The Impact of the COVID-19 Pandemic on Respiratory Illness Admissions at a Single Academic Institution in Arkansas

Mallory Heft 1,*, Joshua Mueller 2, Hanna Jensen 3, Nicholas Kaukis 4 and Mollie Meek 3

1 College of Medicine, University of Arkansas for Medical Sciences, Little Rock, AR 72205, USA  
2 Department of Internal Medicine, University of Arkansas for Medical Sciences, Little Rock, AR 72205, USA  
3 Department of Radiology, University of Arkansas for Medical Sciences, Little Rock, AR 72205, USA  
4 Department of Biostatistics, University of Arkansas for Medical Sciences, Little Rock, AR 72205, USA  
* Correspondence: meheft@uams.edu

Abstract: Background: The first reported COVID-19 case in Arkansas was on 11 March 2020, two months after the first reported case in the United States. We sought to analyze rates of respiratory illness and influenza tests during the 2019/2020 influenza season compared to pre-pandemic years to assess whether there were higher rates of respiratory illness than expected, which may suggest undiagnosed COVID-19 cases. Methods: Using data collected from the data warehouse of the largest hospital in Arkansas, ICD-9 and ICD-10 codes related to respiratory illness were identified for 1 October to 1 May 2017–2020. Results: We identified 25,747 patients admitted with respiratory illness during the study. We found no significant difference in the rate of monthly admissions with respiratory illness between seasons (p = 0.14). We saw a significant increase in the number of influenza tests ordered in 2019/2020 (p < 0.01). Conclusions: The rate of hospitalizations with respiratory illness did not significantly increase during the 2019/2020 season; however, influenza testing increased without a statistically significant difference in positivity rate. The increase in ordered influenza tests indicates an increased clinical suspicion, which may suggest a rise in pre-hospital viral illness associated with COVID-19.

Keywords: public health; rural health; COVID-19

1. Introduction

The first COVID-19 case reported in Arkansas was on 11 March 2020, almost two months after the first reported case in the United States (US) [1]. The largest hospital in Arkansas, the University of Arkansas for Medical Sciences (UAMS), admitted its first patient with COVID-19 on 13 March 2020 [1]. Most research studies at the beginning of the pandemic focused on larger and more urbanized states, such as California, New York, and Washington. Testing for SARS-CoV-2 was more robust in these states than in rural states [2]. This may be the result of deficits in testing capabilities due to fewer authorized labs or limited supplies and storage abilities.

From the beginning of the pandemic, it was quickly discovered that COVID-19 was disproportionately affecting individuals with diabetes mellitus, hypertension, and obesity [3]. According to the Centers for Disease Control and Prevention (CDC), Arkansas is among the highest prevalence states for diabetes mellitus, hypertension, and obesity [4–6]. Despite Arkansas having a largely vulnerable population, there was a delay in identified emergence of COVID-19 in our state compared to more urbanized states. While many rural states experienced their first COVID-19 cases later than more urbanized areas, it is unclear whether it was an actual delay in emergence or a false sense of security due to decreased research and testing.

This study sought to find if there was a difference in the rate of respiratory illness admissions at UAMS during the 2019/2020 influenza season compared to the previous seasons beginning in 2017. A difference in respiratory illness admissions could imply...
an earlier effect of COVID-19 than detected by testing. Furthermore, we analyzed the
positivity rates of influenza tests performed. Increases in respiratory illness without a
parallel increase in positivity rates of common respiratory illnesses may suggest COVID-19
cases that were undetected.

