a more patient-centered focus through the coordination of care across traditional institutional boundaries.

This paper describes the design, development, and infrastructure behind the clinical event detection and notification service developed by Healthix, a RHIO in the New York metropolitan area, to help empower a geriatric emergency department care coordination intervention. The paper also presents preliminary data on the use of this system.

## Background

### The Healthix Regional Health Information Organization

Despite the generally agreed upon advantages of HIT interoperability, the US healthcare system has been slow to achieve true interoperability among HIT systems. The Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 provides "meaningful use" (MU) incentives for hospitals that implement electronic health record (EHR) systems, and has helped spur growth of EHRs. Stage one of MU provides incentives for providers to implement EHRs, but does not focus on interoperability. As of May 2014 the Office of the National Coordination of Health Information Technology (ONC) reported that greater than 90% of hospitals received payment for reaching federal stage 1 MU requirements. Although currently only 6 in 10 hospitals report the ability to share health information with outside providers,<sup>14</sup> interoperability requirements will likely increase as providers progress through stages 2 and 3 of MU over the next few years and these capabilities will certainly increase.

New York State was one of the first to pursue development of HIE in 2004 with passage of the Health Care Efficiency and Affordability Law for New Yorkers (HEAL-NY). The law provided funding for the development of multiple RHIOs across the state,<sup>15,16</sup> including Healthix, which comprises healthcare organizations across the New York metropolitan area and Long Island. Numerous major medical centers, ambulatory practices, long-term care facilities, home health agencies and others participate in the exchange. Healthix included a total of 107 organizations with 383 facilities, 9.2 million patients, and more than 6,500 users performing more than 10,000 patient searches per month as of January 2014.

The Healthix platform uses a federated architecture for data sharing that includes a network of "edge servers" that store clinical data, and a centralized hub that contains patient demographic information. The edge servers may be kept at individual sites behind their own firewalls or in a commercial data center, and contain encounter information, diagnoses, allergies, vital signs, immunizations, lab results, reports (radiology, pathology, cardiology, endoscopy, EKG), medications, discharge summaries and other forms of clinical data. The hub contains a master patient index (MPI) that receives real-time demographic data from the sites via standard Health level 7 (HL7) V2.x interfaces, performs a probabilistic match to determine which other sites an individual patient has visited, and then uses a record locator service to point to the clinical data on the sites' edge servers.<sup>17</sup> All data between the hub and edge servers are transmitted using standard virtual private network (VPN) encryption technology. Authorized users view individual patient data by logging in via a stand-alone web portal.

### The GEDI WISE Care Coordination Program

The GEDI WISE program is designed to address the specific needs of older adults in the ED. It is funded through a \$12.7 million innovations award from the Center for Medicare and Medicaid Services (1C1CMS331055-01-00).<sup>18</sup> An aging population has challenged EDs across the country with the complex task of providing care to an increasing number of older adult patients who have specific needs that may vary from those of the general ED patient population. Geriatric patients often suffer from multiple comorbidities, take numerous medications, and may have functional or cognitive impairments that introduce complexities to their care in a traditional ED, where the primary goal is the rapid triage, evaluation and treatment of acute medical conditions.<sup>13,19,20</sup>

GEDI WISE takes an integrated approach to improving care for geriatric patients via ED facility design, workforce education, and multidisciplinary care.<sup>21</sup> The structural enhancements include a dedicated geriatric ED with non-slip, non-glare floors and ambulation-assist handrails to decrease risk of falls; diurnal lighting and noise reduction rooms to decrease risk of delirium; and thicker mattress pads to decrease risk of pressure ulcers. The workforce education and training program focuses on the needs of geriatric patients with an interdisciplinary, geriatric-centered, ED-based approach. Teams are composed of geriatric ED physicians, transitional care nurse practitioners (NP), social workers, Geriatric ED pharmacists, physical therapists, and CARE (Care And Respect for Elders) volunteers, who provide supportive assistance to geriatric ED patients.<sup>22</sup> One of the major components of the informatics intervention is the implementation of a CEN service.

