The Impact of an Integrated Care Management Program on Acute Care Use and Outpatient Appointment Attendance Among High-Risk Patients With Lupus

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Objective. Patients with systemic lupus erythematosus (SLE) often struggle with high acute care use (emergency department [ED] visits and hospitalizations) and missed appointments. A nurse-led integrated care management program (iCMP) at our multihospital system coordinates care for patients at high risk for frequent acute care use due to comorbidities, demographics, and prior use patterns. We studied whether iCMP enrollment was associated with decreased acute care use and missed appointment rates among patients with SLE.

Methods. We used a validated electronic health record (EHR) machine learning algorithm to identify adults with SLE and then determined which patients were enrolled in the iCMP from January 2012 to February 2019. We then used EHR data linked to insurance claims to compare the incidence rates of ED visits, hospitalizations, potentially avoidable ED visits and hospitalizations, and missed appointments during iCMP enrollment versus the 12 months prior to iCMP enrollment. We used Poisson regression to compare incidence rate ratios (IRRs) during the iCMP versus pre-iCMP for each use measure, adjusted for age, sex, race and ethnicity, number of comorbidities, and calendar year, accounting for within-patient clustering.

Results. We identified 67 iCMP enrollees with SLE and linked EHR claims data. In adjusted analyses, iCMP enrollment was associated with reduced rates of ED visits (IRR 0.63, 95% confidence interval [CI] 0.47-0.85), avoidable ED visits (IRR 0.50, 95% CI 0.28-0.88), and avoidable hospitalizations (IRR 0.37, 95% CI 0.21-0.65).

Conclusion. A nurse-led iCMP was effective at decreasing the rate of all ED visits and potentially avoidable ED visits and hospitalizations among high-risk patients with SLE. Further studies are needed to confirm these findings in other patient populations.

INTRODUCTION

Systemic lupus erythematosus (SLE) is a multisystem and potentially life-threatening rheumatic disease that disproportionally affects patients of low socioeconomic status (SES) (1). In the United States, patients of low SES are more likely to be uninsured or underinsured, more likely to receive care in the emergency department (ED), and less likely to receive timely outpatient care (2,3). Among the adult US Medicaid population with SLE, 40%

have recurrent acute care use (ED visits or hospitalizations) and 25% have recurrent acute care use specifically for SLE (4). Conditions that may be improved by high-quality outpatient care, such as severe SLE, chronic pain, and depression, are associated with recurrent acute care use (4). Patients who are nonadherent to SLE treatment have also been shown to have significantly higher subsequent acute care use (5). Among patients with lupus nephritis, having more treat-and-release ED visits than outpatient

SIGNIFICANCE & INNOVATIONS

- In a tertiary care multihospital system, enrollment in a nurse-led and primary care–based integrated care management program (iCMP) was effective at decreasing the rate of all emergency department (ED) visits for high-risk patients with systemic lupus erythematosus (SLE). Decreased rates of hospitalizations and missed appointments were also seen but were not statistically significant.
- Potentially avoidable hospitalizations and ED visits were significantly reduced during iCMP enrollment compared with pre-iCMP enrollment.
- This program may be adapted to other health care settings to coordinate care for patients with SLE, many of whom are from vulnerable populations and are at high risk for frequent potentially avoidable acute care use.

encounters over a 6-year period is associated with a lower likelihood of receiving recommended SLE treatment (6). Avoidable acute care use for patients with SLE not only contributes to poor outcomes but also contributes to unnecessary excess costs to the patient, the health care system, and society as a whole (7). Thus, interventions to reduce acute care use and increase access to sustained high-quality outpatient care are necessary to improve outcomes and decrease costs for patients with SLE.

Inconsistent, fragmented outpatient care for SLE is a concern at our institution (Brigham and Women's Hospital [BWH]) as well as the nation as a whole, particularly for vulnerable patients (8). For example, we found that between July 2015 and March 2017, only 60% of patients with SLE at BWH kept their rheumatology appointments as scheduled. We also found that in a survey of 107 BWH rheumatology patients, 36% reported medication nonadherence and 86% described at least one barrier to consistent medication use (9). Optimal management of SLE requires frequent outpatient visits to assess disease activity, pain management, medication adherence, medication-related adverse effects, mental health, and preventive care (vaccination, malignancy screening, cardiovascular disease screening, sun protection, and reproductive health). If these factors are not routinely addressed, then the patient may bear an increased risk of potentially avoidable morbidity, mortality, and acute care use.