2. Methods
2.1. Data Collection

An institutional review board (IRB) exemption was granted for this retrospective study
of data from the in-house data warehouse, Arkansas Clinical Data Repository (AR-CDR),
which stores information from the electronic medical records for patients from the UAMS
in Little Rock, AR. The data extracted from the AR-CDR included diagnostic information,
procedural information, influenza volume of tests, and influenza test results. We used
diagnostic information to identify the volume of patients with specific comorbidities of
diabetes, hypertension, and obesity. Our study included any person admitted with an
ICD-9 or ICD-10 code corresponding to respiratory illness (Table 1) for influenza seasons
between 2017–2020, with 1 October to 1 May representing each season. ICD-9 and ICD-10
codes were chosen based on a literature review concerning previous influenza surveillance
studies to determine which codes would help extract the appropriate data [7–13]. Patients
younger than 15 were excluded due to studies indicating COVID-19 was not primarily
affecting this age group at the beginning of the pandemic [3,14,15]. The original dataset
given to the principal investigator included only patients admitted to UAMS during the
specific time frame with the ICD-9 or ICD-10 codes corresponding to respiratory illness.
Each patient had a unique de-identified code.

Table 1. ICD-9 Or ICD-10 Codes Utilized to Extract Data from the Institutional Data Warehouse at
the University of Arkansas for Medical Sciences.

| Diagnosis                              | ICD-9 Code | ICD-10 Code |
|----------------------------------------|------------|-------------|
| Influenza                              | 487–488    | J09–J11     |
| Pneumonia                              | 480–486    | J12–J18     |
| Acute Upper Respiratory Infection      | 460–465    | J00–J06     |
| Respiratory Diseases                   | 466–519    | J00–J99     |
| Circulatory Diseases                   | 390–459    | I00–I99     |
| Fever, Unspecified                     | 780.60     | R50.9       |
| Cough                                  | 786.20     | R05         |
| Throat Pain                            | 786.20     | R07         |
| Unspecified Viral Infection            | 079.99     | B97.89      |
| Unspecified Otitis Media               | 382.90     | H66.9       |
| Respiratory Arrest                     | 799.1      | R09.2       |
| Shortness of Breath                    | 786.05     | R06.02      |
| COVID-19, Confirmed Diagnosis          | -          | U07.1       |
| Symptoms of COVID-19 with known exposure| -          | Z20.828     |
| Coronavirus infection, unspecified     | -          | B34.2       |
| Coronavirus as cause of diseases classified elsewhere | - | B97.29 |

2.2. Statistical Analysis

To ensure comparability across seasons, we calculated weekly and monthly rates of
respiratory-related admissions, volume of influenza tests, and positivity rate of influenza
tests, each standardized by the number of admitted patients within a given week. Single-
factor ANOVA was conducted to evaluate the difference in rates of respiratory-related
illness admissions across seasons. Chi-squared tests were utilized to assess volume counts
for influenza tests and comorbidities. The statistical software used was R version 4.1.0, and
statistical significance was assumed at ($p < 0.05$).
3. Results

During 1 October 2017–2020 through 1 May seasons, 25,747 patients were admitted for respiratory illness at UAMS in Little Rock, AR. Total yearly admission volumes for respiratory illnesses increased from 2017/2018 to 2018/2019; however, they minimally changed from 2018/2019 to 2019/2020 (Table 2). When comparing the rate of monthly admissions for respiratory illness across seasons, there was no significant difference ($p = 0.14$). Respiratory admissions appear to peak in December and January (Table 2). There was a slightly higher admission rate for 2019/2020 from October through February compared to other seasons (Table 2); however, there is no statistically significant difference between these rates ($p = 0.32$).

Table 2. Total Yearly Volume and Monthly Rate $^*$ of Patients Admitted to UAMS with an ICD-9 or ICD-10 code Correlated to Respiratory Illness.

| Season (1 October–1 May) | Volume of Respiratory Illness Admissions | October | November | December | January | February | March | April |
|--------------------------|----------------------------------------|---------|----------|----------|---------|----------|-------|-------|
| 2017–2018                | 8313                                   | 11.7%   | 13.2%    | 14.1%    | 14.6%   | 13.8%    | 15.3% | 14.6% |
| 2018–2019                | 8719                                   | 12.4%   | 13.3%    | 14.4%    | 14.4%   | 13.6%    | 15.3% | 14.2% |
| 2019–2020                | 8715                                   | 12.9%   | 14.8%    | 15.0%    | 15.8%   | 15.4%    | 14.2% | 9.6%  |

* The monthly rate represents patients admitted with ICD-9 or ICD-10 codes corresponding to respiratory illness out of the total volume of patients admitted to UAMS each month.

