Reporting of Infectious Diseases in the United States During the Coronavirus Disease 2019 (COVID-19) Pandemic

Matthew A. Crane,1,2,3,4 D. Miller Research Building, 733 North Broadway, Suite 137, Baltimore, MD 21205-2196, USA; and Matthew A. Crane, Johns Hopkins University School of Medicine, Edward D. Miller Research Building, 733 North Broadway, Suite 137, Baltimore, MD 21205-2196, USA

Correspondence: M. A. Crane, Johns Hopkins University School of Medicine, Edward D. Miller Research Building, 733 North Broadway, Suite 137, Baltimore, MD 21205-2196, USA (crane@jhu.edu).

Received 3 May 2021; editorial decision 1 June 2021; published online 7 June 2021.

© The Author(s) 2021. Published by Oxford University Press for the Infectious Diseases Society of America. All rights reserved. For permissions, e-mail: journals.permissions@oup.com.

Clinical Infectious Diseases® 2021;XX(XX):0–0
DOI: 10.1093/cid/ciab529

BRIEF REPORT • CID 2021:XX (XX XXXX) • 1

The coronavirus disease 2019 (COVID-19) pandemic has led to substantial changes in population behaviors within the United States, potentially resulting in altered patterns of exposure to other infectious pathogens [1]. Evidence suggests the same nonpharmaceutical interventions employed to prevent transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) likely led to reduced incidence of influenza in the United States and other countries in 2020 [2, 3]. The COVID-19 pandemic has also caused disruptions in the reporting of other infectious diseases. It has been shown that reporting of sexually transmitted diseases (STDs) was reduced during national surges in COVID-19 incidence [4] and STD programs nationwide report reappropriation of resources towards COVID-19 response, with disruption of typical disease intervention services [5]. Understanding the impact of the COVID-19 pandemic on transmission patterns of other infectious diseases holds significant implications for public health, but this topic has not yet been studied within the United States. We analyzed national- and state-level surveillance data from 2015 to 2021 to better understand how infectious diseases reporting changed during the COVID-19 pandemic and how such changes may have varied by geography and route of transmission.

METHODS

We analyzed data from the Nationally Notifiable Diseases Surveillance System (NNDSS) maintained by the Centers for Disease Control and Prevention (CDC) [6]. The NNDSS reports weekly provisional data on diseases and conditions from all 50 states and the District of Columbia. We collected data on 42 NNDSS-reported human diseases from 2015 to 2021. Diseases were analyzed if more than 50 cases were recorded in both 2019 and 2020. Two steps were taken to avoid counting cases multiple times: when probable cases were reported alongside confirmed cases for a particular disease, only confirmed cases were included. Additionally, if cases of different serotypes of a disease were reported individually in addition to an “all serotypes” category, we included only the “all serotypes” category.

To investigate differences in reporting by route of transmission, diseases reported by the NNDSS were classified into 5 categories by main route of transmission: sexually transmitted, foodborne/waterborne, vectorborne, injection drug use–associated, and respiratory (Supplementary Table 1). For each route, we compiled annual and weekly incident case counts. For context, we included incident daily COVID-19 cases alongside trends in transmission routes [7]. We also analyzed geographic differences in disease reporting by comparing year-end case totals across diseases between all 50 states and Washington, DC. This study was determined to not constitute human subjects research by the Johns Hopkins Medicine Institutional Review Board.

RESULTS

Reporting Differences by Route of Transmission

We found substantial differences in reporting of diseases between 2019 and 2020 by route of transmission. The greatest relative decrease in reporting compared with 2019 levels was in respiratory diseases (76 147 cases in 2019, 37 558 cases in 2020; −50.7%). Significant decreases in reported cases were also found among injection drug use–associated diseases (6143 in 2019, 3246 in 2020; −47.2%), vectorborne diseases (12 737 in 2019, 7184 in 2020; −43.6%), and foodborne/waterborne diseases (186 491 in 2019, 112 387 in 2020; −39.7%). Sexually
transmitted diseases accounted for the largest proportion of the total difference among all reported cases, but the smallest percentage difference among the 5 categories analyzed (2 141 404 in 2019, 1 933 109 in 2020; −9.7%) (Figure 1A).

