

Trends in Prescribing of Antibiotics and Drugs Investigated for COVID-19 Treatment in U.S. Nursing Home Residents During the COVID-19 Pandemic

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Summary: During the COVID-19 pandemic, there was a high prevalence of nursing home residents with a prescription dispensed for drugs that were investigated for COVID-19 treatment, while antibiotic prescribing among nursing home residents was lower than in the previous year.

Abstract

Background. Trends in prescribing for nursing home (NH) residents, which may have been influenced by the COVID-19 pandemic, have not been characterized.

Methods. Long-term care pharmacy data from 1,944 U.S. NHs were used to evaluate trends in prescribing of antibiotics and drugs that were investigated for COVID-19 treatment, including hydroxychloroquine, famotidine, and dexamethasone. To account for seasonal variability in antibiotic prescribing and decreased NH occupancy during the pandemic, monthly prevalence of residents with a prescription dispensed per 1,000 residents serviced was calculated from January – October and compared as relative percent change from 2019 to 2020.

Results. In April 2020, prescribing was significantly higher in NHs for drugs investigated for COVID-19 treatment than 2019; including hydroxychloroquine (+563%, 95% confidence interval (CI) 5.87, 7.48) and azithromycin (+150%, 95% CI 2.37, 2.63). Ceftriaxone prescribing also increased (+43%, 95% CI 1.34, 1.54). Prescribing of dexamethasone was 36% lower in April (95% CI 0.55, 0.73) and 303% higher in July (95% CI 3.66, 4.45). Although azithromycin and ceftriaxone prescribing increased, total antibiotic prescribing among residents was lower from May (-5%, 95% CI 0.94, 0.97) through October (-4%, 95% CI 0.94, 0.97) in 2020 compared to 2019.

Conclusions. During the pandemic, large numbers of residents were prescribed drugs investigated for COVID-19 treatment, and an increase in prescribing of antibiotics commonly used for respiratory infections was observed. Prescribing of these drugs may increase the risk of adverse events, without providing clear benefits. Surveillance of NH prescribing practices is critical to evaluate concordance with guideline-recommended therapy and improve resident safety.

Keywords: nursing home, antibiotic stewardship, adverse drug events, COVID-19

Introduction

Nursing homes (NHs) have a large burden of coronavirus disease 2019 (COVID-19) associated morbidity and mortality [1]. There are many challenges facing NHs during the COVID-19 pandemic, including prevention and treatment of SARS-CoV-2 infection. NH residents are at increased risk of drug interactions and adverse drug events from polypharmacy and inappropriate medication use, due to age-related physiological changes and multiple comorbid conditions [2-5]. Several drugs have been investigated for the treatment of infection with SARS-CoV-2 and have been highlighted by the media, including hydroxychloroquine, azithromycin, famotidine, and dexamethasone [6-8]. Furthermore, COVID-19 usually manifests with respiratory symptoms [9] for which antibiotics may be prescribed. Antibiotic use is associated with increased risk of adverse events and infection with multi-drug resistant organisms and *Clostridioides difficile* [10]. In the outpatient setting, there was a significant increase in the prescribing of hydroxychloroquine and azithromycin [11, 12], but prescribing trends during the COVID-19 pandemic have not been characterized in NH settings [13]. The majority of U.S. NHs contract with long-term care pharmacies to dispense prescriptions and provide medication monitoring and review [13]. The objective of this analysis was to describe trends in prescribing of antibiotics and drugs that were investigated for treatment of infection with SARS-CoV-2 to guide prescribing practices and prevention of adverse events in NH residents.

Methods

Data Source

We used data from PharMerica, a BrightSpring Health Services company (<https://pharmerica.com/>), a long-term care pharmacy that services long-term care facilities across the U.S., to conduct this study. We analyzed aggregated resident prescription dispensing data to determine the number of NH residents with a new dispensed prescription of interest (numerator) from January 2019 – October 2020. We used the total number of residents serviced each month, defined as the number of residents with any prescription dispense, to assess changes in monthly NH occupancy

and calculate the monthly prevalence of residents with dispensed prescriptions of interest. In total, 1,944 NHs across 48 U.S. states were included in the analysis, comprising approximately 12% of the number of U.S. NHs [14].