Despite no significant difference in the rate of positive influenza tests between seasons, there was a significant difference in the volume of influenza tests ordered ($p < 0.01$). As shown in Table 3, more influenza tests were performed in the 2019/2020 season without a statistically significant change in positivity rate ($p = 0.51$).

Table 3. Total Volume of Influenza Tests Performed with the Corresponding Positivity Rate.

| Season (1 October–1 May) | Total Number of Influenza Tests Performed | Influenza Positive Test Rate |
|--------------------------|------------------------------------------|------------------------------|
| 2017–2018                | 2594                                     | 3.2%                         |
| 2018–2019                | 3492                                     | 1.8%                         |
| 2019–2020                | 4273                                     | 2.0%                         |

The two most common comorbidities were diabetes mellitus and hypertension. A statistically significant increase in patients having diabetes mellitus (DM), hypertension (HTN), and obesity was found in the 2019/2020 season (DM $p < 0.01$, HTN $p < 0.01$, and Obesity $p < 0.01$).

4. Discussion

This study showed no difference in the rate of hospital admissions with respiratory illness at a single academic institution for the 2019/2020 season. However, data shows a statistically significant increase in influenza tests ordered in the 2019/2020 season. There was no significant difference in the positivity rate for influenza across seasons. There was a statistically significant increase in patients with diabetes, hypertension, and obesity in 2019/2020 compared to the previous years.

We hypothesized that the admission rate for patients with respiratory illness at UAMS would be higher for the 2019/2020 season, but with less frequently positive influenza tests, potentially due to the unknown presence of COVID-19, leading to misdiagnosis as influenza or other respiratory illness. While some believe living in a rural community insulates and protects individuals from infection compared to urban areas, this may not be the case. Rural jobs tend to be industrial and, therefore, cannot be moved online [16]. This requires showing up and working in close quarters with others. Henning-Smith et al. reported that
rural areas, on average, have older populations and more people with underlying health conditions [17].

Despite Little Rock, AR, not being a rural area, UAMS serves as the state’s primary tertiary care medical center. According to the University of Arkansas Department of Agriculture, 44% of Arkansas residents live in rural areas, while only 14% of the US population lives in rural areas [18]. These factors make social distancing more difficult and increase the risk of COVID-19 infection. Huang et al. published a study concerning the epidemiology of the COVID-19 pandemic in South Carolina from 1 March to 5 September 2020. They found that when comparing case rates of COVID-19 between urban versus rural counties in South Carolina, rural counties had higher case rates [19]. According to the South Carolina Institute of Medicine and Public Health, 29% of the state’s population lives in rural areas [20]. This highlights the importance of increasing knowledge concerning the epidemiology of the COVID-19 pandemic in rural states.

The clinical presentation of COVID-19 is nonspecific, like other respiratory illnesses, including influenza. Retrospective studies from the pandemic’s beginning in Wuhan, China, reported that 94% of patients with COVID-19 presented with fever, and 72–82% presented with cough [14,15]. Data released from the US CDC also reported fever and cough as the most prominent symptoms of COVID-19 during the early pandemic [3]. Previous studies conducted in the US to evaluate the clinical presentation of influenza have found fever and cough to be the strongest indicators of influenza [11,21,22]. With similar clinical presentation and limitations in diagnostic tests, it is possible to misdiagnose COVID-19 as influenza, especially in the months prior to March 2020, when we were unaware of its presence in Arkansas, yet it was in the US.

