Improving Hospital Metrics Through the Implementation of a Comorbidity Capture Tool and Other Quality Initiatives

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ABSTRACT

Background: Case mix index (CMI) and expected mortality are determined based on comorbidities. Improving documentation and coding can impact performance indicators. During and prior to 2018, our patient acuity was under-represented, with low expected mortality and CMI. Those metrics motivated our quality team to develop the quality initiatives reported here.

Objectives: We sought to assess the impact of quality initiatives on number of comorbidities, diagnoses, CMI, and expected mortality at the University of Miami Health System.

Design: We conducted an observational study of a series of quality initiatives: (1) education of clinical documentation specialists (CDS) to capture comorbidities (10/2019); (2) facilitating the process for physician query response (2/2020); (3) implementation of computer logic to capture electrolyte disturbances and renal dysfunction (8/2020); (4) development of a tool to capture Elixhauser comorbidities (11/2020); and (5) provider education and electronic health record reviews by the quality team.

Setting and participants: All admissions during 2019 and 2020 at University of Miami Health System. The health system includes 2 academic inpatient facilities, a 560-bed tertiary hospital, and a 40-bed cancer facility. Our hospital is 1 of the 11 PPS-Exempt Cancer Hospitals and is the South Florida's only NCI-Designated Cancer Center.

Measures: Number of coded diagnoses and Elixhauser comorbidities; CMI and expected mortality were compared between the pre-intervention and the intervention periods using t-tests and Chi-square test.

Results: There were 33 066 admissions during the study period—13 689 before the intervention and 19 377 during the intervention period. From pre-intervention to intervention, the mean (SD) number of comorbidities increased from 2.5 (1.7) to 3.1 (2.0) ($P < .0001$), diagnoses increased from 11.3 (7.3) to 18.5 (10.4) ($P < .0001$), CMI increased from 2.1 (1.9) to 2.4 (2.2) ($P < .0001$), and expected mortality increased from 1.8% (6.1) to 3.1% (9.2) ($P < .0001$).

Conclusion: The number of comorbidities, diagnoses, and CMI all improved, and expected mortality increased in the year of implementation of the quality initiatives.

Keywords: PS/QI, coding, case mix index, comorbidities, mortality.

Accurate documentation of the patient's clinical course during hospitalization is essential for patient care. To date, Diagnosis Related Groups (DRG) remain the standard for calculating health care system–level risk-adjusted outcomes data and are essential for institutional reputation (eg, *US News & World Report* rankings).[1,2] With an ever-increasing emphasis on pay-for-performance and value-based purchasing within the US health care system, there is a pressing need for

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institutions to accurately capture the complexity and acuity of the patients they care for.

Adoption of comprehensive electronic health record (EHR) systems by US hospitals, defined as an EHR capable of meeting all core meaningful-use metrics including evaluation and tracking of quality metrics, has been steadily increasing.[3,4] Many institutions have looked to EHR system transitions as an inflection point to expand clinical documentation improvement (CDI) efforts. Over the past several years, our institution, an academic medical center, has endeavored to fully transition to a comprehensive EHR system (Epic from Epic Systems Corporation). Part of the purpose of this transition was to help study and improve outcomes, reduce readmissions, improve quality of care, and meet performance indicators.

Prior to 2019, our hospital's patient acuity was low, with a CMI consistently below 2, ranging from 1.81 to 1.99, and an expected mortality consistently below 1.9%, ranging from 1.65% to 1.85%. Our concern that these values underestimated the real severity of illness of our patient population prompted the development of a quality improvement plan. In this report, we describe the processes we undertook to improve documentation and coding of comorbid illness, and report on the impact of these initiatives on performance indicators. We hypothesized that our initiatives would have a significant impact on our ability to capture patient complexity, and thus impact our CMI and expected mortality.

Methods

In the fall of 2019, we embarked on a multifaceted quality improvement project aimed at improving comorbidity capture for patients hospitalized at our institution. The health system includes 2 academic inpatient facilities, a 560-bed tertiary hospital and a 40-bed cancer facility. Since September 2017, we have used Epic as our EHR. In August 2019, we started working with Vizient Clinical Data Base[5] to allow benchmarking with peer institutions. We assessed the impact of this initiative with a pre/post study design.