Agents

We assessed two categories of drugs; antibiotics and drugs that were investigated for COVID-19 treatment. We described total antibiotics dispensed, which included all antibiotic classes, and commonly prescribed individual antibiotics in NHs: amoxicillin, amoxicillin potassium clavulanate, azithromycin, ceftriaxone, cefuroxime, cephalexin, doxycycline, levofloxacin, nitrofurantoin, and trimethoprim-sulfamethoxazole [15, 16]. The drugs that were investigated or purported effective for COVID-19 treatment included hydroxychloroquine sulfate, chloroquine phosphate, dexamethasone, famotidine, zinc, ivermectin, ritonavir, and baloxavir [6-8, 17-20]. We evaluated co-prescribing of azithromycin and hydroxychloroquine based on publicized evidence of potential efficacy of the drug combination for COVID-19 treatment [6] and defined as prescriptions of azithromycin and hydroxychloroquine dispensed to the same resident within 72 hours.

Data Analyses

We calculated monthly prevalence of NH residents with a new prescription dispensed per 1,000 residents from January – October to account for seasonal variability in antibiotic prescribing and the decline in NH occupancy during the COVID-19 pandemic [21]. We conducted log-binomial regression models to estimate the prevalence ratios (PRs) and associated 95% confidence intervals (CIs) for prescribing of each agent in 2020 compared to 2019. We calculated the monthly relative percent change from 2019 to 2020 to evaluate the impacts of COVID-19 on drug use in the subset of NHs included in the study. We conducted all statistical analyses at $\alpha = 0.05$. SAS (version 9.4; SAS Institute) and Excel (version 1908; Microsoft) were used to perform all analyses.

Analyses were conducted by the Centers for Disease Control and Prevention (CDC) as part of public health surveillance activities using deidentified and aggregated data, which do not require human subjects research approval or informed consent. This activity was reviewed by CDC and was

conducted consistent with applicable federal law and CDC policy.¹

Results

Nursing home population

In total, 1,944 NHs in 48 states were included in the analysis, representing approximately 12% of the number of NHs nationally. In 2020, the total number of residents serviced declined by 19%, from 127,705 residents in January to 103,631 residents in October, compared to a 1% increase during this time period in 2019.

Prescribing trends

Prescribing of hydroxychloroquine and azithromycin per 1,000 residents was higher than 2019 between March and October 2020. In April 2020, prescribing was 563% higher for hydroxychloroquine (PR 6.63, 95% CI 5.87, 7.48) and 150% higher for azithromycin (PR 2.50, 95% CI: 2.37, 2.63) compared to 2019 (Table 1). Of residents receiving azithromycin in April 2020, 23% were co-prescribed hydroxychloroquine. Prescribing of these drugs decreased in May 2020 but was still significantly higher than 2019 in July – October 2020 (Figure 1).

There was also a sizeable increase in prescribing of non-antimicrobial drugs that were investigated for COVID-19 treatment to residents from 2019 to 2020 (Figure 1). In April 2020, prescribing was 59% higher for famotidine (PR 1.59, 95% CI 1.50, 1.67) and 155% higher for zinc (PR 2.55, 95% CI 2.21, 2.93) compared to 2019 (Table 1). Of note, prescribing was 34% lower for prednisone (PR 0.66, 95% CI 0.63, 0.69) and 36% lower for dexamethasone (PR 0.64, 95% CI 0.55, 0.73) in April 2020 compared to 2019. In June 2020, prescribing of dexamethasone increased, and by July it was 303% higher than in 2019 (PR 4.03, 95% CI 3.66, 4.45) (Table 1).

From January to June 2020, total antibiotic prescribing among NH residents decreased 16%, from 232 to 196 residents with an antibiotic prescription per 1,000 residents, compared to a seasonal decrease of 9% in 2019 (Figure 2). Total antibiotic prescribing prevalence was lower in 2020 than in 2019 from May (PR 0.95, 95% CI 0.94, 0.97) through October, with 4% lower prescribing prevalence

¹ See e.g., 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.

in October 2020 than 2019 (PR 0.96, 95% CI 0.94, 0.97) (Table 1). While total antibiotic prescribing in NH residents in 2019 and 2020 were similar from January to April, when azithromycin is excluded, the rate of antibiotic prescribing experienced a greater decline in April 2020, with 12% lower prescribing than April 2019 (Figure 2). Antibiotic agents with significantly lower prescribing prevalence among NH residents in April 2020 compared to 2019 included, amoxicillin (-25%, 95% CI 0.68, 0.82), levofloxacin (-19%, 95% CI 0.77, 0.85), cefuroxime (-15%, 95% CI 0.77, 0.93), and cephalexin (-14%, 95% CI 0.82, 0.90). By October 2020, the prescribing prevalence was significantly lower for amoxicillin (-19%, 95% CI 0.74, 0.89), cefuroxime (-12%, 95% CI 0.80, 0.97), levofloxacin (-19%, 95% CI 0.77, 0.85), and trimethoprim-sulfamethoxazole (-10%, 95% CI 0.85, 0.95) (Table 1).

