U.S. Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 75 / No. 33
August 27, 2026

# Use of Nowcasting to Estimate Real-Time Transmission Trends During a Measles Outbreak — South Carolina, October 2025–March 2026

Paige B. Miller, PhD[1,*]; Isobel Routledge, PhD[2,3,*]; Emily D. Pollock, PhD[1,*]; Adria D. Mathis, MSPH[4]; Kelley Raines, MPH[4]; Dina Mistry, PhD[1]; Laureen Mitchell, MSN[5]; Taidy Perez, MPH[5]; LaKita Johnson, MPH[5]; Isaac Ghinai, MBBS[2]; Matthew Biggerstaff, ScD[6]; Katelyn M. Gostic, PhD[1]; Rebecca Kahn, PhD[2]; Marco Tori, MD[5,7]

## Abstract

During October 2025–March 2026, South Carolina experienced the largest measles outbreak in the United States in approximately 30 years, with 997 cases reported. The South Carolina Department of Public Health reported confirmed measles cases to CDC through regular updates of provisional (initially reported) line-list data, including essential date fields for each case (rash onset and public health report dates). As in all disease surveillance systems, because provisional data are subject to reporting delays, determining current transmission trends is challenging. CDC developed a nowcasting estimation model to generate real-time estimates that correct for reporting delays. Real-time estimates were generated for the final case counts and time-varying effective reproduction number ($R_t$), an indicator of whether the rate of new infections is increasing or decreasing. Whether case reporting during an active measles outbreak would be stable enough to support accurate real-time nowcasting was unknown before the data in this report were analyzed. During this outbreak, nowcasts improved estimates of cumulative outbreak size compared with provisional data, and $R_t$ estimates generally captured underlying transmission trends. Nowcast estimates of daily cases were generally accurate, although accuracy declined in January when provisional data were less complete than expected because of a rapid increase in cases. These results demonstrate that if essential date fields are consistently collected, nowcasting can support situational awareness and decisions about response capacity by providing real-time estimates of daily case counts and transmission trends.

## Introduction

Measles is a highly contagious viral disease (*1*). Large measles outbreaks are becoming increasingly common in the United States, often affecting communities with low vaccination coverage (*2*). During October 2025–March 2026, South Carolina experienced the largest measles outbreak in the United States in 3 decades: 997 cases were reported (*3*). Measles is a nationally notifiable disease, and although the South Carolina Department of Public Health (SCDPH) reported cases to CDC approximately twice weekly, provisional (initially reported) data are subject to lags in reporting, even in robust surveillance systems. Cases with recent rash onset might not yet be reported because of delays in seeking health care, specimen testing, and case investigation. As a result, incomplete reporting can result in the appearance that an outbreak is waning when it is actually growing.

Nowcasting models can correct for these routine reporting delays and enable real-time estimation of crucial metrics based on available but incomplete data and historical reporting patterns, including the effective reproduction number ($R_t$). $R_t$ measures the average number of secondary infections caused by a single infected person at a given time and indicates whether an outbreak is growing ($R_t > 1$), stable ($R_t$ = approximately 1), or decreasing ($R_t < 1$). Adjusting for reporting delays is most accurate when delays are relatively stable over time. CDC has applied nowcasting to routine respiratory surveillance data (*4*). However, it was not known whether reporting delays would be



**Continuing Education** examination available at https://www.cdc.gov/mmwr/mmwr_continuingEducation.html

* These authors contributed equally to this report.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION

sufficiently consistent or provisional data sufficiently complete to support nowcasting during measles outbreak responses. This report describes an evaluation of nowcasting models used during the South Carolina measles outbreak response.

## Methods

### Data Source

At the start of the outbreak, SCDPH provided deidentified line-list data containing rash onset date for each case reported to CDC. Beginning on December 19, 2025, SCDPH added the public health report date for each case to line-list updates. This was the date that SCDPH was notified of the case, either from laboratory reporting, clinical provider reporting, or contact investigation. The reporting delay was defined as the interval between rash onset and public health report date, accounting for both the delay in seeking medical care and the delay in reporting to a public health authority. Cases in some patients had been reported to SCDPH as contacts of a measles case before rash onset; reporting delays from these cases (which were negative) were not included in estimates of reporting delay distributions. Cases with a report date but missing rash onset date were excluded from real-time analyses; rash onset dates were often backfilled by SCDPH in subsequent line lists.

### Statistical Analyses

EpiNow2 (*5*) (version 1.9.9; R package) was used to build the nowcast model. The model generated estimates by adjusting provisional data for reporting delays: 1) the true number of recent case counts, with prediction intervals (PIs), which are the range of values with a stated probability of including the final case count and 2) $R_t$, with associated credible intervals (CIs), which represent the probability that the true value exceeded 1. CDC estimated the reporting delay distribution by fitting a nonparametric distribution to observed delays. $R_t$ was estimated using a renewal model, which assumes that each case generates future cases based on the generation interval[†] (*6*) and the incubation period[§] (*6*,*7*). Outbreak trends were categorized using CIs for $R_t$ >1.[¶] The code for these models is publicly available for use by jurisdictional and academic partners (GitHub |CDC Measles Nowcasting 2026).

Nowcasts and $R_t$ estimates were generated for each provisional dataset, and estimates were compared with final daily and cumulative case counts. Performance of nowcasted case counts was assessed using coverage of PIs (i.e., the proportion of final daily case counts within the PI during the nowcast period)[**] (*8*). Coverage of PIs was calculated for estimates of case counts

[†] The time between date of infection for primary and secondary case pairs, assumed to be gamma distributed with a mean of 11.7 days and a variance of 9 days.

[§] The time between infection to rash onset, assumed to be gamma distributed with a mean of 10 days and a variance of 9 days.