Quality Initiatives

This quality improvement project consisted of a series of 5 targeted interventions coupled with continuous monitoring and education.

1. Comorbidity coding. In October 2019, we met with the clinical documentation specialists (CDS) and the coding team to educate them on the value of coding all comorbidities that have an impact on CMI and expected mortality, not only those that optimize the DRG.

2. Physician query. In October 2019, we modified the process for physician query response, allowing physicians to answer queries in the EHR through a reply tool incorporated into the query and accept answers in the body of the Epic message as an active part of the EHR.

3. EHR logic. In August 2020, we developed an EHR smart logic to automatically capture fluid and electrolyte disturbances and renal dysfunction, based on the most recent laboratory values. The logic automatically populated potentially appropriate diagnoses in the assessment and plan of provider notes, which require provider acknowledgment and which providers are able to modify (**eFigure 1** in online Supplement).

4. Comorbidity capture tool. In November 2020, we developed a standardized tool to allow providers to easily capture Elixhauser comorbidities (**eFigure 2** in online Supplement). The Elixhauser index is a method for measuring comorbidities based on *International Classification of Diseases, Ninth Revision, Clinical Modification* and *International Classification of Disease, Tenth Revision* diagnosis codes found in administrative data[1-6] and is used by *US News & World Report* and Vizient to assess comorbidity burden. Our tool automatically captures diagnoses recorded in previous documentation and allows providers to easily provide the management plan for each; this information is automatically pulled into the provider note.

The development of this tool used an existing functionality within the Epic EHR called SmartForms, SmartData Elements, and SmartLinks. The only cost of tool development was the time invested—124 hours inclusive of 4 hours of staff education. Specifically, a panel of experts (including physicians of different specialties, an analyst, and representatives from the quality office) met weekly for 30 minutes per week over 5 weeks to agree on specific clinical criteria and guide the EHR build analyst. Individual panel members confirmed and validated design requirements (in 15 hours over 5 weeks). Our senior clinical analyst II dedicated

80 hours to actual build time, 15 hours to design time, and 25 hours to tailor the function to our institution's workflow. This tool was introduced in November 2020; completion was optional at the time of hospital admission but mandatory at discharge to ensure compliance.

5. Quality team. The CDI functionality was transitioned to be under the direction of the institution's quality team/chief medical officer office. This was a paradigm shift for physician engagement. We started speaking and customizing queries and technology focusing on severity of illness and speaking "physician language." Providers received education on a regular basis, with scheduled meetings with departments and divisions, residents, and advanced practice providers, and on an individual basis as needed to fill gaps in knowledge about the documentation process or occasional requests. Last, extensive review of the medical record was conducted regularly by the quality team and physician champions. The focus of those reviews was on hospital-acquired conditions and patient safety indicators that were validated to ensure that the conditions were present on admission, or if the condition was not clearly documented, that the team request additional clarification by the provider when indicated. Mortality reviews were performed, with special focus on those with mortality well below expected, to ensure that all relevant and impactful codes were included.

Assessment of Quality Initiatives' Impact

Data on the number of comorbidities and performance indicators were obtained retrospectively. The data included all hospital admissions from 2019 and 2020 divided into 2 periods: pre-intervention from January 1, 2019 through September 30, 2019, and intervention from October 1, 2019 through December 31, 2020. The primary outcome of this observational study was the rate of comorbidity capture during the intervention period. Comorbidity capture was assessed using the Vizient Clinical Data Base (CDB) health care performance tool.[5] Vizient CDB uses the Agency for Healthcare Research and Quality Elixhauser index, which includes 29 of the initial 31 comorbidities described by Elixhauser,[6] as it combines hypertension with and without complications into one.

We secondarily aimed to examine the impact of the quality improvement initiatives on several institutional-level performance indicators, including total number of diagnoses, comorbidities or complications (CC), major comorbidities or complications (MCC), CMI, and expected mortality.