In 2006, our overarching health care organization, Mass General Brigham (MGB), created a primary care–embedded integrated care management program (iCMP) for patients at high risk for acute care use. This program was initially funded by the Centers for Medicare & Medicaid Services Case Management for High-Cost Beneficiaries Demonstration program but was subsequently expanded to commercially insured patients as well. The program connects high-risk patients with a nurse and care team of social workers, community resource specialists, and pharmacists who coordinate their medical care. This program has been

effective at decreasing acute care use and health care costs at our institution. Between 2009 and 2014, MGB iCMP participation was associated with a 6% reduction in ED visit rates, an 8% reduction in hospitalization rates, and a 6% reduction in Medicare spending among participants (10). In our study, we examined whether iCMP participation was associated with a decrease in rates of ED visits, hospitalizations, and missed outpatient appointments among the subset of enrolled patients with SLE. We hypothesized that iCMP participation would lead to decreased rates of these three measures among patients with SLE.

PATIENTS AND METHODS

Patient population. The MGB iCMP identifies the top 2% of medically and psychosocially complex patients within our multihospital primary care practices through a machine learning algorithm that incorporates age, sex, more than 20 chronic medical conditions (not including SLE), and health care use (11). Separate machine learning algorithms are administered for patients with Medicare, Medicaid, and commercial insurance. After patients are identified by the algorithm, their primary care physicians (PCPs) are asked whether they are appropriate for enrollment in the iCMP. PCPs may also refer patients to the iCMP separately from this algorithm. On enrollment in the iCMP, patients are paired with a nurse who performs an intake assessment, evaluates social determinants of health (SDoH) needs, coordinates care, serves as an additional clinical resource, and connects patients with social workers, community resource specialists, and pharmacists as needed. The iCMP nurse thus serves as a care coordinator, patient navigator, and health educator and also assists with obtainment of and adherence to medication regimens and appointments. The iCMP nurse also communicates frequently with the PCP about the patient. Rheumatologists are not explicitly involved in the program unless the iCMP nurse chooses to communicate with them regarding the patient.

We identified patients with SLE who were enrolled in the iCMP between January 2012 and February 2019 using a separate validated electronic health record (EHR) machine learning algorithm to detect SLE with a positive predictive value of 90% (12). We restricted our cohort to patients with both EHR and insurance claims data available for the 12-month period prior to iCMP enrollment as well as during iCMP enrollment. After enrolling in the iCMP, patients remain in the program until they meet one of the following criteria: they are no longer considered high risk, they are no longer a patient of the primary care practice, they are deceased, their health insurance is no longer aligned, or they no longer wish to engage with the program. All SLE diagnoses were verified by EHR review by using 1997 American College of Rheumatology (ACR) classification criteria, 2012 Systemic Lupus International Collaborating Clinics (SLICC) classification criteria, or the treating rheumatologist's opinion (13,14). This study was

TABLE 1. Characteristics of patients with SLE enrolled in iCMP from January 2012 to February 2019 (n = 67)

Characteristics	Value
Age, mean ± SD, years	60 ± 17
Duration of SLE, mean ± SD, years	15 ± 13
Duration of iCMP enrollment, median ± IQR, months	33 ± 46
Female sex, n (%)	62 (93)
Race, n (%)	
White	37 (55)
Black	17 (25)
Other	13 (19)
Hispanic ethnicity, n (%)	14 (21)
Insurance type, n (%)	
Medicare	59 (88)
Commercial and/or Medicaid	24 (36)
>1 insurance type	16 (24)

Note: Percentages may not add up to 100% because of rounding. Cell sizes <11 are suppressed to protect patient confidentiality. The category of other was determined by patient self-report and included patients of more than one race as well as patients who self-identified as Hispanic ethnicity.
Abbreviations: iCMP, integrated care management program; IQR, interquartile range; SD, standard deviation; SLE, systemic lupus erythematosus.

approved by the MGB Human Subjects Research Committee, which provided a waiver of written informed consent. This study was conducted in compliance with the Helsinki Declaration.