In addition to azithromycin, antibiotic agents with higher prescribing prevalence among NH residents in April 2020 versus 2019 were ceftriaxone (+43%, 95% CI 1.34, 1.54) and doxycycline (+6%, 95% CI 1.01, 1.12) (Table 1). Ceftriaxone prescribing remained significantly elevated in May (+22%, 95% CI 1.13, 1.31) through October (+11%, 95% CI 1.03, 1.20) in 2020 compared to 2019. There were no notable changes in the following antimicrobial agents assessed from 2019 to 2020: chloroquine phosphate, ivermectin, ritonavir, or baloxavir. These drugs have relatively infrequent use at baseline in NHs (fewer than 3 residents with dispensed prescription in a month per 1,000 residents, Supplementary Table 1).

Discussion

Health care providers caring for NH residents prescribed agents that were investigated for treatment of COVID-19 to large numbers of NH residents. With the potential for high morbidity and mortality among NH residents, health care providers have urgently sought specific treatment for residents at risk for severe illness who may be infected with SARS-CoV-2. The increases in prescribing of these drugs to NH residents without clear benefits are concerning, as they may put residents at greater risk of adverse events.

Prescribing of hydroxychloroquine, azithromycin, famotidine, and dexamethasone was substantially higher than expected and coincide with the publicized information regarding the

potential efficacy of these treatments (Figure 1). On March 20, 2020, Gautret et al. published a study with preliminary evidence of decreased SARS-CoV-2 viral load associated with co-prescribing of hydroxychloroquine and azithromycin [6]. On March 28, 2020 the U.S. Food and Drug Administration (FDA) emergency use authorization was issued for the use of hydroxychloroquine for treatment of infection with SARS-CoV-2 [22]. Concurrently, there was a 563% increase in hydroxychloroquine and 150% increase in azithromycin prescribing among NH residents in April 2020 compared to 2019. Furthermore, 23% of residents receiving azithromycin were co-prescribed hydroxychloroquine, emphasizing the adoption of drug therapies under evaluation for COVID-19 treatment. On April 24, FDA released a Drug Safety Communication warning of heart rhythm irregularities in COVID-19 patients treated with hydroxychloroquine, often in combination with azithromycin [23]. This coincides with the decline in prescribing rates of hydroxychloroquine and azithromycin in May 2020; however, prescribing of these agents remained elevated through October 2020, which is concerning for resident safety. The 59% increase in famotidine in April 2020 may be associated with the \$21 million emergency contract awarded to Alchem Laboratories by the U.S. Biomedical Advanced Research and Development Authority on April 14, 2020 to assess co-prescribing of hydroxychloroquine and famotidine for COVID-19 treatment [7]. Prescribing of dexamethasone and prednisone for NH residents decreased substantially in April 2020, which may be due to guidance cautioning against the use of corticosteroids in COVID-19 patients [24]. It is unclear if the decline in occupancy led to a change in case-mix of residents with conditions that require corticosteroid prescribing. However, in June 2020, with evidence that dexamethasone could reduce COVID-19 mortality in critically ill patients infected with SARS-CoV-2 [8], the prescribing of dexamethasone increased, further demonstrating the rapid uptake of treatments that may improve resident COVID-19 outcomes. However, at that time, dexamethasone was only recommended for the treatment of SARS-CoV-2 in critically ill hospitalized patients with respiratory failure and not in NH settings, since corticosteroids may cause adverse events and increased susceptibility to other infections [25]. While we did not have access to data on supplemental oxygen use among residents, understanding out-of-hospital treatment would provide context to the increased prescribing of dexamethasone. Many drugs have been evaluated for efficacy to treat COVID-19 in in vitro and

animal studies; however, their effectiveness and appropriate dosing and duration in humans have not been determined. Due to specific concerns of age-related physiology changes in older adults and increased potential for drug interactions with polypharmacy, when caring for residents infected with SARS-CoV-2 in NH settings, appropriate treatment protocols should be followed and the potential benefits of prescribing drugs under investigation for COVID-19 treatment should be carefully weighed against risks of adverse drug events.

There was a greater decrease in total antibiotic use in the NH setting during the COVID-19 pandemic than expected for seasonal declines. This overall decline may be attributed to changes in healthcare delivery among NH residents and changes in the resident population in a pandemic setting. Antibiotic use rates are higher in short-stay residents (residents that stay in the NH for <100 days) that need skilled nursing services following hospital discharge [15]. However, with the decrease in elective procedures during the pandemic, the proportion of short-stay residents may have decreased and may be partially responsible for the decline in antibiotic use [15]. Lower antibiotic use during this time may also be due to increased testing practices for viral respiratory pathogens among residents [26]. In addition, with increased awareness and improved implementation of infection prevention and control measures, declines in the transmission of infections may have led to decreased antibiotic prescribing to NH residents. It is important to highlight that some antibiotic agents, such as fluoroquinolones, had lower prescribing prevalence among residents in January and February 2020 compared to 2019; this may reflect changes in prescribing practices driven by antibiotic stewardship programs in NHs that preceded the COVID-19 pandemic.