[¶] The trend thresholds used for the posterior probability that $R_t$ exceeded 1 were as follows: ≥95% (increasing), 60% to <95% (likely increasing), 40% to <60% (stable), 5% to <40% (likely decreasing), and <5% (decreasing).

[**] The coverage describes the percentage of final observations that fall within a given range. The 90% PI of a well-calibrated model should include the true value approximately 90% of the time (i.e., should be 90% coverage).

The *MMWR* series of publications is published by the Office of Science, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

**Suggested citation:** [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2026;75:[inclusive page numbers].

during the observation period, which was defined as the 2-week period leading up to each line-list receipt date, when provisional data were most likely to be affected by reporting delays. $R_t$ categories were qualitatively evaluated by visually comparing their categorization with trends evident in the final, fully reported daily case-count series.

## Results

### Characteristics of Provisional and Nowcast Data

The estimated median delay (interval) between rash onset and public health report date was 2–3 days (Supplementary Table 1), with an average of 92.8% of cases reported within 14 days of rash onset. Provisional counts were less complete at the end of the observation period and demonstrated an apparent decline in reported cases that updated datasets revealed to be an artifact of reporting delays and backfilling (updating missing rash onset dates for cases once case investigations were complete) (Supplementary Figure). The percentage of cases in provisional line lists that were missing rash onset date and therefore excluded from the analysis ranged from 0% (no cases) to 10% (66 cases). In addition, 362 (36.7%) cases were identified through contact tracing before rash onset, meaning their report date preceded their symptom onset date; thus, the interval from symptom onset to public health report date appeared negative for certain cases. These cases were included in the analysis; however, they were excluded from estimates of delay distributions.

### Accuracy of the Nowcast Model

The first two nowcasts were produced using line lists from December 19 and 23, 2025, when provisional data contained 76.5%–77.2% of final counts (Table) and indicated declining trends. Nowcasts included final daily and cumulative counts within 90% PIs and indicated a likely increasing trend (Figure 1). Partially because of these estimates, SCDPH maintained high staffing levels during the winter holiday period and began hiring additional staff members. After the holiday period, case counts increased rapidly (final cumulative counts increased from 185 to 424 from December 23, 2025, to January 6, 2026), with backfilling of cases throughout January. On January 6, provisional data only contained 25.7% of final counts, reflecting a lower than expected rate of reporting. Nowcasts of the January 6 data underestimated final values and fell outside 90% PIs (Table) (Supplementary Table 2); however, they still improved the real-time estimate of cumulative daily case counts relative to provisional counts and provided an accurate estimate of whether the trend was increasing or decreasing. $R_t$ trends continued to indicate that the outbreak was increasing or likely increasing during this time.

The number of cases peaked on January 13–14 (Figure 1). The model did not detect the decline in the January 16 or 23 data (Supplementary Table 2). Despite missing this shift, nowcasts improved estimates of total outbreak size by 10.5%–11.3% compared with provisional counts (Figure 2). On January 27, the model estimated that the outbreak was likely decreasing.

**TABLE. Nowcast estimated number of measles cases compared with provisional and final numbers of cases — South Carolina, December 19, 2025–February 17, 2026**

| Provisional line-list date | Cumulative no. of cases | | | % of final cases reported in provisional data during nowcast period† | Coverage during nowcast period, 90% PI§ |
|---|---|---|---|---|---|
| | Provisional* | Nowcast, median (90% PI) | Final* | | |
| **2025** | | | | | |
| Dec 19 | 146 | 158 (118–215) | 170 | 77.2 | 1 |
| Dec 23 | 153 | 168 (125–226) | 185 | 76.5 | 1 |
| **2026** | | | | | |
| Jan 6 | 223 | 249 (197–319) | 424 | 25.7 | 0.714 |
| Jan 13 | 383 | 432 (335–558) | 611 | 45.6 | 0.571 |
| Jan 16 | 466 | 545 (430–705) | 701 | 54.2 | 0.786 |
| Jan 23 | 633 | 721 (581–911) | 835 | 64.9 | 1 |
| Jan 27 | 722 | 774 (641–943) | 870 | 72.1 | 1 |
| Jan 30 | 785 | 842 (698–1,018) | 901 | 73.7 | 1 |
| Feb 3 | 834 | 893 (755–1,068) | 930 | 75 | 1 |
| Feb 6 | 884 | 929 (789–1,100) | 936 | 82.3 | 1 |
| Feb 10 | 905 | 939 (803–1,107) | 945 | 88.5 | 1 |
| Feb 17 | 936 | 962 (822–1,127) | 970 | 76.1 | 0.929 |
| Mar 17 (final) | 986 | 991 (853–1,153) | — | — | — |