Primary outcome measurement. Primary outcomes (ED visits, hospitalizations, and missed appointments) were assessed by using review of both MGB EHR and insurance claims data. Missed appointments included all missed outpatient visits, whether for primary or specialty care. If an ED visit, hospitalization, or missed appointment was captured in both EHR and insurance claims data, it could only be counted once. For patients who had accessible EHR data, the primary reason for ED visit or hospitalization was determined by manual chart review of discharge summaries performed by a member of our team to improve accuracy because claims diagnosis codes often did not reflect the true

reason for the encounter. For patients who only had claims data, the primary reason for ED visit or hospitalization was based on the primary diagnosis code. We also classified ED visit and hospitalization primary diagnosis codes as either avoidable or nonavoidable. We used the Agency for Healthcare Research and Quality's 10 prevention quality indicators for adults (15) and a set of 25 SLE-specific, ambulatory care–sensitive potentially preventable outcomes (16) to determine which conditions were avoidable (see Supplementary Table 1). Fractures were considered osteoporotic if they occurred at the wrist, humerus, pelvis, or hip as per recently published methodology (17); we also classified vertebral fractures as osteoporotic. All upper gastrointestinal (GI) bleeds and osteoporotic fractures were considered potentially avoidable because we did not have detailed information about whether patients were taking corticosteroids, nonsteroidal anti-inflammatory drugs (NSAIDs), anticoagulation, GI protectants, or osteoporosis therapy at the time of their acute care use.

Secondary outcome measurement. Secondary outcomes included exploratory analyses of diagnostic categories of ED visits and hospitalizations during the iCMP compared with pre-iCMP. We categorized ED visit and hospitalization primary diagnosis codes as follows: SLE related; cardiovascular; renal; venous thromboembolism; GI; infection; hematologic; oncologic; musculoskeletal; allergic and medication related; neurologic; metabolic; ear, nose, and throat; psychiatric; gynecologic; obstetric; pulmonary; ophthalmologic; endocrinologic; dermatologic; preventive care; or other.