During the pandemic, more NH residents were prescribed antibiotic agents that are commonly prescribed for respiratory infections, including azithromycin, ceftriaxone, and doxycycline, than in 2019. While azithromycin prescribing declined after FDA warnings, ceftriaxone prescribing remained elevated, similar to prescribing practices in the hospital setting [27]. Ceftriaxone may be more easily accessible onsite in NH emergency kits and can be administered intramuscularly without the need for intravenous access. Furthermore, ceftriaxone may have been administered prior to hospital transfer or post-hospital discharge for respiratory infections; however, this cannot be determined based on these dispensing data. A systematic meta-analysis found that while frequency of bacterial co-infections in

hospitalized patients infected with SARS-CoV-2 are low, more than 90% of patients received empiric antibiotic therapy [28]. When residents are started on antibiotic therapy for a respiratory illness, appropriate testing, monitoring and follow-up is important so antibiotic therapy can be adjusted or stopped if SARS-CoV-2 infection is confirmed and no evidence of bacterial co-infection or sepsis is found [29]. Appropriate antibiotic prescribing is important to reduce risk of complications of antibiotic use, including adverse drug events and infection with multi-drug resistant organisms and *C. difficile* [10]. COVID-19-specific testing and treatment protocols that incorporate antibiotic stewardship principles can improve the diagnosis and treatment of residents with suspected infection with SARS-CoV-2 and other respiratory illnesses [30]. Long-term care consultant pharmacists can also provide drug expertise and support by monitoring medication use in residents during the pandemic, and in the development and implementation of treatment protocols [13, 30].

Limitations

This study is subject to several limitations. During the COVID-19 pandemic, NH occupancy declined for multiple reasons, including decreases in elective procedures and subsequent NH admissions, family decisions motivated by risk reduction, higher share of COVID-19 cases in NHs that resulted in resident hospital transfer or death, and changes in the distribution of NHs in a pandemic setting [31]. We assessed a subset of U.S. NHs, in which the number of residents decreased by 19% from January to October 2020, compared to a reported decline of 10% in NH occupancy nationally during the pandemic [21]. Our study population may overrepresent NHs that experienced larger number of resident decreases during the pandemic and have a different case-mix of residents, and thus may not be nationally representative. Although we evaluated NHs in 48 states, the trends in prescribing may be driven by NHs undergoing outbreaks and incidence of infection by state. A limitation of dispensing data is that they do not include indications; therefore, we could not determine whether drugs were prescribed for respiratory illnesses or infection with SARS-CoV-2. In addition, we could not evaluate the impact of drug prescribing on adverse events and resident outcomes. Further evaluation of diagnoses and subsequent adverse outcomes associated with prescribing of these drugs will be important. It is unclear if the reduction in antibiotic prescribing observed from January to October 2020 was driven by decreases in unnecessary or necessary antibiotic prescriptions, and

how much of the decline is related to changes in prescribing behaviors as a result of antibiotic stewardship initiatives that predate the COVID-19 pandemic. More data on bacterial co-infections with SARS-CoV-2 are needed to assess appropriateness of antibiotic therapy. Finally, we could not distinguish prescriptions that were initiated in the NH or in the hospital, so these data may not solely reflect NH prescribing practices.

Conclusion

Ensuring the safety of NH residents during the COVID-19 pandemic is of paramount importance. As more data on effective therapy for SARS-CoV-2 infection become available, it is critical that clinicians carefully weigh the risks and benefits when prescribing treatments that have not been proven effective but have established adverse event profiles, to avoid medication-related harm and potential complications in NH populations, who are at increased risk of adverse drug events and drug interaction. Studies that link prescribing data to diagnoses, as well as outcomes, are important to assess both the appropriateness of prescribing to NH residents and health impact of the changes in prescribing behavior during the COVID-19 pandemic.

Notes:

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Table 1. Number of Nursing Home Residents With Prescription Dispensed for Antibiotics and Drugs Investigated for COVID-19 Treatment per 1,000 Residents Served and Relative Percent Change From 2019 to 2020, January Through October.