Case mix index is the average Medicare Severity-DRG (MS-DRG) weighted across all hospital discharges (appropriate to their discharge date). The expected mortality represents the average expected number of deaths based on diagnosed conditions, age, and gender within the same time frame, and it is based on coded diagnosis; we obtained the mortality index by dividing the observed mortality by the expected mortality. The Vizient CDB Mortality Risk Adjustment Model was used to assign an expected mortality (0%-100%) to each case based on factors such as demographics, admission type, diagnoses, and procedures.

Standard statistics were used to measure the outcomes. We used Excel to compare pre-intervention and intervention period characteristics and outcomes, using *t*-testing for continuous variables and Chi-square testing for categorial outcomes. *P* values <0.05 were considered statistically significant.

The study was reviewed by the institutional review board (IRB) of our institution (IRB ID: 20210070). The IRB determined that the proposed activity was not research involving human subjects, as defined by the Department of Health and Human Services and US Food and Drug Administration regulations, and that IRB review and approval by the organization were not required.

Results

The health system had a total of 33 066 admissions during the study period—13 689 pre-intervention (January 1, 2019 through September 30, 2019) and 19,377 during the intervention period (October 1, 2019 to December 31, 2020). Demographics were similar among the pre-intervention and intervention periods: mean age was 60 years and 61 years, 52% and 51% of patients were male, 72% and 71% were White, and 20% and 19% were Black, respectively (**Table 1**).

The multifaceted intervention resulted in a significant improvement in the primary outcome: mean comorbidity

Table 1. **Baseline Characteristics of Groups**

	Pre-intervention (n = 13 689)	Intervention (n = 19 377)
Age, mean (SD), y	60 (17)	61 (16)
Sex		
Male	7092 (52)	9861 (51)
Female	6597 (48)	9515 (49)
Race		
White	9878 (72)	13 769 (71)
Black	2744 (20)	3841 (19)
Asian	143 (1)	202 (1)
Other	278 (2)	395 (2)

All results are expressed as No. (%), except where noted.

capture increased from 2.5 (SD, 1.7) before the intervention to 3.1 (SD, 2.0) during the intervention ($P < .00001$). Secondary outcomes also improved. The mean number of secondary diagnoses for admissions increased from 11.3 (SD, 7.3) prior to the intervention to 18.5 (SD, 10.4) ($P < .00001$) during the intervention period. The mean CMI increased from 2.1 (SD, 1.9) to 2.4 (SD, 2.2) post intervention ($P < .00001$), an increase during the intervention period of 14%. The expected mortality increased from 1.8% (SD, 6.1%) to 3.1% (SD, 9.2%) after the intervention ($P < .00001$) (**Table 2**).

There was an overall observed improvement in percentage of discharges with documented CC and MCC for both surgical and medical specialties. Both CC and MCC increased for surgical specialties, from 54.4% to 68.5%, and for medical specialties, from 68.9% to 76.4%. (**Figure 1**). The diagnoses that were captured more consistently included deficiency anemia, obesity, diabetes with complications, fluid and electrolyte disorders and renal failure, hypertension, weight loss, depression, and hypothyroidism (**Figure 2**). A summary of the timeline of interventions overlaid with CMI and expected mortality is shown in **Figure 3**.

During the 9-month pre-intervention period (January 1 through September 30, 2019), there were 2795 queries, with an agreed volume of 1823; the agreement rate was 65% and the average provider turnaround time was 12.53 days. In the 15-month postintervention period, there were 10 216 queries, with an agreed volume of 6802 at 66%. We created a policy to encourage responses no later than 10 days after the query, and our average turnaround time decreased by more than 50% to 5.86 days. The average number of monthly queries increased by 55%, from an average of 311 monthly queries in the preintervention period to an average of 681 per month in the postintervention period. The more common queries that had an impact on CMI included sepsis, antineoplastic chemotherapy–induced pancytopenia, acute posthemorrhagic anemia, malnutrition, hyponatremia, and metabolic encephalopathy.