Covariate measurement. Covariate data were determined by EHR review. Covariates included age, sex (male or female), race (Black, Asian or Pacific Islander, American Indian or Alaska Native, other, which was determined by patient self-report and included patients of more than one race as well as patients who self-identified as Hispanic ethnicity), ethnicity, (Hispanic or
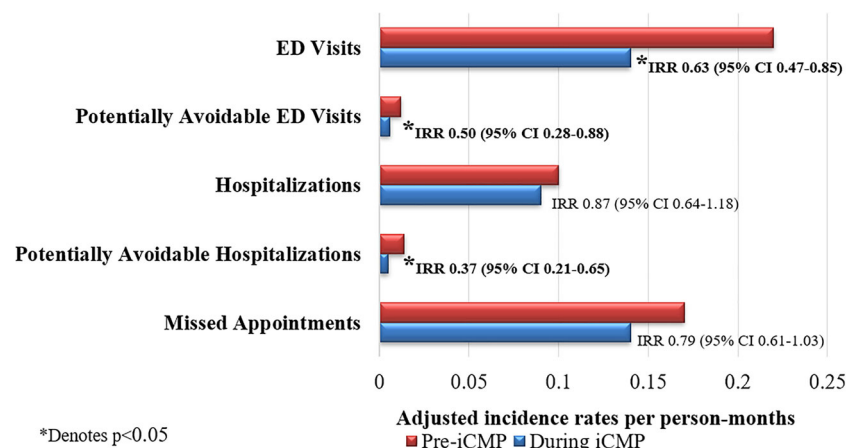
FIGURE 1. Adjusted incidence rates of medical care use and missed outpatient appointments among high-risk patients with SLE pre-iCMP versus during the iCMP. CI, confidence interval; ED, emergency department; iCMP, integrated care management program; IRR, incidence rate ratio; SLE, systemic lupus erythematosus.
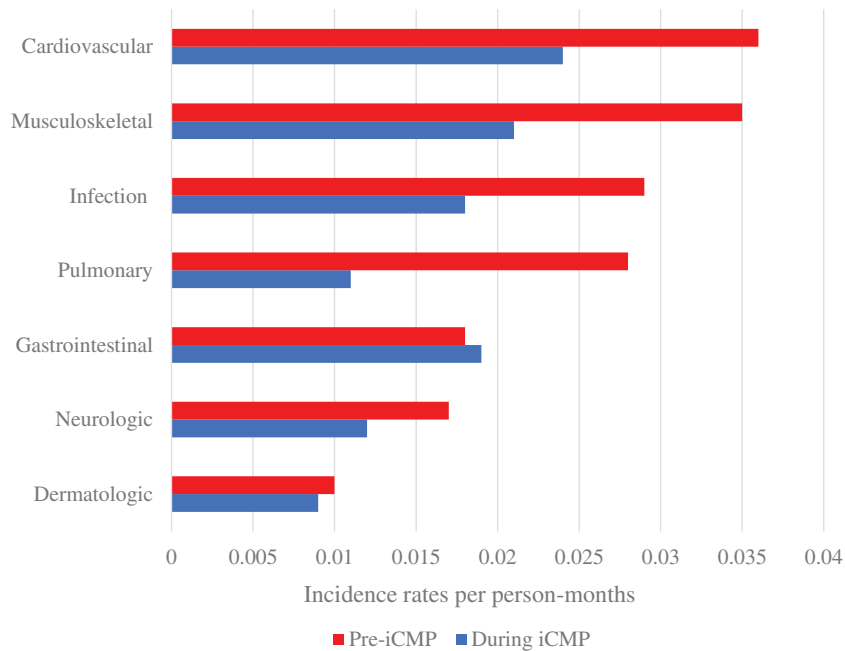
FIGURE 2. Incidence rates of ED primary diagnoses pre-iCMP versus during the iCMP. ED, emergency department; iCMP, integrated care management program.

non-Hispanic), number of comorbidities (ascertained by determining the number of problems listed in the EHR), and calendar year of iCMP enrollment (2012-2019). The number of comorbidities was calculated by manual review of the EHR problem list, and the physician reviewer only included problems that were considered true comorbidities on the basis of the physician reviewer's judgement (eg, asthma was considered to be a comorbidity but

cough was not). This covariate was measured at the first encounter of the 12-month pre-iCMP period and the first encounter after enrollment in the iCMP.

Statistical analyses. We used EHR data linked to insurance claims to compare the incidence rates of ED visits, hospitalizations, and missed appointments during iCMP enrollment

TABLE 2. IRRs for primary diagnostic categories for ED visits and hospitalizations during the iCMP compared with pre-iCMP (reference)

Category	ED visit IRR (95% CI)	P	Hospitalization IRR (95% CI)	P
SLE	2.02 (0.50-8.10)	0.32	1.03 (0.20-5.34)	0.97
Cardiovascular	0.66 (0.33-1.33)	0.25	0.87 (0.50-1.54)	0.64
Pulmonary	0.39 (0.10-1.57)	0.19	0.37 (0.14-1.00)	0.05
Infection	0.64 (0.37-1.12)	0.12	0.92 (0.48-1.78)	0.81
Gastrointestinal	1.05 (0.65-1.67)	0.85	1.41 (0.82-2.40)	0.21
Neurologic	0.72 (0.29-1.77)	0.47	1.57 (0.75-3.31)	0.23
Renal	N/A	N/A	0.38 (0.10-1.38)	0.14
Musculoskeletal	0.60 (0.41-0.87)	0.008*	1.83 (0.65-5.16)	0.25
Dermatologic	0.94 (0.42-2.11)	0.88	0.35 (0.08-1.58)	0.17
Hematologic	2.59 (0.34-20.03)	0.36	1.38 (0.40-4.74)	0.61
Psychiatric	N/A	N/A	N/A	N/A
Oncologic	N/A	N/A	1.55 (0.19-12.77)	0.68
Metabolic	0.77 (0.19-3.08)	0.71	1.04 (0.12-9.26)	0.97
Gynecologic	1.04 (0.12-9.35)	0.97	0.26 (0.02-4.16)	0.34
Allergic	0.79 (0.08-7.61)	0.84	0.26 (0.02-4.16)	0.34
Endocrinologic	N/A	N/A	N/A	N/A
ENT	0.31 (0.08-1.29)	0.11	N/A	N/A
Obstetric	N/A	N/A	N/A	N/A
VTE	1.32 (0.14-12.20)	0.81	N/A	N/A
Preventive care	N/A	N/A	N/A	N/A
Ophthalmologic	0.50 (0.13-1.94)	0.32	N/A	N/A