AGENT		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
ANTIBIOTICS		Number of residents with prescription dispensed per 1,000 residents serviced									
TOTAL ANTIBIOTICS											
	2019	232.3	216.8	219.6	215.6	215.6	211.2	209.8	210.9	207.3	213.5
	2020	232.2	208.3	217.4	217.3	204.9	195.9	206.6	206.5	199.2	204.4
	PR 2020 v 2019 (95% CI) ^{a,b}	1.00 (0.99, 1.01)	0.96 (0.95, 0.98) [†]	0.99 (0.98, 1.01)	1.01 (0.99, 1.02)	0.95 (0.94, 0.97) [†]	0.93 (0.91, 0.94) [†]	0.98 (0.97, 1.00)	0.98 (0.96, 0.99) [†]	0.96 (0.95, 0.98) [†]	0.96 (0.94, 0.97) [†]
	Relative change from 2019 to 2020, %	0%	-4%	-1%	1%	-5%	-7%	-2%	-2%	-4%	-4%
AMOXICILLIN											
	2019	9.5	9.3	9.3	9.0	9.0	8.6	8.6	8.5	8.5	9.0
	2020	9.6	8.5	8.4	6.7	6.5	7.3	7.3	7.5	7.1	7.3
	PR 2020 v 2019 (95% CI)	1.02 (0.94, 1.10)	0.91 (0.84, 0.99) [†]	0.90 (0.83, 0.98) [†]	0.75 (0.68, 0.82) [†]	0.72 (0.66, 0.80) [†]	0.85 (0.77, 0.93) [†]	0.85 (0.77, 0.93) [†]	0.88 (0.81, 0.97) [†]	0.83 (0.76, 0.92) [†]	0.81 (0.74, 0.89) [†]
	Relative change from 2019 to 2020, %	2%	-9%	-10%	-25%	-28%	-15%	-15%	-12%	-17%	-19%
AMOXICILLIN/POTASSIUM CLAVULANATE											
	2019	26.5	25.4	26.6	25.5	25.6	24.3	24.7	24.2	23.4	25.0
	2020	28.2	26.2	26.7	23.4	23.4	22.6	22.6	23.6	22.2	23.5
	PR 2020 v 2019 (95% CI)	1.06 (1.02, 1.11) [†]	1.03 (0.98, 1.08)	1.00 (0.96, 1.05)	0.92 (0.87, 0.97) [†]	0.91 (0.87, 0.96) [†]	0.93 (0.88, 0.98) [†]	0.92 (0.87, 0.97) [†]	0.97 (0.92, 1.03)	0.95 (0.90, 1.00)	0.94 (0.89, 0.99) [†]
	Relative change from 2019 to 2020, %	6%	3%	0%	-8%	-9%	-7%	-8%	-3%	-5%	-6%
AZITHROMYCIN											
	2019	22.2	19.2	17.7	16.6	16.3	15.1	12.9	12.5	14.2	15.0

2020	23.1	18.6	21.2	41.5	22.2	14.3	24.0	22.4	16.4	19.3
PR 2020 v 2019 (95% CI)	1.04 (0.99, 1.09)	0.97 (0.92, 1.03)	1.19 (1.13, 1.26) [†]	2.50 (2.37, 2.63) [†]	1.36 (1.28, 1.44) [†]	0.95 (0.89, 1.02)	1.86 (1.74, 1.98) [†]	1.79 (1.68, 1.91) [†]	1.15 (1.08, 1.23) [†]	1.29 (1.21, 1.37) [†]
Relative change from 2019 to 2020, %	4%	-3%	19%	150%	36%	-5%	86%	79%	15%	29%
AGENT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
ANTIBIOTICS	Number of residents with prescription dispensed per 1,000 residents serviced									
CEFTRIAXONE										
2019	12.3	11.5	12.2	11.3	11.6	11.2	11.1	11.4	11.2	11.1
2020	12.4	12.4	14.3	16.2	14.2	13.0	14.6	14.0	12.5	12.4
PR 2020 v 2019 (95% CI)	1.01 (0.94, 1.08)	1.09 (1.01, 1.17) [†]	1.17 (1.09, 1.25) [†]	1.43 (1.34, 1.54) [†]	1.22 (1.13, 1.31) [†]	1.16 (1.08, 1.25) [†]	1.32 (1.23, 1.42) [†]	1.22 (1.14, 1.32) [†]	1.12 (1.03, 1.21) [†]	1.11 (1.03, 1.20) [†]
Relative change from 2019 to 2020, %	1%	9%	17%	43%	22%	16%	32%	22%	12%	11%
CEFUROXIME AXETIL										
2019	9.5	8.6	9.3	8.6	8.7	8.3	7.8	7.7	7.4	8.3
2020	8.0	8.0	8.0	7.3	7.5	7.0	7.6	7.1	6.8	7.3
PR 2020 v 2019 (95% CI)	0.84 (0.78, 0.92) [†]	0.92 (0.85, 1.01)	0.87 (0.80, 0.95) [†]	0.85 (0.77, 0.93) [†]	0.85 (0.78, 0.94) [†]	0.84 (0.76, 0.92) [†]	0.97 (0.88, 1.07)	0.92 (0.84, 1.01)	0.91 (0.82, 1.01)	0.88 (0.80, 0.97) [†]
Relative change from 2019 to 2020, %	-16%	-8%	-13%	-15%	-15%	-16%	-3%	-8%	-9%	-12%
CEPHALEXIN										
2019	30.2	28.1	29.2	29.7	30.6	30.1	32.3	31.6	29.8	30.4
2020	30.5	27.7	28.9	25.5	27.6	28.1	27.5	28.6	28.1	29.1
PR 2020 v 2019 (95% CI)	1.01 (0.97, 1.06)	0.98 (0.94, 1.03)	0.99 (0.94, 1.04)	0.86 (0.82, 0.90) [†]	0.90 (0.86, 0.95) [†]	0.93 (0.89, 0.98) [†]	0.85 (0.81, 0.89) [†]	0.91 (0.87, 0.95) [†]	0.94 (0.90, 0.99) [†]	0.96 (0.91, 1.00)
Relative change from 2019 to 2020, %	1%	-2%	-1%	-14%	-10%	-7%	-15%	-9%	-6%	-4%
DOXYCYCLINE										
2019	27.2	23.9	25.4	26.2	25.1	24.4	24.3	24.8	23.9	25.9
2020	30.2	26.8	29.5	27.8	24.8	25.3	25.6	25.3	24.1	25.0