Implementation of the CEN system for the GEDI WISE program began in January 2013 and patient enrollment and notifications began in March 2013. GEDI WISE patients can be enrolled in the CEN program in several ways. Patients aged 65 years or older who are triaged to a bed in the Geriatric ED are added to the CEN program list. Alternatively, geriatric patients triaged to another physical area of the ED are enrolled if a social worker, transitional care NP, geriatric ED pharmacist or geriatric physical therapist signs a note on that patient's chart, or if the GEDI WISE transitional care NP assigns herself to the patient's treatment team. Each of these events initiates a series of automated CEN enrollment steps: 1) patients are flagged in the Mount Sinai EHR, 2) the Mount Sinai EHR runs a report every 24 hours to generate a list of currently active GEDI WISE program patients, 3) this list is sent to Healthix twice daily via an HL7 interface, and 4) Healthix enrolls all patients on the list for CEN services, over-

writing the list from the day prior so new patients are added and any patients who have had the GEDI WISE program flag removed in the Mount Sinai EHR are disenrolled. Once Healthix enrolls participants in the CEN program, the system generates automatic electronic notifications when it detects the occurrence of one of the predetermined events (described in more detail below).

### The Clinical Event Notification (CEN) Intervention

Generically, CEN services are designed to recognize the occurrence of specific, predetermined events when they occur within a specific population of patients, and send notifications to the appropriate subscribers.<sup>9,11</sup> This process can be described by a framework containing five elements: 1) a subscription (e.g., all patients enrolled in the GEDI WISE intervention), 2) trigger events (e.g., ED visits), 3) the payload (e.g., the content of the actual notification, which may include patient demographics, encounter site, date and type, and additional clinical information), 4) the delivery mechanism (e.g., email, EHR, etc.), and 5) the recipient (e.g., the PCP).