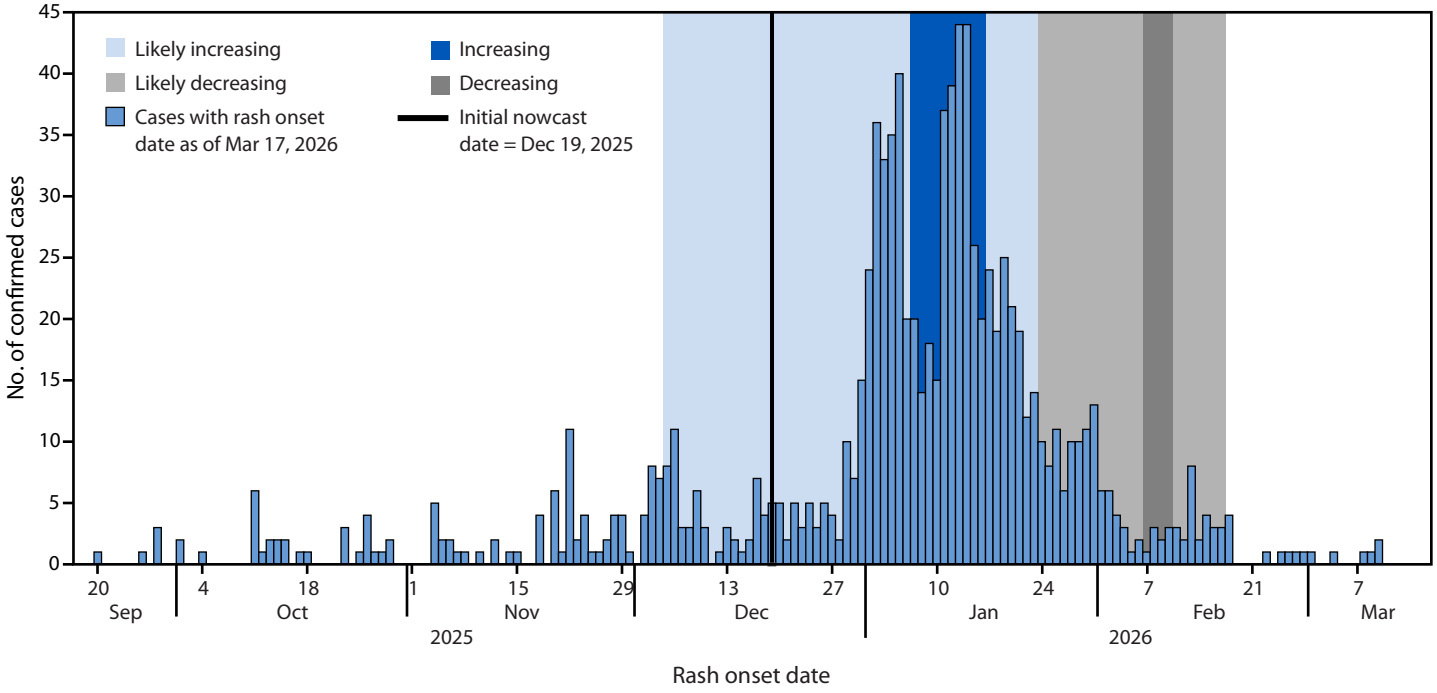
**Abbreviation:** PI = prediction interval.

* Provisional cases are the cumulative number of cases with rash onset date reported at the time of each line list. The percentage of cases with a missing rash onset date that were excluded ranged from 0% to 10% across all line lists. Final cases are the cumulative number of cases at each previous line-list date as reported in the final March 17, 2026, line list.

† Number of incident cases reported relative to final case counts during the nowcast period (14 days before line-list date). The absolute percent improvement is the difference between the percentage of final cases estimated by median cumulative nowcast and the proportion of cumulative cases in provisional data.

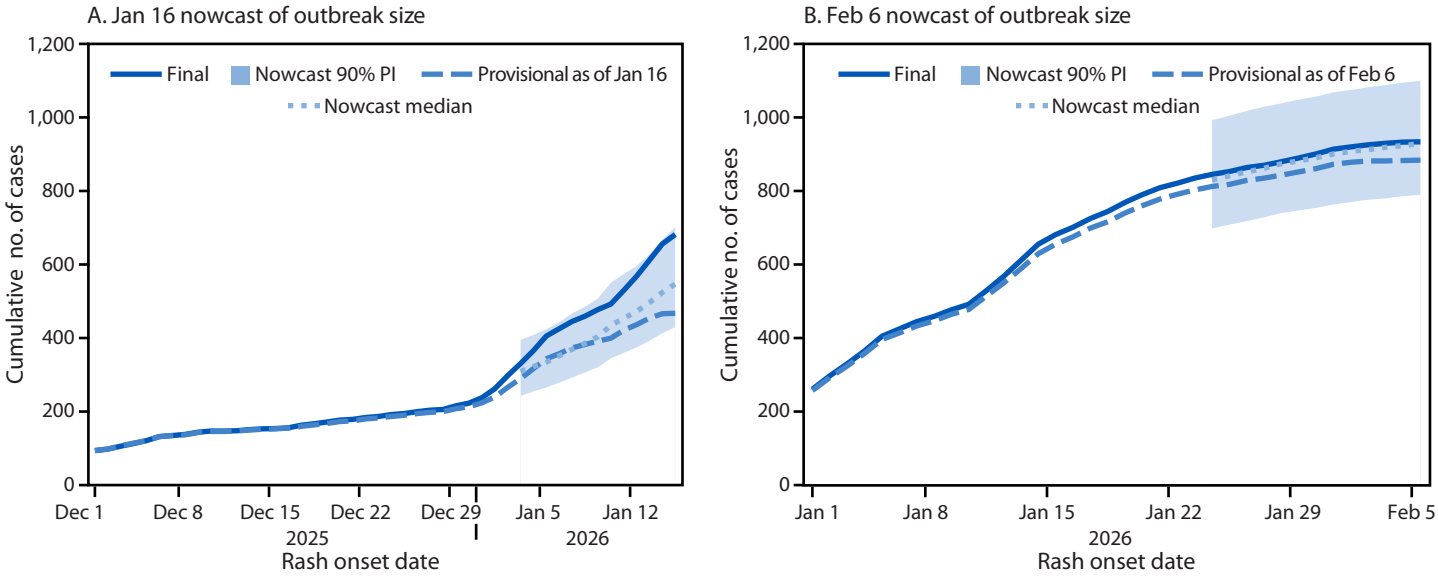
§ Coverage indicates the proportion of final daily case counts within PI during the nowcast period for each line list. The 90% PI of a well-calibrated model should include the true value approximately 90% of the time (i.e., coverage should be 90%).