Due to decreased testing rates and less stringent restrictions on travel and physical distancing in Arkansas and other rural states, we wanted to see if there was an increase in inpatient admissions for respiratory illness potentially due to undiagnosed cases of COVID-19. The volume of influenza tests ordered significantly increased during the 2019/2020 season, suggesting a higher clinical suspicion for influenza or respiratory illness symptoms, leading to increased testing. The positivity rate tests for influenza showed no statistically significant change across seasons. Furthermore, the weekly influenza report released on 7 March 2020 from the Arkansas Department of Health indicates that the percent of outpatient visits with influenza-like illness was higher for 2019/2020 compared to 2018/2019 and higher than the average for 2013–2018 [23]. Likewise, the same report shows a sharp decrease in positive influenza tests for influenza A and B around week 6 of 2020 [23]. Considering COVID-19 has a similar presentation to influenza, it would not be unreasonable to postulate these people with negative influenza tests could have been infected with COVID-19. Our data show a statistically significant increase in patients admitted for respiratory illness with comorbidities of hypertension, obesity, and diabetes mellitus for the 2019/2020 season, which corresponds to a population known to be more vulnerable to COVID-19.

Interestingly, the SHARE study recently published by Veronese et al. found individuals older than 50 who received the influenza vaccine were at lower risk of COVID-19 infection, symptomatic forms of COVID-19, and hospitalization for COVID-19 [24]. According to the CDC in Arkansas, during 2019/2020, there was an estimated influenza vaccine coverage rate of 53.6% [25]. Though future research will need to be conducted to elucidate this relationship further, this could potentially explain why there was not an increase in hospital admissions for respiratory illness in 2019/2020, which represents more severe forms of COVID-19.

A limitation of this study is that ICD-9 and ICD-10 codes used in the study were selected in June 2020. At the time, little was known about COVID-19 surveillance; therefore, this study was modeled like other influenza surveillance studies, which could have led to selection bias. Another limitation of this study was that the original dataset had incomplete data for patient characteristics such as age and sex; thus, we could not analyze those characteristics in this study.
5. Conclusions

Various factors make Arkansas residents a more vulnerable population to COVID-19 infection, yet our data suggest a delayed impact in the influx of COVID-19 in Arkansas. Despite no difference in respiratory illness admissions at UAMS for the 2019/2020 season, the increased influenza testing in the same season suggests an increased clinical suspicion of respiratory illness. This finding, in addition to data provided by the Arkansas Department of Health for the 2019/2020 influenza season, could potentially correlate to a subtle increase in community COVID-19 cases. Considering our population only included hospitalized patients, it could be postulated that respiratory illness was increasing in outpatient clinics throughout Arkansas prior to seeing the influx of more severe cases in the hospital setting. Future studies could compare the 2020/2021 season to previous years to see if respiratory illness admissions increased at UAMS, considering the state did not truly experience the first peak wave of COVID-19 cases until January 2021 [26].

Author Contributions: N.K. was the statistician on this project and helped organize the original dataset received from the AR-CDR. M.M. and H.J. were the faculty advisors. They developed the initial hypothesis and guided M.H. through the research process. They assisted in editing the paper and providing constructive feedback. M.H. ensured the project progressed along from literature review, data extraction, data analysis, and manuscript drafting. J.M. assisted M.H. in writing the manuscript and further literature review. All authors have read and agreed to the published version of the manuscript.

Funding: The project was supported by the Translational Research Institute (TRI), grant UL1 TR003107 through the National Center for Advancing Translational Sciences of the National Institutes of Health (NIH). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Institutional Review Board Statement: An IRB exemption was granted by UAMS due to no patient identifiers used in this study. IRB number 261238.

Informed Consent Statement: Patient consent was waived due to use of deidentified data.

Data Availability Statement: All corresponding data can be accessed at this google drive link: https://drive.google.com/drive/folders/1iVovA8j2iFF4rs5qHTQ8vdWNENSJLImG?usp=sharing (accessed on 30 August 2022).