CEN services have been described elsewhere, including notifications sent to the PCPs at a federally qualified health center (FQHC) through their EHR; notifications sent to the home care agency call center so the agency could appropriately cancel a previously scheduled visit if the patient was hospitalized or schedule a new visit if the patient was discharged; notifications sent to a Medicaid special need plan (SNP) to improve coordination of care for patients living with HIV and AIDS; and notifications sent to an accountable care organization (ACO) regarding members of their attributed population.<sup>9,11</sup>

The CEN service developed for the GEDI WISE program is similar to those described above, but with some important innovations. These include the near real-time delivery of notifications and a method for alerting multiple stakeholders across several platforms. Notifications alert team members of the occurrence of any one of three event types occurring at any hospital participating in the RHIO: 1) the arrival of a GEDI WISE patient to another ED, 2) admission to another hospital, and 3) discharge from another hospital. These notifications allow recipients the opportunity to contact providers at the other hospital or the patients themselves after hospital discharge to improve care coordination. These three events were selected because they are situations with maximal opportunity for improving subsequent care of the patient and because they were readily discernible using encounter data already in the HIE.

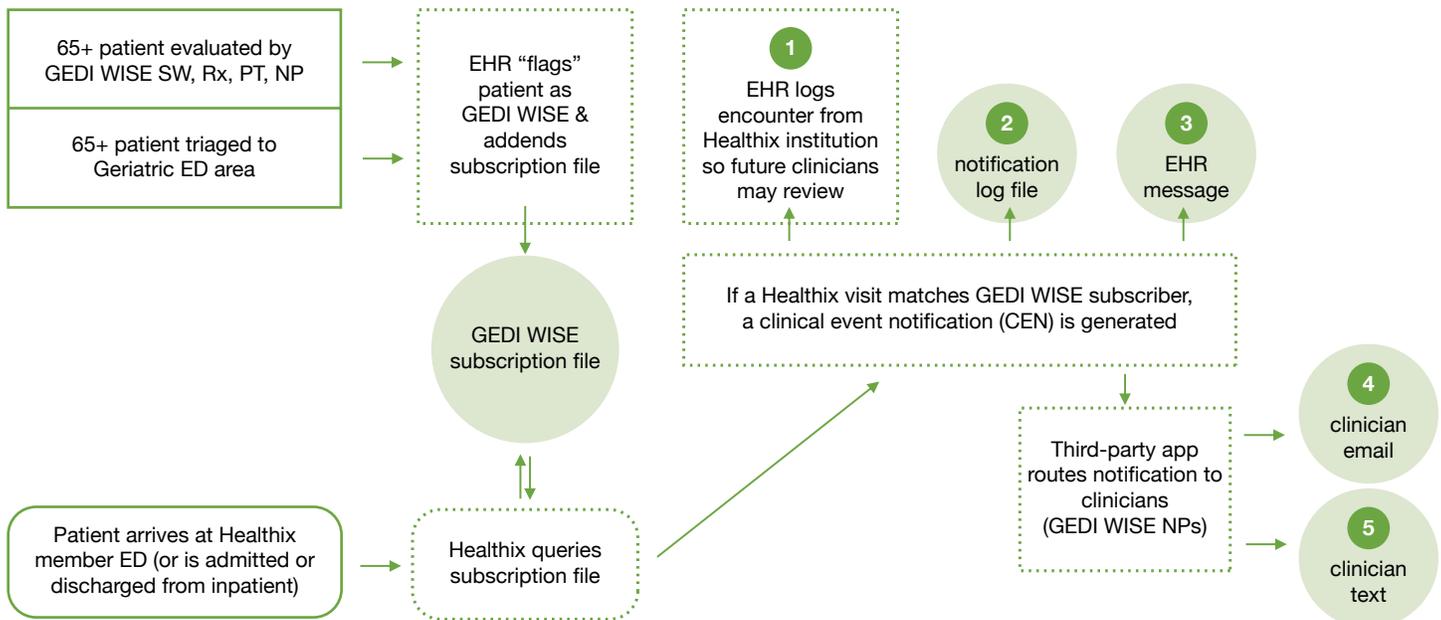
When one of these events is detected for a patient on the subscription list, a notification is sent via a standard HL7 v2.x message. When this message arrives at the hospital, it is securely forwarded via five different methods (see Figure 1): 1) an encounter is created in the EHR so providers outside of the GEDI WISE team can view the event and 2) notifications are written to a data file on a secure server for analytics. Additionally, GEDI WISE team members are notified via 3) their EHR “in-baskets,” 4) email, and 5) text messages to their internet protocol “zone” phones (see Figure 2 for images of the EHR encounter, email and text message notifications).