**FIGURE 1. Measles outbreak transmission trends* estimated by nowcast modeling† — South Carolina, September 20, 2025–March 17, 2026**




* The trend thresholds used for the posterior probability that the effective reproduction number exceeded 1 were as follows: ≥95% (increasing), 60% to <95% (likely increasing), 40% to <60% (stable), 5% to <40% (likely decreasing), and <5% (decreasing).
† The model was first run using line-list data from December 19, 2025. Outbreak trend estimates before this date were generated retrospectively from the first line list received.

**FIGURE 2. Nowcast estimated number of measles cases compared with provisional* and final numbers of cases, by rash onset date — South Carolina, 2025–2026**




**Abbreviation:** PI = prediction interval.
* Provisional cases are the cumulative number of cases with rash onset date reported at the time of each line list. Final cases are the cumulative number of cases at each previous line-list date as reported in the final March 17, 2026, line list.

After January 23, 2026, nowcasts captured cumulative and daily case counts within 90% PIs, coinciding with high reporting (72.1%–88.5% of final cases). Nowcasts indicated that cases were decreasing or likely decreasing, although median estimates remained below final counts (Supplementary Table 2), consistent with ongoing efforts to backfill cases from earlier in January

**Summary**

What is already known about this topic?

Measles is a highly infectious, vaccine-preventable disease. During October 2025–March 2026, South Carolina experienced a large measles outbreak. Reporting delays can complicate real-time assessments of outbreak trends. Nowcasting uses models to adjust for incomplete reported data based on historical reporting delays, to estimate current trends in disease metrics. CDC has applied nowcasting to routine respiratory surveillance data, but rarely in an outbreak setting.

What is added by this report?

CDC developed a nowcast model that corrected for reporting delays to estimate real-time case counts and the effective reproduction number ($R_t$). Although accuracy depended on the stability of case reporting patterns, the model improved situational awareness and provided more reliable real-time signals than did provisional case counts alone.

What are the implications for public health practice?

When surveillance data are timely and consistently reported, nowcasting can help support public health decision-making in outbreak response.

(Supplementary Figure). Nowcasts provided reassurance that the declines observed in late January were true declines rather than artifacts of delayed reporting, enabling deescalation of SCDPH response efforts during February and March.

## Discussion

During this measles outbreak, nowcasting improved situational awareness by correcting for reporting lags. Accuracy was highest during periods of sustained transmission and decline, when reporting patterns remained relatively stable. During periods of rapidly increasing case counts and temporary declines in reporting completeness, nowcasts underestimated final case counts. Nevertheless, this outbreak highlights that nowcasting can provide a useful indicator of outbreak trends, even when surveillance data are incomplete.

The nowcasting model produced estimates within minutes of receiving updated line lists and integrated outputs into automated reports shared with SCDPH. Inclusion of rash onset and public health report dates enabled nowcasting with little additional effort from frontline staff members. Nowcasting was bolstered by SCDPH contact tracing efforts and investment in disease surveillance, which likely contributed to shorter and more consistent reporting patterns. Because this nowcasting method relies primarily on surveillance data, it can be readily deployed during outbreaks when granular data are not yet available, although estimates might be less stable during periods of rapid increases in case counts or changes in reporting completeness. In practice, these estimates complemented provisional data and other surveillance indicators to support the hiring of additional response staff members.

Although nowcasting has been applied to outbreaks retrospectively (*9*) and to routine surveillance data (*4*), this report describes the first CDC implementation of nowcasting during an active measles outbreak. As analytic methods and the underlying surveillance data improve, these tools could become more reliable and provide more actionable results.

### Limitations

The findings in this report are subject to at least three limitations. First, transmission increased rapidly at the end of December, likely because of changes in contact patterns around holiday gatherings. The nowcast model did not account for this. Relatedly, provisional data completeness decreased in January because of backfilling and backlogging (case counts missing from provisional data despite being later reported). Accordingly, nowcasts were least accurate and cases were underestimated during these weeks. Nevertheless, nowcasts accurately reflected the general trend, whereas the provisional data did not. Second, although estimates from this nowcasting approach were sufficient to support situational awareness, other nowcasting methods might perform better by incorporating epidemiologic changes or allowing for more rapid changes in $R_t$. EpiNow2 was selected because it jointly estimates case counts and $R_t$ and could be quickly applied to this outbreak. During estimation of the reporting delay, right truncation was not accounted for,[††] potentially contributing to underestimation of cases during periods of outbreak growth (*10*). Furthermore, more than one third of cases (36.7%) in this outbreak were identified through contact tracing before the rash onset. Because this early identification does not represent the reporting delay that the model is intended to correct for, these cases were excluded when estimating reporting delay distributions. Finally, no objective reference exists against which to validate $R_t$ trends. This absence posed challenges to quantitatively evaluating the accuracy of estimated $R_t$ trends. Given the short period during which this measles outbreak peaked and declined, contemporaneous $R_t$ estimates were visually compared with final data.

### Implications for Public Health Practice

During a disease outbreak, all surveillance data are subject to reporting delays. Nowcasting can help correct for these delays and provide more accurate, real-time information. In this response, SCDPH used nowcasts to interpret provisional measles case counts, distinguish true declines from reporting artifacts, and support decisions to hire additional staff members. With these systems in place, nowcasting can provide a practical tool for real-time estimation of case counts and epidemic trends.

[††] Right truncation of reporting delays means that long reporting delays that were not yet observed were not accounted for in estimation of the reporting delay distribution.