Discussion

The need for accurate documentation by physicians has been recognized for many years.[7] Patient acuity

Table 2. **Captured Outcomes Stratified by Time Period**

Metrics	Pre-intervention period Mean (SD)	Intervention period Mean (SD)	T statistic	P value
No. of comorbidities	2.5 (1.7)	3.1 (2.0)	29.6	<.00001
No. of diagnoses	11.3 (7.3)	18.5 (10.4)	74.6	<.00001
Case mix index	2.1 (1.9)	2.4 (2.2)	9.8	<.00001
Expected mortality, %	1.8 (6.1)	3.1 (9.2)	14.4	<.00001

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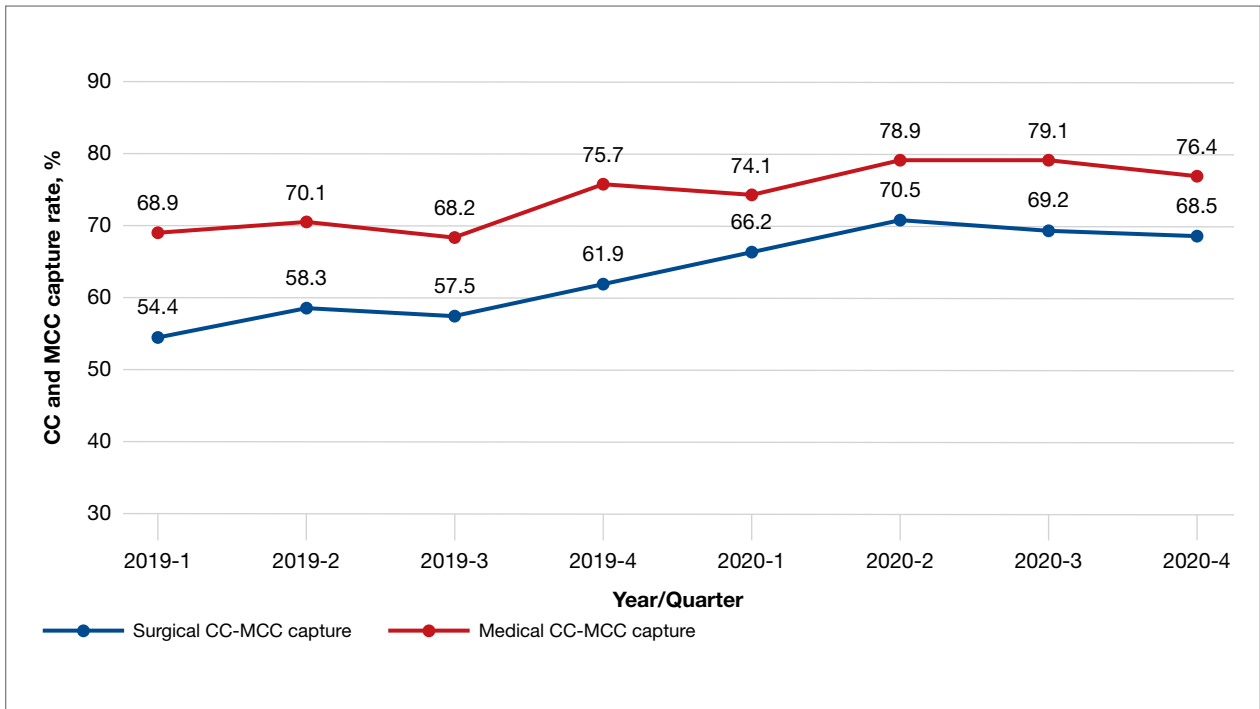
Figure 1. Capture of complication or comorbidity (CC) and major complication or comorbidity (MCC) for surgical and medical Diagnosis Related Groups over time. (Data from the Vizient Clinical Data Base used with permission of Vizient, Inc. All rights reserved.)

at our institution during 2018 and prior was under-represented, with low expected mortality and CMI. Those metrics motivated our quality team to develop the initiatives described here. We had previously sought to improve documentation and performance indicators at our institution through educational initiatives. These unpublished interventions included quarterly data review by departments and divisions with physician educational didactics. These educational initiatives are necessary but require considerable workforce time and are limited to the targeted subgroup. While education and engagement of providers are essential to enhance documentation and were an important part of our interventions, we felt that additional, more sustainable interventions were needed. Leveraging the EHR to facilitate physician documentation was key. All our interventions, including our tool to help capture fluid and electrolyte abnormalities and renal dysfunction, together with our Elixhauser comorbidities tool, had a substantial impact on performance metrics.