The first ten months of the implementation was considered a pilot, as bugs were worked out, latency issues addressed (latency is the time lag between an event and the actual receipt of a notification), and workflow for the GEDI WISE transitional NPs was optimized. Descriptive statistics were regularly run during the first year of implementation to monitor and optimize the program. These data are presented below in the findings section.

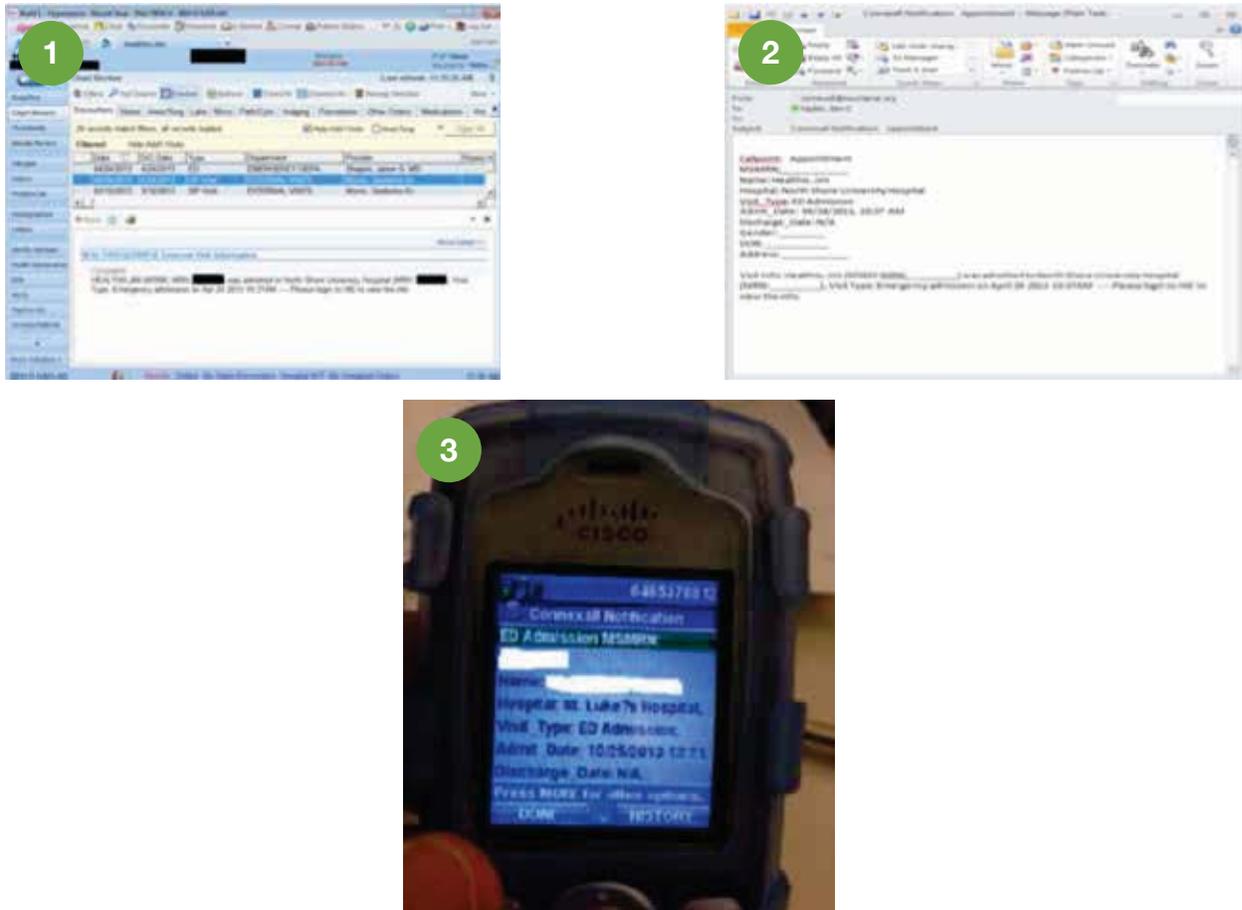
### Workflow for Handling CENs

ED notifications are the most time sensitive because they represent an opportunity to reduce potentially avoidable admissions. When a notification of this type is received during regular working hours (8:30 a.m. to 8:15 p.m. weekdays, and 10:30 a.m. to 8 p.m. on weekends), one of the two GEDI WISE transitional care NPs contacts the ED where the patient is being seen, usually within an hour of receipt, to offer additional information and provide assistance. This may be as simple as informing the provider of the patient’s well-structured outpatient support, or may include faxing copies of diagnostic reports, arranging for home care or arranging outpatient follow-up the next day. After contacting that ED, the NP sends an email to the GEDI WISE team informing it of the outcome of that discussion.

**Figure 1. Clinical Event Notification (CEN) Flowchart**



Patient care events at Mount Sinai automatically trigger enrollment in the GEDI WISE program (upper left) and lead to the adding of the patient to the GEDI WISE subscription file. When future patient activity occurs at a Healthix institution (lower left) the patient’s details are checked against the subscription file and if a match occurs, a notification is generated and routed across five systems: 1) an encounter is created in the Mount Sinai EHR so providers outside of GEDI WISE can view the event, 2) the notification is written to a data file for analytics, 3) GEDI WISE recipients receive the notification in their EHR “in-basket”, 4) email, and 5) a text message to their internet protocol-based “zone” phone.

**Figure 2. Examples of CEN**


Notes: 1) EHR, as an "external visit" encounter within the patient's chart; 2) An email to a clinician; 3) A secure clinical phone message via a third-party application.

Because notifications regarding a hospital admission are less time sensitive, an administrative member of the GEDI WISE team contacts that hospital to obtain contact information for the inpatient provider. This allows the GEDI WISE transitional NP to contact that provider at some point during the inpatient stay and offer additional information that could assist in the treatment or disposition of that patient.

Notifications regarding inpatient discharge are also less time sensitive. When these notifications are received, the GEDI WISE transitional NP is able to place a follow-up call to patients within a few days of discharge to check on the patient and ensure that appropriate appointments have been made, medications prescribed and services put in place to prevent hospital readmission.