## Acknowledgments

South Carolina Department of Public Health Measles Response Team; Damon Bayer, Zachary Susswein, Predict Division, Center for Forecasting and Outbreak Analytics, CDC; Inga Holmdahl, Inform Division, Center for Forecasting and Outbreak Analytics, CDC.

Corresponding author: Paige B. Miller, pmiller3@cdc.gov.

[1]Predict Division, Center for Forecasting and Outbreak Analytics, CDC; [2]Inform Division, Center for Forecasting and Outbreak Analytics, CDC; [3]Goldbelt C6, Washington, DC; [4]Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, CDC; [5]South Carolina Department of Public Health; [6]Influenza Division, National Center for Immunization and Respiratory Diseases, CDC; [7]Division of State and Local Readiness, Office of Readiness and Response, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

## References

1. CDC. Measles (rubeola): clinical overview of measles. Atlanta, GA: US Department of Health and Human Services, CDC; 2026. https://www.cdc.gov/measles/hcp/clinical-overview/index.html
2. CDC. Measles (rubeola): measles cases and outbreaks. Atlanta, GA: US Department of Health and Human Services, CDC; 2026. https://www.cdc.gov/measles/data-research/index.html
3. South Carolina Department of Public Health. 2025 measles outbreak. Cayce, SC: South Carolina Department of Public Health; 2026. https://dph.sc.gov/diseases-conditions/infectious-diseases/measles-rubeola/2025-measles-outbreak
4. Richard DM, Susswein Z, Connolly S, et al. Detection of real-time changes in direction of COVID-19 transmission using national- and state-level epidemic trends based on $R_t$ estimates—United States overall and New Mexico, April–October 2024. MMWR Morb Mortal Wkly Rep 2024;73:1058–63. PMID:39570787 https://doi.org/10.15585/mmwr.mm7346a3
5. Abbott S, Hellewell J, Sherratt K, et al. EpiForecasts. EpiNow2: estimate real-time case counts and time-varying epidemiological parameters. London, England: London School of Hygiene & Tropical Medicine; 2024. https://epiforecasts.io/EpiNow2/
6. Klinkenberg D, Nishiura H. The correlation between infectivity and incubation period of measles, estimated from households with two cases. J Theor Biol 2011;284:52–60. PMID:21704640 https://doi.org/10.1016/j.jtbi.2011.06.015
7. CDC. Health Alert Network (HAN): expanding measles outbreak in the United States and guidance for the upcoming travel season. Atlanta, GA: US Department of Health and Human Services, CDC; 2025. https://www.cdc.gov/han/php/notices/han00522.html
8. Gneiting T, Balabdaoui F, Raftery AE. Probabilistic forecasts, calibration and sharpness. J R Stat Soc Series B Stat Methodol 2007;69:243–68. https://doi.org/10.1111/j.1467-9868.2007.00587.x
9. Charniga K, Madewell ZJ, Masters NB, Asher J, Nakazawa Y, Spicknall IH. Nowcasting and forecasting the 2022 U.S. mpox outbreak: support for public health decision making and lessons learned. Epidemics 2024;47:100755. PMID:38452454 https://doi.org/10.1016/j.epidem.2024.100755
10. Charniga K, Park SW, Akhmetzhanov AR, et al. Best practices for estimating and reporting epidemiological delay distributions of infectious diseases. PLOS Comput Biol 2024;20:e1012520. PMID:39466727 https://doi.org/10.1371/journal.pcbi.1012520

# Buprenorphine Dispensed by Pharmacies and Administered in Emergency Departments in Urban and Rural Areas — United States, 2019–2025

Gery P. Guy, Jr., PhD[1]; Yijie Chen, PhD[1]; Kun Zhang, PhD[1]; Nisha Nataraj, PhD[1]; Macarena C. Garcia, DrPH[2]; Deborah Dowell, MD[1]; Grant Baldwin, PhD[1]

## Abstract

Drug overdose deaths remain a major public health concern in the United States. Although buprenorphine is approved by the Food and Drug Administration to treat opioid use disorder and reduces overdose risk and deaths, the medication remains underused in the United States, and many persons who could benefit from treatment lack access. This report describes 2019–2025 trends in buprenorphine dispensing by pharmacies, treatment initiation among persons newly receiving buprenorphine, treatment retention, pharmacy availability, and emergency department (ED) administration by urban-rural county classification using IQVIA data on buprenorphine dispensed by pharmacies and the Premier Healthcare Database. Dispensing rates increased from 2019 to 2021, before declining thereafter, and remained consistently higher in rural counties than in urban counties. The number of patients per prescriber and prescriptions per prescriber declined in both urban and rural counties. Initiation and retention were higher in rural counties; initiation declined in urban counties, and retention declined over time in both urban and rural counties. Pharmacy availability of buprenorphine increased in both urban and rural counties. Adoption and administration of ED buprenorphine increased in both urban and rural counties but remained lower in rural counties. These findings highlight differences between urban and rural areas in buprenorphine access and treatment, with more reliance on pharmacies dispensing buprenorphine in rural counties and higher ED-based administration in urban counties. Opportunities to improve access include use of a low threshold for prescribing buprenorphine, strengthening pharmacy availability of buprenorphine, and (particularly in rural areas) supporting ED-based treatment and sustaining telehealth flexibilities.

## Introduction

Drug overdose deaths remain a major public health concern in the United States. In 2024, opioid-involved deaths accounted for 54,045 (68.1%) overdose deaths (Drug Overdose Deaths | National Center for Health Statistics | CDC). Also in 2024, an estimated 4.8 million persons had a diagnosed opioid use disorder (OUD) (2024 National Survey on Drug Use and Health | Substance Abuse and Mental Health Services Administration). Medications for OUD reduce opioid use, overdose risk, and deaths (*1*); however, only approximately one in four persons with OUD receives medication for OUD (*2*).