Acknowledgments: Clara Brown for her public health expertise advice. Judy Bennet for aiding in organizing the original dataset.

Conflicts of Interest: The authors declare no conflict of interest.

References
1. Ranck, J. UAMS Staff Reflects on Pandemic Two Years after First Arkansas COVID-19 Case. Available online: https://www.fox16.com/news/coronavirus/uams-staff-reflects-on-pandemic-two-years-after-first-arkansas-covid-19-case (accessed on 17 July 2022).
2. Souch, J.M.; Cossman, J.S. A Commentary on Rural-Urban Disparities in COVID-19 Testing Rates per 100,000 and Risk Factors. J. Rural Health 2020, 37, 188–190. [CrossRef] [PubMed]
3. Garg, S.; Kim, L.; Whitaker, M.; O’Halloran, A.; Cummings, C.; Holstein, R.; Prill, M.; Chai, S.J.; Kirley, P.D.; Alden, N.B.; et al. Hospitalization Rates and Characteristics of Patients Hospitalized with Laboratory-Confirmed Coronavirus Disease 2019—COVID-NET, 14 States, March 1–30, 2020. MMWR Morb. Mortal. Wkly. Rep. 2020, 69, 458–464. [CrossRef] [PubMed]
4. Centers for Disease Control and Prevention. Adult Obesity Prevalence Maps. 2021. Available online: https://www.cdc.gov/obesity/data/prevalence-maps.html (accessed on 5 January 2022).
5. Centers for Disease Control and Prevention. Hypertension Maps and Data Sources. 2021. Available online: https://www.cdc.gov/bloodpressure/maps_data.html (accessed on 23 January 2022).
6. Centers for Disease Control and Prevention. National and State Diabetes Trends. 2021. Available online: https://www.cdc.gov/diabetes/library/reports/reportcard/national-state-diabetes-trends.html (accessed on 23 January 2022).
7. Eick-Cost, A.A.; Hunt, D.J. Assessment of ICD-9-based Case Definitions for Influneza-Like Illness Surveillance. Med. Surveill. Mon. Rep. 2015, 22, 2–5.
8. Chow, E.J.; Rolfes, M.A.; O’Halloran, A.; Alden, N.B.; Anderson, E.J.; Bennett, N.M.; Billing, L.; Dufort, E.; Kirley, P.D.; George, A.; et al. Respiratory and Nonrespiratory Diagnoses Associated with Influenza in Hospitalized Adults. *JAMA Netw. Open* **2020**, *3*, e201323. [CrossRef] [PubMed]

9. Ortiz, J.R.; Neuzil, K.M.; Cooke, C.R.; Neradilek, M.B.; Goss, C.H.; Shay, D.K. Influenza Pneumonia Surveillance among Hospitalized Adults May Underestimate the Burden of Severe Influenza Disease. *PLoS ONE* **2014**, *9*, e113903. [CrossRef] [PubMed]

10. Moore, K.; Black, J.; Rowe, S.; Franklin, L. Syndromic surveillance for influenza in two hospital emergency departments. Relationships between ICD-10 codes and notified cases, before and during a pandemic. *BMC Public Health* **2011**, *11*, 338. [CrossRef] [PubMed]

11. Shah, S.C.; Rumoro, D.P.; Hallock, M.P.; Trenholme, G.M.; Gibbs, G.S.; Silva, J.C.; Waddell, M.J. Clinical Predictors for Laboratory-Confirmed Influenza Infections: Exploring Case Definitions for Influenza-Like Illness. *Infect. Control Hosp. Epidemiol.* **2015**, *36*, 241–248. [CrossRef] [PubMed]

12. U.S. Influenza Surveillance System: Purpose and Methods. Available online: https://www.cdc.gov/flu/weekly/overview.htm#anchor_1571167821424 (accessed on 2 May 2020).