Abbreviations: CI, confidence interval; ED, emergency department; ENT, ear, nose, and throat; iCMP, integrated care management program; IRR, incidence rate ratio; N/A, not applicable; SLE, systemic lupus erythematosus; VTE, venous thromboembolism.
* $P < 0.05$.
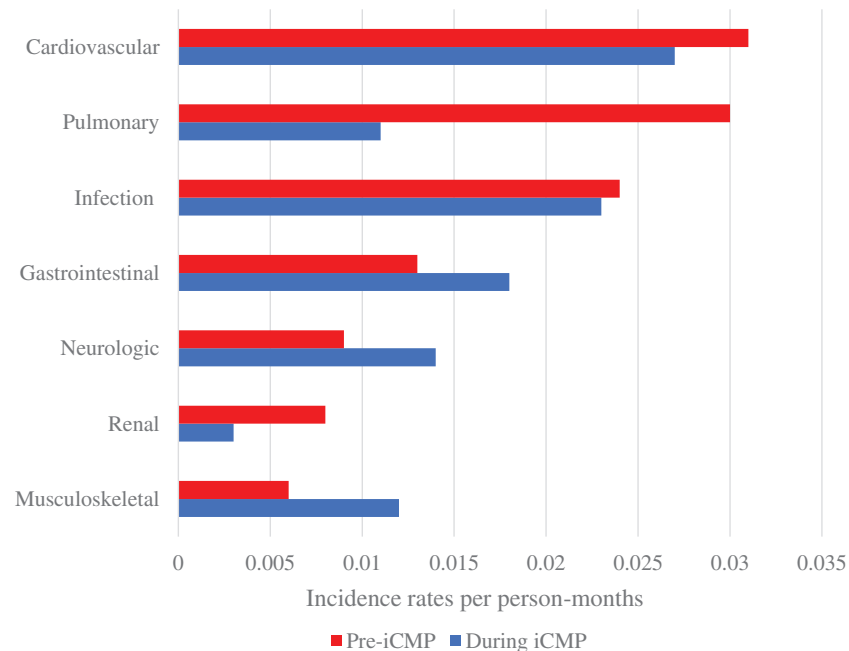
FIGURE 3. Incidence rates of hospital primary diagnoses pre-iCMP versus during the iCMP. iCMP, integrated care management program.

versus during the 12 months prior to iCMP enrollment. We used Poisson regression to examine the incidence rate ratios (IRRs) during iCMP enrollment versus pre-iCMP enrollment for each of these use measures, accounting for within-patient clustering. In the Poisson regression models, we adjusted for age, sex, race, ethnicity, number of comorbidities, and calendar year of iCMP enrollment. The Poisson regression models were also used to examine IRRs during the iCMP versus pre-iCMP for avoidable conditions (composite and individual variables) and primary diagnostic categories for both ED visits and hospitalizations. We set $\alpha = 0.05$ to determine statistical significance, and all P values were two-sided. Data were analyzed by using SAS 9.4 (SAS Institute, Inc).

Sensitivity analysis. We hypothesized that acute care use during the first 6 months of iCMP enrollment may be increased compared with the pre-iCMP period given increased contact with the health care system after enrollment. Thus, we conducted a sensitivity analysis comparing the IRRs for ED visits and hospitalizations during the first 6 months of iCMP enrollment versus during the 12-months prior to iCMP enrollment, adjusted for age, sex, race, ethnicity, number of comorbidities, and calendar year of iCMP enrollment.