PR 2020 v 2019 (95% CI)	1.11 (1.06, 1.16)†	1.12 (1.07, 1.18)†	1.16 (1.10, 1.22)†	1.06 (1.01, 1.12)†	0.99 (0.94, 1.04)	1.04 (0.98, 1.09)	1.05 (1.00, 1.11)	1.02 (0.97, 1.08)	1.01 (0.95, 1.06)	0.96 (0.91, 1.01)
Relative change from 2019 to 2020, %	11%	12%	16%	6%	-1%	4%	5%	2%	1%	-4%

AGENT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
ANTIBIOTICS	Number of residents with prescription dispensed per 1,000 residents serviced									
LEVOFLOXACIN										
2019	39.0	33.8	34.6	32.8	32.1	30.2	27.9	27.8	28.8	29.4
2020	34.5	28.8	31.1	26.7	25.1	22.6	24.5	23.9	23.2	23.7
PR 2020 v 2019 (95% CI)	0.88 (0.85, 0.92)†	0.85 (0.81, 0.89)†	0.90 (0.86, 0.94)†	0.81 (0.77, 0.85)†	0.78 (0.74, 0.82)†	0.75 (0.71, 0.79)†	0.88 (0.83, 0.92)†	0.86 (0.82, 0.91)†	0.81 (0.77, 0.85)†	0.81 (0.77, 0.85)†
Relative change from 2019 to 2020, %	-12%	-15%	-10%	-19%	-22%	-25%	-12%	-14%	-19%	-19%
NITROFURANTOIN										
2019	17.7	16.6	17.7	17.5	17.2	17.6	17.7	17.9	17.0	17.5
2020	17.8	16.2	16.4	16.5	18.0	17.8	17.2	17.3	17.0	17.4
PR 2020 v 2019 (95% CI)	1.00 (0.95, 1.06)	0.97 (0.91, 1.03)	0.92 (0.87, 0.98)†	0.94 (0.88, 1.00)	1.04 (0.98, 1.11)	1.01 (0.95, 1.07)	0.97 (0.91, 1.03)	0.97 (0.91, 1.03)	1.00 (0.94, 1.07)	1.00 (0.94, 1.06)
Relative change from 2019 to 2020, %	0%	-3%	-8%	-6%	4%	1%	-3%	-3%	0%	0%
TRIMETHOPRIM-SULFAMETHOXAZOLE										
2019	22.9	22.5	22.6	22.6	23.7	22.9	24.3	24.4	23.3	23.1
2020	22.9	20.2	22.2	20.5	22.6	21.4	20.9	21.0	21.4	20.8
PR 2020 v 2019 (95% CI)	1.00 (0.95, 1.05)	0.90 (0.85, 0.95)†	0.98 (0.93, 1.03)	0.91 (0.86, 0.96)†	0.95 (0.90, 1.01)	0.93 (0.88, 0.99)†	0.86 (0.82, 0.91)†	0.86 (0.82, 0.91)†	0.92 (0.87, 0.97)†	0.90 (0.85, 0.95)†
Relative change from 2019 to 2020, %	0%	-10%	-2%	-9%	-5%	-7%	-14%	-14%	-8%	-10%
DRUGS INVESTIGATED FOR COVID-19 TREATMENT	Number of residents with prescription dispensed per 1,000 residents serviced									
DEXAMETHASONE										