Analysis over time showed a coinciding increase in COVID-19 cases and decrease in weekly reporting of other infectious diseases nationwide. The COVID-19 pandemic was declared a national emergency in the United States on 13 March 2020. Prior to this date, we note a relative increase in 2020 at time points for all transmission routes. Following the emergency declaration, however, we found that weekly reported cases of respiratory diseases were consistently 50% below 2019 cases (median relative change by week: −52.0%; interquartile range [IQR]: −58.0% to −41.6%). Reporting for vectorborne (median relative change by week: −42.7%; IQR: −58.0% to −25.1%), foodborne (median relative change by week: −52.2%; IQR: −58.1% to −43.8%), and injection drug use–associated (median relative change by week: −54.8%; IQR: −76.2% to −36.7%) routes similarly showed consistent decreases for the remainder of 2020. Reporting of STDs decreased at most time points but increased towards the end of 2020 and showed greater variability overall (median relative change: −24.0%; IQR: −30.8% to 4.2%) (Figure 1B).

The individual diseases with the largest decreases in reported cases between 2020 and 2019 are also shown. We note the particularly significant decreases in cases of chlamydia (−234 007; −14.9%) and campylobacteriosis (−24 581; −37.9%) (Figure 1C). These findings underscore the large number of reported cases of sexually transmitted and foodborne/waterborne diseases analyzed, respectively, accounting for 63.6% and 22.6% of the decrease in total cases of all diseases observed from 2020 to 2019. In order to investigate whether year-specific reporting variations in 2019 may

Figure 1. Nationally Notifiable Disease Reporting in the United States, 2019–2020. Panel A shows relative change in 2020 compared with 2019 for the year-end cumulative count of all reported cases within each route of transmission. Panel B shows relative change between weekly new provisional cases in 2020 compared with 2019, as reported by end date of epidemiologic week. Relative change is shown as a moving 5-week average of the difference between epidemiologic weeks in 2020 compared with 2019. The second vertical axis shows the moving 7-day average of new daily COVID-19 cases reported nationally in 2020 [7]. The final epidemiologic week of 2020 (week 53) is not shown in the figure. Some data were excluded in the panel for vectorborne diseases prior to week 2 and injection drug use–associated diseases prior to week 2, and at week 5 due to minor reporting abnormalities resulting in an excessive relative difference. Panel C shows the diseases with the largest relative and absolute decreases in year-end cumulative count of reported cases in 2020 compared with 2019. COVID-19 is not tabulated among other nationally notifiable infectious diseases in this panel. Panel D shows relative change in 2020 compared with 2019 for the year-end cumulative count of all reported cases of all routes of transmission by all 50 US states. The District of Columbia is not pictured. Abbreviation: COVID-19, coronavirus disease 2019.
have influenced our findings, we also investigated reporting relative to the 5-year mean of provisional cases and found largely consistent results. We found that reported cases of 37 of the 42 diseases decreased in 2020 relative to 2019 counts and reported cases of 33 of the 42 diseases decreased in 2020 relative to the 5-year mean from 2015–2019 (Supplementary Table 1).