## Findings

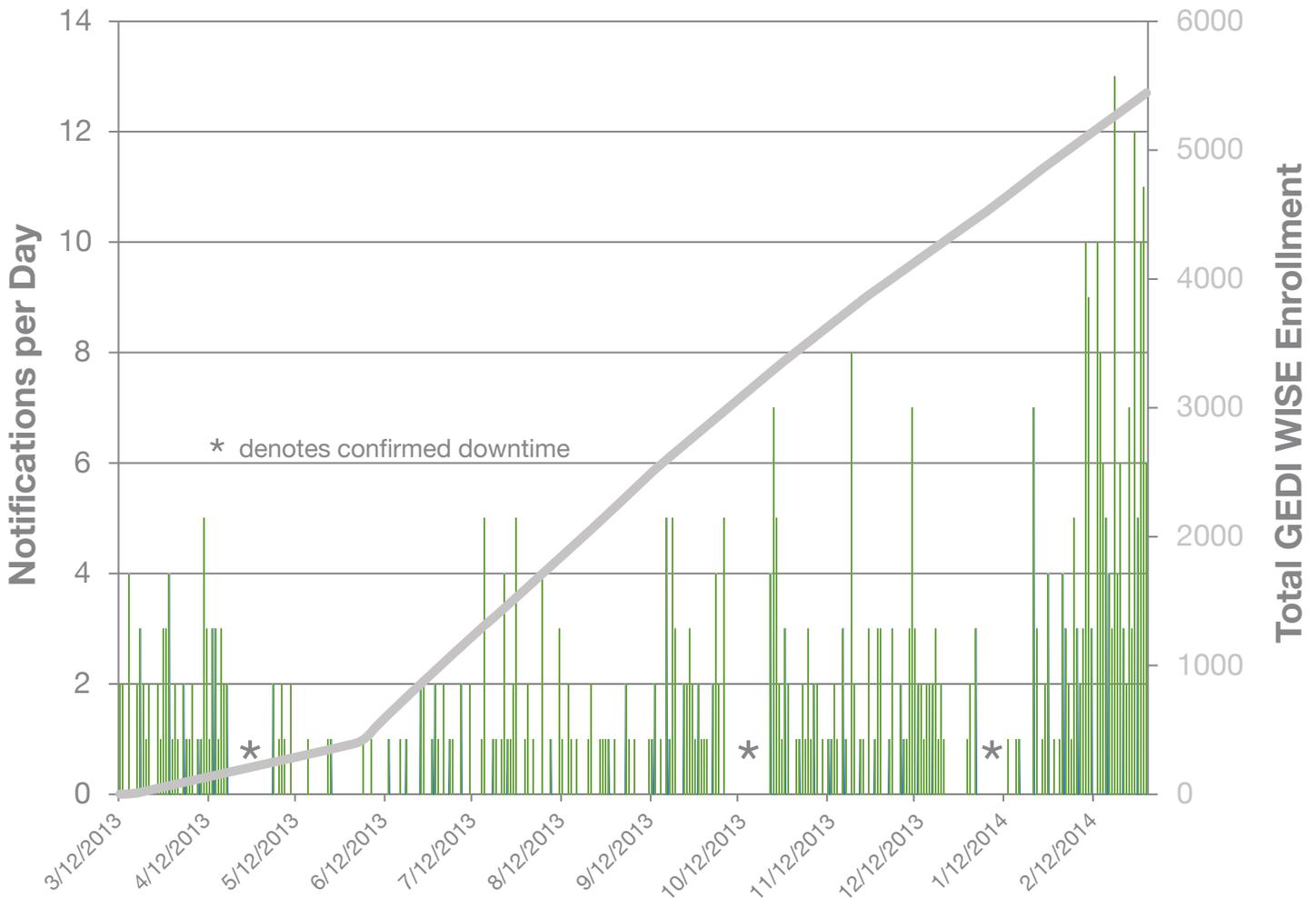
### General Descriptive Statistics

The CEN program went into effect on March 11, 2013. Between that date and March 2, 2014, the CEN program enrolled 5722 patients and 612 notifications were sent to the GEDI WISE team. During this initial period, there were numerous downtimes as the CEN implementation was continuously improved (Figure 3).

After removing duplicate messages, 497 event notifications were received regarding 206 unique patients. Notifications originated from 23 separate institutions, though eight facilities accounted for 85% of the ED notifications. ED visits comprised 219 (44%) of the notifications, and 98 notifications were for inpatient admissions, yielding a 45% admit rate for GEDI WISE participants presenting to the ED of other hospitals. Based on the timing of inpatient admission and discharge notifications, the median admission lasted 5 days and 11 hours, with 17.8% of admissions lasting 48 hours or less.

The following data are presented to establish a baseline and provide some context regarding inpatient admissions across Healthix and ED visits and admissions at Mount Sinai. According to the New York State Department of Health, among the 23 hospitals that sent notifications, inpatient discharges ranged from 8,612 to 53,183 per year in 2011, and among the top eight hospitals the range was from 24,467 to 53,183 inpatient discharges.<sup>23</sup> Within the Mount Sinai ED itself, there were 96,844 total ED visits between March 11, 2013 and March 2, 2014, with an admission rate of 21.4%. Among the 65 and older population, there were 17,328 ED visits with an admission rate of 46.1%.

**Figure 3. Clinical Event Notifications Per Day (Left Axis) and Total GEDI Wise Enrollment (Right Axis, Gray) Over the Study Period**



### Timeliness of Notifications

During GEDI WISE transitional care NP working hours (between 8:30 a.m. and 8:15 p.m. on weekdays, and 10:30 a.m. to 8 p.m. on weekends), 121 (55%) notifications regarding ED presentations were received. Notifications received after hours were addressed the following morning.