Buprenorphine, the most prescribed of the three Food and Drug Administration (FDA)–approved medications for OUD, can be prescribed in clinical settings and dispensed through retail pharmacies. Emergency department (ED) administration of buprenorphine after nonfatal overdose or OUD-related visits can also facilitate linkage to treatment. However, pharmacy dispensing rates and ED administration have changed little in recent years (*3*,*4*), and buprenorphine remains underused (*2*).

Geographic variation in access might contribute to underuse, reflecting differences in prescriber and pharmacy availability and health system capacity. This report describes trends in buprenorphine dispensing, initiation, retention, and ED administration during 2019–2025 by urban-rural county classification using national pharmacy and hospital data.

## Methods

### Data Sources

**Pharmacy dispensing.** Data on pharmacy-dispensed buprenorphine during 2019–2025 were obtained from IQVIA,* a U.S. health information technology and clinical research company that includes approximately 94% of U.S. retail pharmacy prescriptions. Measures included dispensing rates calculated per 1,000 persons using annual U.S. Census Bureau population estimates, days' supply per prescription, average daily dose per prescription, prescribers (health care providers who prescribed at least one buprenorphine prescription in a year) per 1,000 persons, patients per prescriber, prescriptions per prescriber, percentage of prescriptions from the top 10% of prescribers (prescribers whose annual buprenorphine prescriptions were >90th percentile among all buprenorphine prescribers during that year), percentage of prescriptions from emergency medicine settings (i.e., emergency medicine specialists and clinicians practicing in EDs), and pharmacy availability of buprenorphine (defined as a pharmacy dispensing at least one buprenorphine prescription during every month a pharmacy was in operation in a given year).† Monthly initiations per 100,000 persons (receipt of a buprenorphine prescription by a patient who had not received a prescription during the preceding 180 days) and

*IQVIA data sources include IQVIA Xponent, IQVIA Longitudinal Prescriptions, and IQVIA Prescriber Level Xponent.

†Pharmacy availability of buprenorphine was operationally defined using dispensing as a proxy. Percentages were calculated by dividing the number of pharmacies dispensing buprenorphine by the total number of pharmacies in operation during the same year.

180-day retention (receipt of a continuous 180-day supply, which could be achieved through one or more prescriptions and refills, without a gap of >7 days) were evaluated. Initiations during July–December 2025 were excluded to ensure 180 days of follow-up data for all patients included in the analysis.

**ED administration.** ED-administered buprenorphine data were obtained from the Premier Healthcare Database, an all-payer database including approximately 8 million inpatient admissions and 86 million outpatient visits annually from approximately 1,400 hospitals. Measures included annual rates of buprenorphine administration (administrations per 1,000 ED visits and administrations per 1,000 OUD or nonfatal opioid overdose visits) and ED adoption (administration of buprenorphine to at least one person each month during which an OUD or overdose visit occurred). An OUD visit was defined as a visit with at least one *International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM)* diagnosis code in the F11 category. A nonfatal opioid overdose visit was defined as a visit with at least one *ICD-10-CM* diagnosis code for opium (T40.0), heroin (T40.1), natural and semisynthetic opioids (T40.2), methadone (T40.3), synthetic opioids other than methadone (T40.4), or other and unspecified narcotics (T40.6).

### Analysis

Measures were stratified by 2020 U.S. Census Bureau urban-rural county classification using prescriber location for dispensing data and ED location for ED-administered buprenorphine.[§] Trends were calculated using Joinpoint (version 5.0; National Cancer Institute) regression and reported as average annual percent change (AAPC) or average monthly percent change (AMPC), and segment-specific trends were reported as annual percent change (APC) or monthly percent change (MPC). Analyses were conducted using Stata (version 17.0; StataCorp), Spark SQL (version 3.5.0; The Apache Software Foundation) and Joinpoint (version 5.4.0; National Cancer Institute). This activity was reviewed by CDC, deemed not research, and conducted consistent with applicable federal law and CDC policy.[¶]

## Results

### Retail Pharmacy Dispensing

**Dispensing rates in rural and urban counties.** Buprenorphine pharmacy dispensing rates increased from 2019 to 2021, and rate increases were more pronounced in rural counties (APC = 7.0) than in urban counties (APC = 0.7). During 2021–2025, pharmacy dispensing rates declined in both rural and urban counties; rates remained higher in rural counties despite decreasing more rapidly in rural counties (Table). During 2019–2025, the average prescription supply increased from 17.6 to 22.6 days in urban counties and from 17.4 to 22.2 days in rural counties; the percentage of prescriptions for ≥15 days increased from 45.1% to 65.2% in urban counties and from 30.7% to 53.7% in rural counties. Modest increases in average daily dose per prescription were noted.

**Buprenorphine prescribers.** From 2019 to 2025, the number of prescribers per 1,000 persons increased in both urban counties (from 0.1 to 0.4) and rural counties (from 0.1 to 0.2) at the same time that the number of patients per prescriber and the number of prescriptions per prescriber decreased, with patients per prescriber decreasing from 48.7 to 25.7 in urban counties and from 60.1 to 36.3 in rural counties and prescriptions per prescriber decreasing from 312.8 to 116.0 in urban counties and from 469.2 to 195.8 in rural counties. Among buprenorphine prescriptions dispensed from retail pharmacies, the percentage prescribed by the top 10% of prescribers increased from 71.1% to 84.8% in urban counties and from 65.6% to 81.0% in rural counties, whereas the percentage prescribed in emergency medicine settings decreased from 3.5% to 3.0% in urban counties and from 5.2% to 2.2% in rural counties.