Reporting Differences by Geography
Analysis of case totals among all diseases between states demonstrated variation by geography but decreased reporting in a majority of states (median change among total cases: −14.4%; IQR: −29.6% to −14.4%). Five states exhibited a decrease in cases in 2020 relative to 2019 that exceeded 50%: Hawaii (8588 in 2019 to 2118 in 2020; −75.3%), Kentucky (20,003 to 10,139; −66.2%), Nebraska (14,033 to 4931; −64.9%), Missouri (54,168 to 22,472; −58.5%), and North Dakota (5700 to 2558; −55.1%). We found 5 states with a relative decrease from 40% to 49%, 3 states with a relative decrease from 30% to 39%, 7 states with a relative decrease from 20% to 29%, and 16 states with a relative decrease from 10% to 19%. We also found 8 states with increases in reported cases in 2020, most notably South Carolina (23,722 to 55,186; 132%) (Figure 1D). We also examined the 5-year mean in all cases reported by states and found similar but reduced results when looking beyond 2019, with 34 states showing decreased reporting relative to mean case totals from 2015–2019 (median change by state: −5.9%; IQR: −20.5% to 4.0%) (Supplementary Table 2). On standard linear regression we found no trend when looking beyond 2019, with 34 states showing decreased reporting relative to the 5-year mean from 2015–2019 (median change by state: −5.9%; IQR: −20.5% to 4.0%) (Supplementary Table 2). On standard linear regression we found no trend between cumulative annual COVID-19 cases per 100,000 population and the relative difference in reporting from 2019 to 2020 (Supplementary Figure 1).

Reporting Differences Through March 2021
We also investigated differences in reporting from mid-March 2020 to mid-March 2021, and found that reporting of 28 of 42 diseases decreased in this comparison (median change between cases in 2021 relative to 2020: −36.6%; IQR: −64.8% to 15.7%) (Supplementary Table 3). On state-level analysis, 28 states showed a decrease in total cases reported to date (median change among total cases by state: −7.0%; IQR: −15.1% to 11.1%) (Supplementary Table 4). Conclusions from these data are limited by smaller case numbers for comparison and differential timing of typical reporting by state to the CDC.

DISCUSSION
We found decreased reporting of almost all nationally notifiable infectious diseases and conditions during the COVID-19 pandemic. These decreases were found nationwide and at the state level. Decreases varied by route of transmission, with STDs the least reduced and respiratory infections the most reduced. Transmission routes of foodborne/waterborne, vectorborne, and injection drug use–associated routes also exhibited marked reduction in comparison to prior years.

It is unknown whether the observed decrease in reporting indicates a true decrease in disease or an impairment of typical disease reporting during the COVID-19 pandemic. Both factors likely contributed to our findings. Our study is limited by a reliance on provisional data from a single database. These data will be updated and finalized over time as cases are investigated and fully tabulated [8]. In order to mitigate limitations posed by provisional data use, we compared only provisional case counts in our analysis between years. Furthermore, our conclusions regarding patterns of disease transmission are limited by the selection of diseases that are nationally notifiable.

Time series analysis and state differences suggest that disease-detection systems were impacted by the pandemic. This hypothesis is supported by practitioner accounts and the known phenomenon of medical care avoidance during the pandemic [5, 9, 10]. This idea is also supported by the discrepancy between our observed decrease in injection drug use–associated diseases with recent reports of increased drug overdose deaths during the pandemic [11]. Differences between transmission routes suggest that behavioral changes have also impacted transmission patterns. This hypothesis is supported by observational studies on influenza as well as a similar analysis conducted on notifiable diseases in Australia [2, 3, 12].

These results indicate a need for robust surveillance in the wake of the COVID-19 pandemic to respond to potentially undiscovered patterns of disease transmission. Furthermore, they point to preliminary consequences of infectious disease resource reallocation for COVID-19 response and underscore the need for continual investment in routine surveillance efforts despite pandemic conditions. As healthcare systems return to prepandemic conditions, additional attention will be necessary to compensate for prior medical care avoidance and engage patients with underreported conditions, both to reduce immediate morbidity as well as to promote public health.

Supplementary Data
Supplementary materials are available at Clinical Infectious Diseases online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes
Author contributions. M. A. C., A. P., J. A. R., and K. G. G designed the study. M. A. C., A. P., and R. P. collected and analyzed data. M. A. C. wrote the first draft of the manuscript. All authors contributed to developing the manuscript and provided input on the final manuscript.