2019	4.6	4.4	3.9	4.5	4.7	4.5	4.3	4.8	4.9	4.8
2020	4.6	4.5	4.1	2.9	2.9	4.9	17.3	16.2	9.5	14.9
PR 2020 v 2019 (95% CI)	1.00 (0.89, 1.12)	1.02 (0.90, 1.14)	1.04 (0.92, 1.18)	0.64 (0.55, 0.73)†	0.61 (0.53, 0.71)†	1.09 (0.97, 1.24)	4.03 (3.66, 4.45) †	3.37 (3.07, 3.71)†	1.96 (1.77, 2.17)†	3.11 (2.83, 3.42)†
Relative change from 2019 to 2020, %	0%	2%	4%	-36%	-39%	9%	303%	237%	96%	211%
AGENT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
DRUGS INVESTIGATED FOR COVID-19 TREATMENT Number of residents with prescription dispensed per 1,000 residents serviced										
FAMOTIDINE										
2019	18.8	18.0	18.9	19.4	19.4	19.5	19.9	20.0	18.4	29.9
2020	26.1	23.1	24.7	30.7	23.0	23.8	26.4	25.2	23.8	26.5
PR 2020 v 2019 (95% CI)	1.39 (1.32, 1.46)†	1.28 (1.21, 1.36)†	1.30 (1.24, 1.38)†	1.59 (1.50, 1.67)†	1.19 (1.12, 1.26)†	1.22 (1.15, 1.29)†	1.33 (1.26, 1.40) †	1.26 (1.19, 1.33)†	1.29 (1.22, 1.37)†	0.89 (0.85, 0.93)†
Relative change from 2019 to 2020, %	39%	28%	30%	59%	19%	22%	33%	26%	29%	-11%
HYDROXYCHLOROQUINE SULFATE										
2019	2.6	2.4	2.5	2.6	2.4	2.5	2.3	2.7	2.5	2.7
2020	2.6	2.1	3.3	17.1	4.9	2.4	3.6	3.4	3.2	3.7
PR 2020 v 2019 (95% CI)	1.00 (0.86, 1.17)	0.88 (0.74, 1.04)	1.32 (1.13, 1.53)†	6.63 (5.87, 7.48)†	2.01 (1.74, 2.33)†	0.97 (0.82, 1.15)	1.53 (1.31, 1.79) †	1.26 (1.08, 1.46)†	1.25 (1.07, 1.47)†	1.35 (1.17, 1.56)†
Relative change from 2019 to 2020, %	0%	-12%	32%	563%	101%	-3%	53%	26%	25%	35%
PREDNISONE										
2019	47.9	45.3	45.4	43.8	44.4	40.3	39.7	38.1	38.8	40.6
2020	49.0	43.5	39.0	28.9	27.6	29.8	31.6	31.1	31.1	32.7
PR 2020 v 2019 (95% CI)	1.02 (0.99, 1.06)	0.96 (0.93, 1.00)†	0.86 (0.83, 0.89)†	0.66 (0.63, 0.69)†	0.62 (0.59, 0.65)†	0.74 (0.71, 0.77)†	0.80 (0.76, 0.83) †	0.82 (0.78, 0.85)†	0.80 (0.77, 0.84)†	0.81 (0.77, 0.84)†
Relative change from 2019 to 2020, %	2%	-4%	-14%	-34%	-38%	-26%	-20%	-18%	-20%	-19%
ZINC										

2019	2.8	2.6	2.3	2.4	2.3	2.2	2.3	2.5	1.8	1.6
2020	2.0	1.6	1.7	6.0	4.3	3.3	3.4	5.3	4.0	11.8
PR 2020 v 2019 (95% CI)	0.71 (0.61, 0.84)†	0.61 (0.51, 0.73)†	0.71 (0.60, 0.85)†	2.55 (2.21, 2.93)†	1.89 (1.63, 2.20)†	1.48 (1.26, 1.74)†	1.49 (1.27, 1.74) †	2.13 (1.85, 2.46)†	2.17 (1.84, 2.56)†	7.42 (6.39, 8.62)†
Relative change from 2019 to 2020, %	-29%	-39%	-29%	155%	89%	48%	49%	113%	117%	642%

Abbreviations: CI, confidence interval; PR, prevalence ratio

^a PRs were derived using a log binomial regression model, comparing with year as a categorical variable and the year 2019 as the reference.