In addition, over the course of the nearly one-year study period, 70% of notifications were received within one hour of the event, 73% within two hours and 90% occurred within 12 hours of event occurrence. Many of the latency issues have since been addressed, with a separate analysis of data from March 2014 showing that 71% of notifications were received within 15 minutes of the event, 84% within one hour and 90% within 2 hours. Most of the remaining latency during that month was accounted for by four consecutive notifications received from a single site during a 24-hour period; this was caused by a problem with their edge server, which was quickly addressed. When these outliers are removed, 95% of notifications arrived within one hour during March 2014.

### System Downtime

During this initial period, there were numerous downtimes as the CEN implementation was continuously improved (Figure 3), and CEN service was unavailable for approximately 30 days total. Despite these initial issues, at least three admissions were averted during the study period, where the ED provider at the other institution confirmed for the GEDI WISE transitional care NP that he or she would have admitted the patient if it were not for this intervention.

### Limitations

This study has some important limitations. For one, there were numerous system downtimes during the first year of implementation, and notification latency — especially for ED notifications — limited the opportunity for intervention by the transitional care NPs. The system only began to operate in a stable manner with minimal downtimes in February 2014, giving a rather limited window during which potentially avoidable admissions could have been actually avoided. Additionally, the workflow for call-

backs by the GEDI WISE team was only standardized in the final months of the study period, and call-backs for ED notifications are still only taking place during normal business hours, likely leading to lost opportunities to avert some admissions. The GEDI WISE team has recently hired a third NP, and there are plans to develop an on-call schedule to allow extended hours for call-backs. Future evaluation after expansion of the call-back hours would likely lead to more notifications that could be acted upon and a higher number of avoided admissions. Finally, not all hospitals in the region are part of the Healthix RHIO. Further consolidation of the RHIOs into a platform that allows cross RHIO CEN is currently underway through Healthix.

## Discussion

The US healthcare system has the advantage of offering care from numerous types of providers and in many locations—from independent outpatient clinics and testing centers to new retail clinics to large medical centers and at home from specialized agencies. However, this variety has also led to fragmentation of care delivery and made it more difficult to ensure continuity of care. Interoperable EHRs and HIE offer a solution to this problem by giving providers at multiple sites access to patient clinical data. The GEDI WISE CEN system via the Healthix HIE takes this access to the next logical step by not only providing access to patient records via a web-based clinical portal, but also by notifying providers—in real-time—when patients present for care at other institutions.

Despite the limitations mentioned above, this study demonstrates the potential of CEN systems to improve care coordination by alerting providers to the occurrence of specific events. Although it could not directly be demonstrated here, we believe that widespread use of CEN systems has the potential to decrease avoidable admissions, testing and procedures, and thereby decrease costs. The 17.8% of admissions detected through the CEN that had lengths of stay less than 48 hours may represent a particular subgroup of patients more likely amenable to outpatient care or short observation stays rather than hospital admissions. Although current data collection methods did not allow for subgroup analyses, this is an area that will be investigated further.

This study focuses on the use of a CEN system for a geriatric care coordination program; however, it could easily be applied to a wider population of patients through numerous other programs, which are increasing in number under various payment reform models. These programs may include ACOs, Medicaid-funded health homes, case management programs focusing on reducing recidivism by frequent ED users, and interventions focused on decreasing 30-day hospital readmissions.

This study is descriptive in nature and begins to define how CEN services might be used more broadly but the analyses presented in this paper are limited and based on data collected periodically during the first year of implementation for operations purposes. Additional studies are needed to further evaluate the CEN, including an evaluation of the impact of NP workflow, including expanded call hours, on outcomes. Also, further investigation of

the subgroup of patients with hospital admissions from the ED lasting less than 48 hours may help better define this subgroup and allow us to better target interventions to prevent potentially avoidable admissions.

Additionally, there is hope to continue the GEDI WISE CEN program beyond the duration of the current federal funding. GEDI WISE program leadership is exploring additional funding mechanisms and the possibility for institutional support to continue salary lines for the transitional care NPs. The ongoing operational costs for the CEN itself are minimal and other state- and federally-funded care coordination programs at the institution, including an ACO, and a Health Home, plan to also use the CEN in the near future.

Because many RHIOs have already built the infrastructure and are accumulating the data needed to implement a CEN system, there is great potential for new, innovative CEN-based programs and further research. Future studies should focus on the use of notification systems in other populations, and on trying to quantify the impact on resource utilization, cost, quality and safety.

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