With the growing complexity of the documentation and coding process, it is difficult for clinicians to keep up with the terminology required by the Centers for Medicare and Medicaid Services (CMS). Several different methods to improve documentation have been proposed. Prior interventions to standardize documentation templates in the trauma service have shown improvement in CMI.[8] An educational program on coding for internal medicine that included a lecture series and creation of a laminated pocket card listing common CMS diagnoses, CC, and MCC has been implemented, with an improvement in the capture rate of CC and MCC from 42% to 48% and an impact on expected mortality.[9] This program resulted in a 30% decrease in the median quarterly mortality index and an increase in CMI from 1.27 to 1.36.

Our results show that there was an increase in comorbidities documentation of admitted patients after all interventions were implemented, more accurately reflecting the complexity of our patient population in a tertiary care academic medical center. Our CMI increased by 14% during the intervention period. The estimated CMI dollar impact increased by 75% from the pre-intervention period (adjusted for PPS-exempt hospital). The hospital-expected mortality increased from
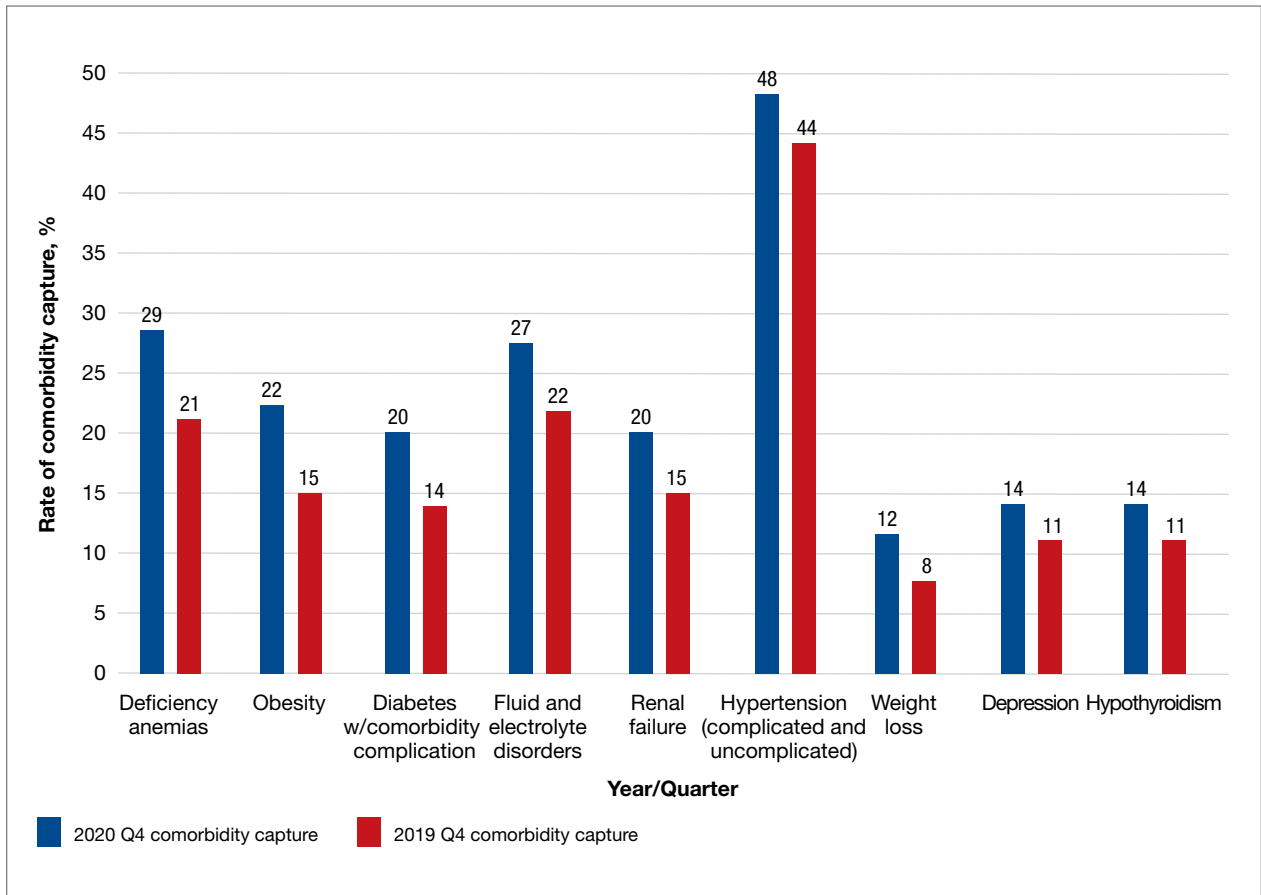
Figure 2. Comparison of comorbidity capture before (2019 Q4) and after (2020 Q4) intervention. (Data from the Vizient Clinical Data Base used with permission of Vizient, Inc. All rights reserved.)