^b Confidence intervals that do not overlap the null value of PR=1 are indicated with †

FIGURE LEGENDS

Figure 1. Relative Percent Change in Prescribing of Drugs Investigated for COVID-19 Treatment Among Nursing Home Residents, January Through October, From 2019 to 2020.

The relative percent change in the prevalence of nursing home residents with a prescription dispensed for hydroxychloroquine, azithromycin, famotidine, and dexamethasone in January through October, comparing monthly values in 2019 to 2020. Data were obtained from PharMerica, a BrightSpring Health Services company.

Figure 2. Number of Nursing Home Residents With a Prescription Dispensed for Total Antibiotics, Total Antibiotics Without Azithromycin, Azithromycin, and Ceftriaxone per 1,000 Residents Served, From January to October, 2019 versus 2020.

The figure shows eight trend lines of monthly antibiotic prescribing per 1,000 nursing home residents serviced from January to October in 2019 and 2020: the number of nursing home residents with any antibiotic prescription dispensed, the number of nursing home residents with an antibiotic prescription dispensed that was not azithromycin, the number of nursing home residents with an azithromycin prescription dispensed, and the number of nursing home residents with a ceftriaxone prescription dispensed. Data were obtained from PharMerica, a BrightSpring Health Services company.

Figure 1

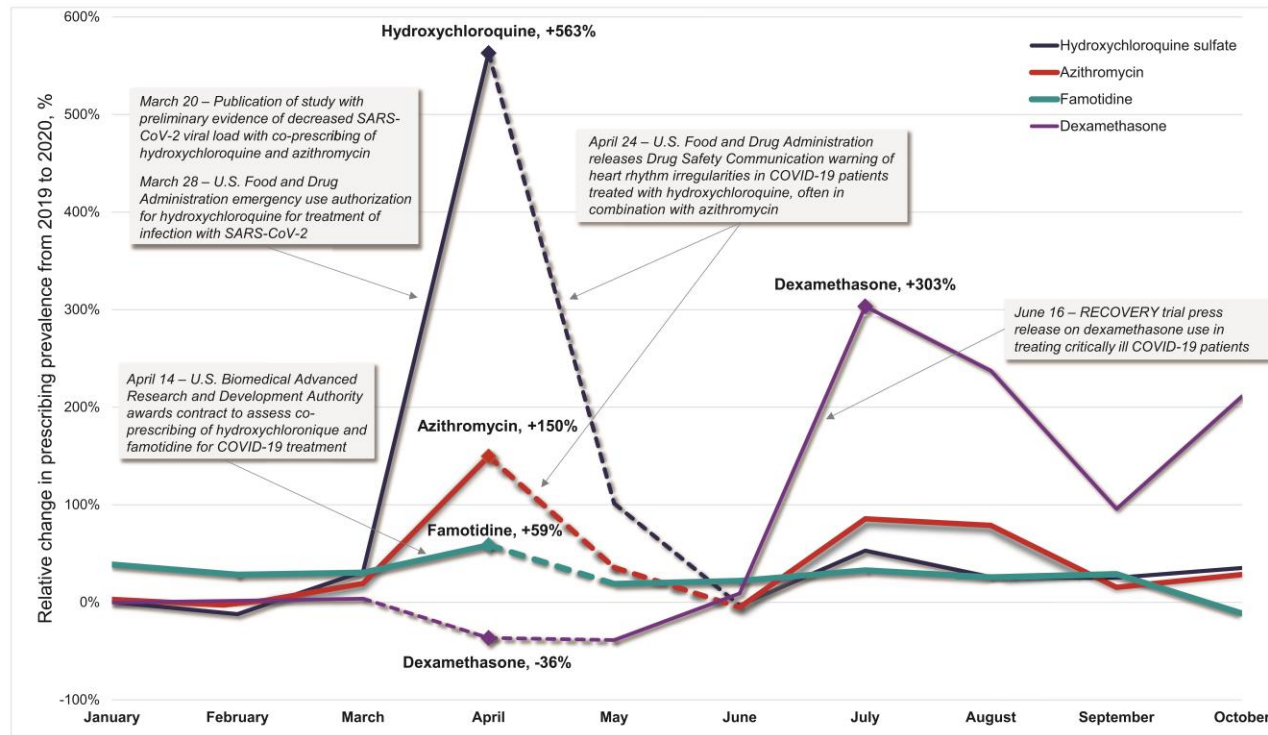


Figure 2