**Initiation and retention.** Median monthly treatment initiation and 180-day treatment retention rates were higher in rural counties (14.2 per 100,000 persons and 23.1%, respectively) than in urban counties (11.8 per 100,000 persons and 17.7%, respectively) (Figure 1). Initiation declined in urban counties (AMPC = −0.2%) but remained stable in rural counties (AMPC = −0.02%). Retention increased in both rural and urban counties through July 2020, then declined in urban counties through September 2023 (MPC = −0.8%) before stabilizing and continued to decline in rural counties through June 2025 (MPC = −0.6%).

**Pharmacy availability of buprenorphine.** During 2019–2025, pharmacy availability of buprenorphine increased in urban counties (from 64.8% to 72.4%; AAPC = 1.4%). Availability also increased in rural counties (from 64.9% to 80.0%; AAPC = 2.7%) (Figure 2).

### Emergency Department Adoption and Administration

ED adoption increased from 6.7% to 31.4% in urban counties (AAPC = 30.3%) and from 2.3% to 10.3% in rural counties (AAPC = 23.3%) (Figure 2). Rates of ED-administered buprenorphine also increased in both urban counties (from 0.3 to 1.0 per 1,000 ED visits; AAPC = 18.4%) and rural

[§] The U.S. Census Bureau defines an urban area as a territory in which core census groups or blocks have a population density of at least 1,000 persons per square mile and surrounding census blocks have an overall density of at least 500 persons per square mile. Rural areas are considered territory outside the definition of urban.

[¶] 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

**TABLE. Percentage change in buprenorphine dispensed by retail pharmacies and administered in emergency departments in urban and rural areas,* by year — United States, 2019–2025**

| Characteristic | Year | | | | | | | AAPC | APC† (95% CI) |
|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | | |
| **Dispensed by retail pharmacies** | | | | | | | | | |
| Dispensing rate per 1,000 persons | | | | | | | | | |
| Urban | 46.4 | 46.9 | 46.9 | 46.3 | 44.9 | 44.1 | 42.9 | −1.3 (−1.4 to −1.2) | 2019–2021: 0.7 (0.5 to 0.9)<br>2021–2025: −2.3 (−2.4 to −2.2) |
| Rural | 51.8 | 56.5 | 58.3 | 58.3 | 56.4 | 53.4 | 51.1 | −0.2 (−0.9 to 0.5) | 2019–2021: 7.0 (3.3 to 9.7)<br>2021–2025: −3.6 (−5.1 to −2.7) |
| Days' supply per prescription | | | | | | | | | |
| Urban | | | | | | | | | |
| Mean | 17.6 | 19.2 | 19.6 | 20.6 | 21.0 | 21.9 | 22.6 | 3.9 (3.4 to 4.2) | 2019–2021: 5.3 (4.1 to 6. 6)<br>2021–2025: 3.2 (1.7 to 3.6) |
| Percentage | | | | | | | | | |
| ≤7 days | 36.7 | 30.9 | 28.3 | 26.0 | 23.3 | 21.7 | 19.9 | — | — |
| 8–14 days | 18.2 | 18.5 | 18.0 | 17.4 | 16.9 | 16.0 | 14.9 | — | — |
| ≥15 days | 45.1 | 50.6 | 53.7 | 56.7 | 59.8 | 62.3 | 65.2 | — | — |
| Rural | | | | | | | | | |
| Mean | 17.4 | 18.5 | 19.3 | 20.3 | 20.8 | 21.6 | 22.2 | 4.17 (4.1 to 4.2) | 2019–2021: 5.8 (5.4 to 6.0)<br>2021–2025: 3.4 (3.2 to 3.5) |
| Percentage | | | | | | | | | |
| ≤7 days | 47.1 | 43.0 | 40.6 | 37.5 | 33.0 | 29.9 | 27.6 | — | — |
| 8–14 days | 22.2 | 22.6 | 21.1 | 20.9 | 20.3 | 19.3 | 18.7 | — | — |
| ≥15 days | 30.7 | 34.4 | 38.3 | 41.6 | 46.6 | 50.8 | 53.7 | — | — |
| Average daily dose per prescription, mg | | | | | | | | | |
| Urban | 14.6 | 14.8 | 14.8 | 15.0 | 15.1 | 15.2 | 15.5 | 0.8 (0.7 to 1.0) | 2019–2022: 0.5 (0.1 to 0.8)<br>2022–2025: 1.2 (0.9 to 1.6) |
| Rural | 14.8 | 14.9 | 14.9 | 15.1 | 15.2 | 15.4 | 15.6 | 0.9 (0.8 to 1.0) | 2019–2023: 0.7 (0.5 to 0.8)<br>2023–2025: 1.3 (1.0 to 1.5) |
| No. of prescribers per 1,000 persons | | | | | | | | | |
| Urban | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 19.0 (17.1 to 21.1) | 2019–2021: 10.8 (4.7 to 17.6)<br>2021–2025: 23.3 (20.8 to 29.8) |
| Rural | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 20.7 (18.7 to 22.7) | 2019–2022: 17.1 (9.9 to 22.3)<br>2022–2025: 24.5 (19.4 to 31.9) |
| Patients per prescriber§ | | | | | | | | | |
| Urban | 48.7 | 46.8 | 44.2 | 41.2 | 30.9 | 27.3 | 25.7 | −11.0 (−12.9 to 9.6) | 2019–2021: −3.9 (−9.9 to 1.9)<br>2021–2025: −14.4 (−19.6 to −12.6) |
| Rural | 60.1 | 57.4 | 58.9 | 58.3 | 46.0 | 39.0 | 36.3 | −8.7 (−11.4 to −5.9) | 2019–2022: −1.9 (−6.2 to 10.1)<br>2022–2025: −15.1 (−24.7 to −11.3) |
| Prescriptions per prescriber§ | | | | | | | | | |
| Urban | 312.8 | 295.5 | 260.1 | 228.5 | 156.0 | 131.1 | 116.0 | −16.4 (−18.4 to −14.9) | 2019–2021: −8.3 (−15.0 to −2.0)<br>2021–2025: −20.2 (−25.6 to −18.3) |
| Rural | 469.2 | 460.9 | 430.7 | 391.6 | 282.1 | 228.3 | 195.8 | −14.0 (−15.4 to 13.0) | 2019–2021: −1.7 (−8.3 to 2.7)<br>2021–2025: −19.6 (−22.5 to −18.1) |
| Percentage of buprenorphine prescriptions from top 10% of prescribers¶ | | | | | | | | | |
| Urban | 71.1 | 71.1 | 72.9 | 75.0 | 82.0 | 84.3 | 84.8 | 3.7 (2.3 to 5.1) | — |
| Rural | 65.6 | 65.5 | 65.8 | 67.5 | 76.3 | 79.3 | 81.0 | 4.0 (3.3 to 4.9) | 2019–2021: −0.1 (−2.6 to 2.9)<br>2021–2025: 6.3 (5.2 to 8.3) |
| Percentage of buprenorphine prescriptions from emergency medicine settings** | | | | | | | | | |
| Urban | 3.5 | 3.1 | 3.0 | 3.0 | 2.9 | 3.0 | 3.0 | −2.3 (−2.9 to −1.6) | 2019–2021: −6.9 (−8.6 to −4.3)<br>2021–2025: 0.1 (−0.9 to 1.7) |
| Rural | 5.2 | 3.9 | 3.2 | 3.0 | 2.7 | 2.5 | 2.2 | −12.6 (−13.5 to −11.2) | 2019–2021: −19.8 (−22.7 to −15.0)<br>2021–2025: −8.8 (−10.5 to −5.0) |
| **Administered in EDs** | | | | | | | | | |
| ED visits with buprenorphine administered per 1,000 ED visits | | | | | | | | | |
| Urban | 0.3 | 0.5 | 0.6 | 0.7 | 0.7 | 0.9 | 1.0 | 18.4 (16.0 to 20.5) | 2019–2021: 30.34 (21.5 to 38.6)<br>2021–2025: 12.88 (7.1 to 15.1) |
| Rural | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.7 | 6.9 (4.8 to 8.3) | 2019–2023: 2.2 (−2.3 to 4.1)<br>2023–2025: 16.8 (9.2 to 22.8) |
| Buprenorphine administration rate per 1,000 ED visits for OUD or nonfatal opioid overdose†† | | | | | | | | | |
| Urban | 33.9 | 38.9 | 51.1 | 62.8 | 74.8 | 97.0 | 111.1 | 23.3 (22.5 to 24.0) | — |
| Rural | 25.2 | 39.0 | 37.3 | 47.1 | 62.9 | 87.1 | 103.3 | 25.1 (20.9 to 28.7) | 2019–2022: 18.1 (4.6 to 28.0)<br>2022–2025: 32.4 (22.1 to 46.3) |