1.77 to 3.07 (peak at 4.74 during third quarter of 2020) during the implementation period, which is a key driver of quality rankings for national outcomes reporting services such as US News & World Report.

There was increased physician satisfaction as a result of the change of functionality of the query response system, and no additional monetary provider incentive for complete documentation was allocated, apart from education and 1:1 support that improved physician engagement. Our next steps include the implementation of an advanced program to concurrently and automatically capture and nudge providers to respond and complete their documentation in real time.

Limitations

The limitations of our study include those inherent to a retrospective review and are associative and observa-

tional in nature. Although we used expected mortality and CMI as a surrogate for patient acuity for comparison, there was no way to control for actual changes in patient acuity that contributed to the increase in CMI, although we believe that the population we served and the services provided and their structure did not change significantly during the intervention period. Additionally, the observed increase in CMI during the implementation period may be a result of described variabilities in CMI and would be better studied over a longer period. Also, during the year of our interventions, 2020, we were affected by the COVID-19 pandemic. Patients with COVID-19 are known to carry a lower-than-expected mortality, and that could have had a negative impact on our results. In fact, we did observe a decrease in our expected mortality during the last quarter of 2020, which correlated with one of
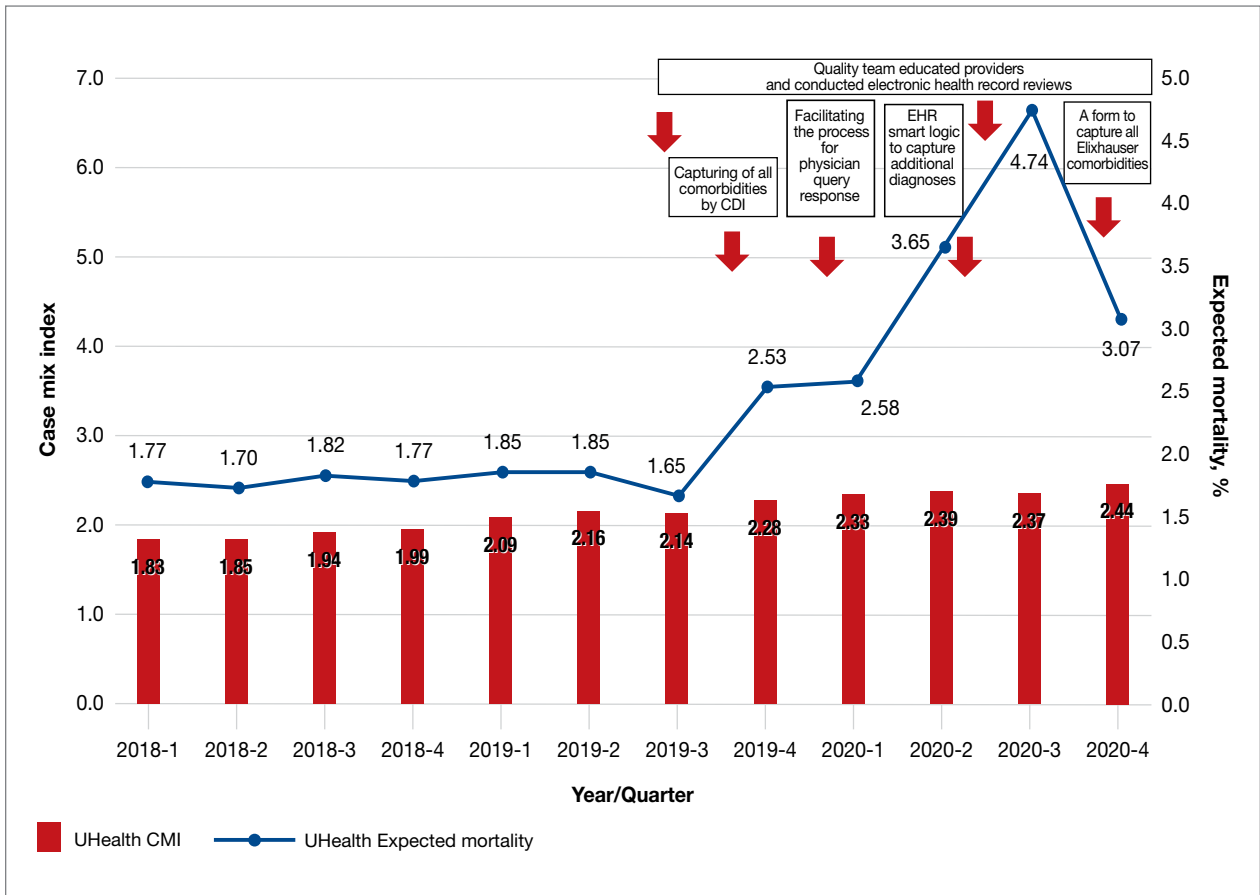
Figure 3. Timeline of interventions overlaid with captured case mix index (CMI) and expected mortality. CDI, clinical documentation improvement. (Data from the Vizient Clinical Data Base used with permission of Vizient, Inc. All rights reserved.)

our regional peaks for COVID-19, and that could be a confounding factor. While the described intervention process is potentially applicable to multiple EHR systems, the exact form to capture the Elixhauser comorbidities was built into the Epic EHR, limiting external applicability of this tool to other EHR software.

Conclusion

A continuous comprehensive series of interventions substantially increased our patient acuity scores. The increased scores have implications for reimbursement and quality comparisons for hospitals and physicians. Our institution can now be stratified more accurately with our peers and other hospitals. Accurate medical record documentation has become increasingly important, but also increasingly complex. Leveraging the EHR through quality initiatives that facilitate the workflow for providers

can have an impact on documentation, coding, and ultimately risk-adjusted outcomes data that influence institutional reputation