Acknowledgments. We acknowledge assistance from Tushar Jois (Johns Hopkins University), who provided uncompensated assistance in data collection. We are grateful to the Centers for Disease Control and Prevention Division of Health Informatics and Surveillance for maintaining the Nationally Notifiable Diseases Surveillance System and we are grateful to
the healthcare providers and public health professionals who have contributed towards data collection.

Financial support. The authors report no financial support.

Potential conflicts of interest. K. G. G. reports 2018 travel support from Roche Diagnostics for travel to attend diagnostics meeting in Vienna, outside the submitted work. J. A. R. reports contracts/grants from Bureau of Economic Analysis, UCLA, paid to his, and grants/contracts from National Institute on Aging, Cedars-Sinai, California Hospital Association, paid to his institution, both outside the submitted work. All other authors report no potential conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Crane MA, Shermock KM, Omer SB, Romley JA. Change in reported adherence to nonpharmaceutical interventions during the COVID-19 pandemic, April-November 2020. JAMA 2021; 325:883–5.
2. Olsen SJ, Azziz-Baumgartner E, Budd AP, et al. Decreased influenza activity during the COVID-19 pandemic—United States, Australia, Chile, and South Africa, 2020. MMWR Morb Mortal Wkly Rep 2020; 69:1305–9.
3. Cowling BJ, Ali ST, Ng TWY, et al. Impact assessment of non-pharmaceutical interventions against coronavirus disease 2019 and influenza in Hong Kong: an observational study. Lancet Public Health 2020; 5:e279–88.
4. Crane MA, Popovic A, Stolbach AI, Ghanem KG. Reporting of sexually transmitted infections during the COVID-19 pandemic. Sex Transm Infect 2021; 97:101–2.
5. National Coalition of STD Directors. Covid-19 & the state of the STD field: phase III. Available at: https://www.ncsddc.org/wp-content/uploads/2021/01/COVID19-State-of-STD-Field-Phase-III-Report-1.28.21-FINAL-1.pdf. Accessed 29 April 2021.
6. Centers for Disease Control and Prevention. National Notifiable Diseases Surveillance System, Weekly Tables of Infectious Disease Data. Atlanta, GA: CDC Division of Health Informatics and Surveillance. Available at: https://www.cdc.gov/nndss/infectious-tables.html. Accessed 29 April 2021.
7. Dong E, Du H, Gardner L. An interactive web-based dashboard to track COVID-19 in real time. Lancet Infect Dis 2020; 20:533–4.
8. Centers for Disease Control and Prevention. National Notifiable Diseases Surveillance System, readers’ guide: understanding weekly and annual national notifiable diseases surveillance system WONDER tables. Atlanta, GA: CDC Division of Health Informatics and Surveillance. Available at: https://www.cdc.gov/nndss/docs/Readers-Guide-WONDER-Tables-20210421-508.pdf. Accessed 25 May 2021.
9. Czeisler ME, Marynak K, Clarke KEN, et al. Delay or avoidance of medical care because of COVID-19-related concerns—United States, June 2020. MMWR Morb Mortal Wkly Rep 2020; 69:1250–7.
10. Anderson KE, McGinty EE, Presskreischer R, Barry CL. Reports of forgone medical care among US adults during the initial phase of the COVID-19 pandemic. JAMA Netw Open 2021; 4:e2034882.
11. Ahmad FB, Rossen LM, Sutton P. Provisional drug overdose death counts. National Center for Health Statistics. 2021. Available at: https://www.cdc.gov/nchs/mvsr/vsr/drug-overdose-data.htm. Accessed 29 April 2021.
12. Adegbija O, Walker J, Smoll N, Khan A, Graham J, Khandaker G. Notifiable diseases after implementation of COVID-19 public health prevention measures in Central Queensland, Australia. Commun Dis Intell (2018) 2021;45. doi: 10.3322/cdi.2021.045.11. Epub ahead of print, 26 February 2021.