13. Thompson, W.W.; Shay, D.; Weintraub, E.; Brammer, L.; Bridges, C.B.; Cox, N.J.; Fukuda, K. Influenza-Associated Hospitalizations in the United States. *JAMA* **2004**, *292*, 1333–1340. [CrossRef] [PubMed]

14. Ngandu, T.; Lehtisalo, J.; Solomon, A.; Levälahti, E.; Ahtiluoto, S.; Antikainen, R.; Bäckman, L.; Hänninen, T.; Jula, A.; Laatikainen, T.; et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: A retrospective cohort study. *Lancet* **2020**, *395*, 1054–1062. [CrossRef]

15. Miller, R.; Englund, K. Clinical presentation and course of COVID-19. *Clevel. Clin. J. Med.* **2020**, *87*, 384–388. [CrossRef] [PubMed]

16. Laughlin, L. Beyond the Farm: Rural Industry Workers in America. The United States Census Bureau. 2021. Available online: https://www.census.gov/newsroom/blogs/randomsamplings/2016/12/beyond_the_farm_rur.html (accessed on 18 January 2022).

17. Henning-Smith, C. The Unique Impact of COVID-19 on Older Adults in Rural Areas. *J. Aging Soc. Policy* **2020**, *32*, 396–402. [CrossRef] [PubMed]

18. Miller, W.; Wheeler, E. Rural Profile of Arkansas. University of Arkansas, Division of Agriculture, Research and Extension. Available online: https://www.uaex.uada.edu/publications/pdf/MP564.pdf (accessed on 30 August 2022).

19. Huang, Q.; Jackson, S.; Derakhshan, S.; Lee, L.; Pham, E.; Jackson, A.; Cutter, S.L. Urban-rural differences in COVID-19 exposures and outcomes in the South: A preliminary analysis of South Carolina. *PLoS ONE* **2021**, *16*, e0246548. [CrossRef] [PubMed]

20. Legend of Urban, Rural, and Very Rural Definitions. South Carolina Institute of Medicine and Public Health. Available online: http://www.scphi.org/wordpress/wp-content/uploads/2011/08/rural-health-report.pdf (accessed on 18 September 2022).

21. Boivin, G.; Hardy, I.; Tellier, G.; Maziade, J. Predicting Influenza Infections during Epidemics with Use of a Clinical Case Definition. *Clin. Infect. Dis.* **2000**, *31*, 1166–1169. [CrossRef] [PubMed]

22. Woolpert, T.; Brodine, S.; Lemus, H.; Waalen, J.; Blair, P.; Faix, D. Determination of clinical and demographic predictors of laboratory-confirmed influenza with subtype analysis. *BMC Infect. Dis.* **2012**, *12*, 129. [CrossRef] [PubMed]

23. Simmons, L.; McCartney, K.; Dillaha, J.; Cima, M. Outbreak Response/Epidemiology Influenza Weekly Report Arkansas 2019–2020. Available online: https://ssl-adh.ark.org/images/uploads/pdf/Weekly_Influenza_Report_Week_Ending_Saturday_March_7_2020.pdf (accessed on 17 July 2022).

24. Veronese, N.; Smith, L.; Di Gennaro, F.; Bruyère, O.; Yang, L.; Demurtas, J.; Maggi, S.; Sabico, S.; Al-Daghri, N.M.; Barbagallo, M.; et al. Influenza Vaccination and COVID-19 Outcomes in People Older than 50 Years: Data from the Observational Longitudinal SHARE Study. *Vaccines* **2022**, *10*, 899. [CrossRef] [PubMed]

25. Centers for Disease Control and Prevention. Influenza Vaccination Coverage for Persons 6 Months and Older. Available online: https://www.cdc.gov/flu/fluview/interactive-general-population.htm (accessed on 19 September 2022).

26. The New York Times. Arkansas Coronavirus Map and Case Count. 2020. Available online: https://www.nytimes.com/interactive/2021/us/arkansas-covid-cases.html (accessed on 26 January 2022).