RESULTS

Patient characteristics. We identified 69 iCMP enrollees with SLE and linked EHR claims data between January 2012 and February 2019; two patients were excluded because of lack of insurance data for at least 12 months pre-iCMP and during iCMP enrollment, leading to a final N = 67 (see Table 1). Ninety-seven percent met 1997 ACR criteria or 2012 SLICC criteria for SLE; the remainder did not meet diagnostic criteria but were

diagnosed with SLE by their treating rheumatologist. Median iCMP enrollment time was 33 months (interquartile range 46 months). The mean age at iCMP enrollment was 60 years (standard deviation [SD] 17 years), and the mean duration of SLE at iCMP enrollment was 15 years (SD 13 years). Ninety-three percent of patients were female. The racial breakdown was 55% White, 25% Black, and 19% other race; 21% were of Hispanic ethnicity. Eighty-eight percent of patients had Medicare insurance, as the program was originally developed for Medicare beneficiaries, and 24% had more than one insurance type.

Primary outcomes. The frequency of primary outcomes pre-iCMP vs. during iCMP are displayed in Supplementary Table 2. After adjusting for demographics, year of enrollment, comorbidities, and repeated measures, we found that during the iCMP there was a 37% reduction in the rate of ED visits (IRR 0.63; 95% confidence interval [CI] 0.47-0.85), a 50% reduction in potentially avoidable ED visits (IRR 0.50; 95% CI 0.28-0.88), and a 63% reduction in potentially avoidable hospitalizations (IRR 0.37; 95% CI 0.21-0.65) compared with the pre-iCMP period (see Figure 1). During the iCMP, reduced hospitalizations (IRR 0.87; 95% CI 0.64-1.18) and fewer missed appointments (IRR 0.79; 95% CI 0.61-1.03) were also seen but were not statistically significant. We also found that during iCMP enrollment versus pre-iCMP enrollment, there was an increase in the rate of ED visits for primary diagnosis of upper GI bleed (IRR 1.28; 95% CI 1.15-1.42).

Secondary outcomes. The incidence rates of primary diagnostic categories for ED visits in the pre-iCMP and during iCMP periods are displayed in Figure 2. During the iCMP, there was a reduction in the rate of ED visits for primary diagnosis of

musculoskeletal disorder (IRR 0.60; 95% CI 0.41-0.87); none of the other findings were statistically significant (Table 2). The incidence rates of primary diagnostic categories for hospitalizations in the pre-iCMP and during iCMP periods are displayed in Figure 3; no significant differences were found (Table 2). For primary diagnosis of SLE, there was also no significant difference in the incidence rates of ED visits (0.002 per person-month pre-iCMP vs 0.004 per person-month during iCMP) or hospitalizations (0.002 per person-month pre-iCMP vs 0.003 per person-month during iCMP).

Sensitivity analysis. There was no significant difference in the rate of ED visits (IRR 0.70; 95% CI 0.46-1.06) or hospitalizations (IRR 0.89; 95% CI 0.57-1.39) during the first 6 months of iCMP enrollment compared with the 12 months prior to iCMP enrollment.

DISCUSSION

In a cohort of 67 high-risk, racially and ethnically diverse, and predominantly Medicare-insured patients with SLE, we found that enrollment in an iCMP, a primary care–based, nurse-led care coordination program, led to a significant reduction in the rate of ED visits overall, as well as a significant reduction in the rate of ED visits and hospitalizations for avoidable conditions. SLE flares accounted for a minimal amount of acute care use, although common causes of acute care use, such as cardiovascular disorders or infections, are often associated with SLE or treatment for SLE. We did not see an increase in acute care use during the first 6 months of iCMP enrollment even though patients presumably had increased contact with the health care system during this period. Of note, we also did not see a statistically significant decrease in hospitalizations or missed appointments during iCMP enrollment, possibly because we were underpowered. We did find increased rates of ED visits for GI bleeds during iCMP enrollment, which we hypothesize might have been drug related rather than SLE related (eg, greater corticosteroid, NSAID, anticoagulant, and immunosuppressant use during the iCMP).