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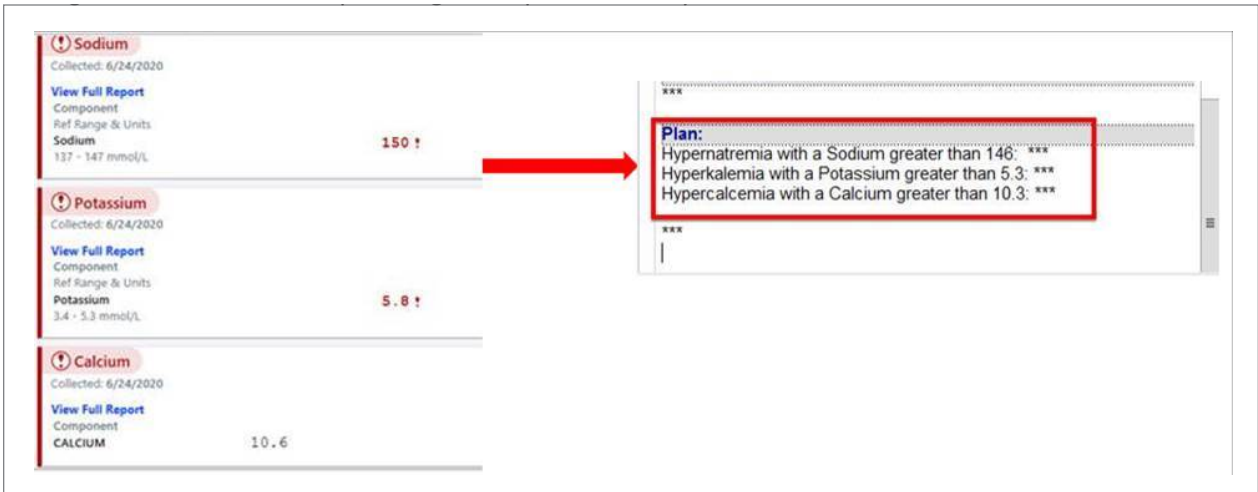
eFigure 1. Automated computer logic to capture electrolyte disturbances
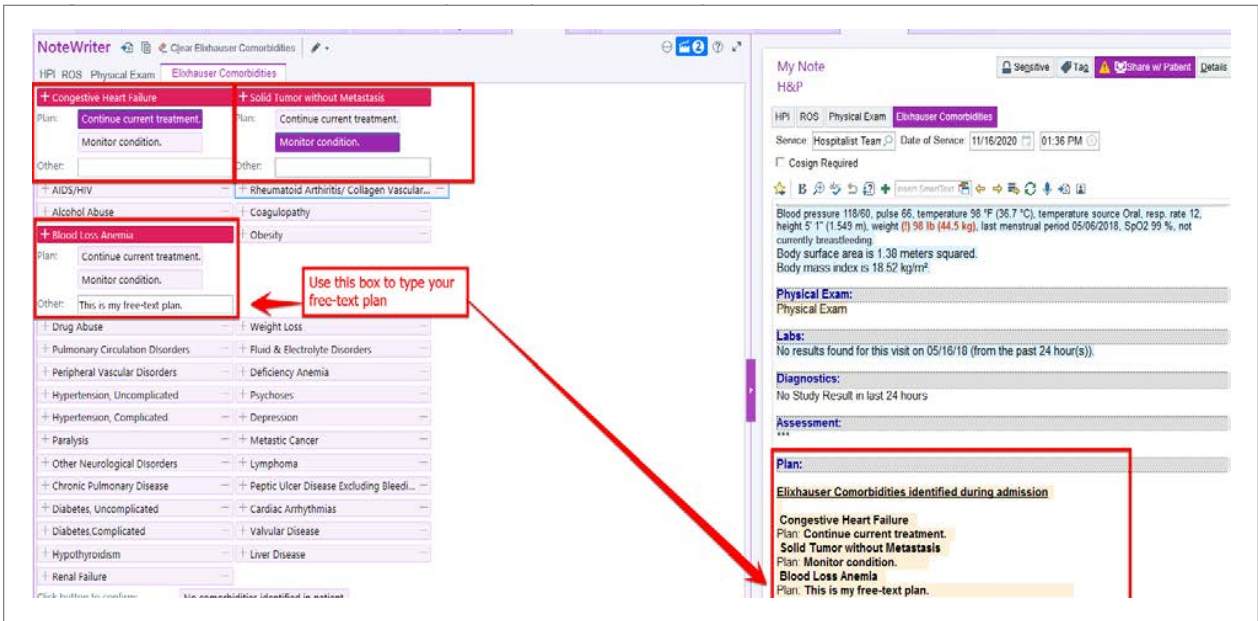
eFigure 2. Standardized tool to easily allow providers to capture Elixhauser comorbidities