Our results suggest that enhanced care coordination through iCMP enrollment may be associated with decreased ED use and decreased acute care use for avoidable conditions, resulting in health benefits for the patient as well as likely reduced health care costs. At our hospital, iCMP nurses act as a liaison between the patient and their PCP, and this enhanced care coordination may have led to less acute care use and more contact with primary care. A recent study found that high-need, high-cost patients with SLE (defined as three or more hospital admissions per year) are more likely than other patients with SLE to be Black, to be younger, to have been diagnosed with SLE at a younger age, to have medication nonadherence, and to reside in high-poverty areas (18). These risk factors are associated with limited resources, inexperience navigating the health care system, and/or

mistrust of health care providers (19,20). These SDoH factors play a major role in patients' health and health care use patterns. The addition of an iCMP team–based model to care plans of high-need, high-cost patients with SLE mitigates these SDoH factors by connecting patients with additional resources (such as social work support), improving care coordination, and nurturing relationships and trust. For example, our group recently found that among our cohort of patients with SLE enrolled in the iCMP between 2012 and 2019, iCMP nurses addressed at least one SDoH need for 81% of patients in our cohort and connected 75% of patients with additional resources (21). Of note, the 37% reduction in ED visit rates among patients with SLE enrolled in the iCMP at our institution from 2012 to 2019 is much greater than the 6% reduction in ED visit rates among all patients enrolled in the iCMP at our institution from 2009 to 2014 (10). We hypothesize that this may be due to greater SDoH and care coordination needs among patients with SLE compared with other medically complex patients, possibly due to the disproportionate burden of SLE in marginalized and oppressed groups (racial and ethnic minority groups and women).

There is precedent for a team-based care model to improve outpatient care and decrease acute care use among high-risk patients with SLE. In 2017, Anandarajah (22) initiated a program at the University of Rochester entitled Improve the Quality of Low-Income, Underserved, Poor, Underprivileged, SLE Patients (IQ-LUPUS). This program created care coordination teams for high-risk patients with SLE consisting of a nurse, a social worker, and two physicians, with intermittent support from other providers, such as pharmacists. IQ-LUPUS participants were provided with a business card with direct contact information for their care team. IQ-LUPUS team members met every 2 weeks to discuss patient care and established a lupus clinic in an underserved area of Rochester, NY, to better serve their patients. Specific IQ-LUPUS interventions included assistance with scheduling appointments, behavioral modification (eg, self-efficacy programs), community outreach efforts, detection and management of depression, and education of patients and referring providers. During the first 2 years of IQ-LUPUS, participants achieved a reduction in hospital admissions, 30-day readmissions, and missed appointment rates. In another recently published study, investigators identified patients with SLE who were admitted to the hospital for any reason and sent a templated message to the rheumatology clinic nurses at discharge (23). This message prompted the nurses to contact the patient to assist with care coordination and education. This intervention led to a 10% reduction in the 30-day readmission rate, although results were not statistically significant.

Strengths of our study include focus on a high-risk patient population, racial and ethnic diversity of our study population, inclusion of both detailed EHR and insurance claims data, and an established sustainable intervention with prior demonstration of benefit, although not previously studied for patients with SLE.

Limitations of our study include lack of a control group that would help account for temporal trends, missing EHR data from outside records, missing insurance claims data from periods of unenrollment, the possibility that lower use rates after iCMP enrollment are related to regression to the mean because high health care use is a trigger for iCMP enrollment, older age of our cohort compared with the general SLE population, and lack of data regarding the specific components of the iCMP that may be associated with decreased acute care use.

In conclusion, we found that participation in a primary case–based, nurse-led iCMP was associated with a reduced rate of ED visits overall, avoidable ED visits, and avoidable hospitalizations for high-risk patients with SLE. Further studies are needed to determine the root causes of high use patterns for vulnerable patients with SLE, quantify the financial impact of SLE care coordination programs, and develop further SLE-specific interventions to improve care given the unique needs of this population.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Dr. Williams had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study conception and design. Williams, Feldman.
Acquisition of data. Williams, Taber, Cunningham, McLaughlin, Vogeli, Wichmann, Feldman.
Analysis and interpretation of data. Williams, Huang, Collins, Feldman.

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