See table footnotes on the next page.

**TABLE. (*Continued*) Percentage change in buprenorphine dispensed by retail pharmacies and administered in emergency departments in urban and rural areas,* by year — United States, 2019–2025**

**Abbreviations:** AAPC = average annual percent change; APC = annual percent change; ED = emergency department; *ICD-10-CM = International Classification of Diseases, Tenth Revision, Clinical Modification*; OUD = opioid use disorder.
**Source:** IQVIA Xponent, IQVIA Longitudinal Prescription Database, IQVIA Prescriber Level Xponent, and Premier Healthcare Database, 2019–2025.
* The U.S. Census Bureau defines an urban area as a territory in which core census groups or blocks have a population density of at least 1,000 persons per square mile, and surrounding census blocks have an overall density of at least 500 persons per square mile. Rural areas are considered territory outside the definition of urban.
† APCs represent segment-specific trends in which any Joinpoint is identified by the regression model, and AAPCs represent the estimated trend over the entire study period.
§ Prescribers are health care providers who prescribed at least one buprenorphine during a year.
¶ Top 10% is defined as prescribers whose annual buprenorphine prescriptions were above the 90th percentile of all buprenorphine prescribers in that year.
** Percentage of all buprenorphine prescriptions prescribed in emergency medicine settings (i.e., emergency medicine specialists and clinicians practicing in EDs).
†† An OUD visit was defined as any visit with at least one *ICD-10-CM* diagnosis code in the F11 category. A nonfatal opioid overdose visit was defined as any visit with at least one *ICD-10-CM* diagnosis code for opium (T40.0), heroin (T40.1), natural and semisynthetic opioids (T40.2), methadone (T40.3), synthetic opioids other than methadone (T40.4), or other and unspecified narcotics (T40.6).

counties (from 0.4 to 0.7; AAPC = 6.9%). Among ED visits for OUD or nonfatal opioid overdose, rates of buprenorphine ED administration increased from 33.9 to 111.1 in urban counties (AAPC = 23.3%) and from 25.2 to 103.3 in rural counties (AAPC = 25.1%) (Table).

## Discussion

Buprenorphine dispensed by retail pharmacies remained consistently higher in rural than in urban counties during 2019–2025, with larger increases in rural counties during 2019–2021. These patterns might reflect benefits of COVID-19–related telehealth flexibilities, particularly in areas with longer travel distances and more limited access to specialty care (*5*,*6*). Higher dispensing rates in rural areas might also indicate increased reliance on office-based buprenorphine, because opioid treatment programs are less available in rural areas (*5*). Together, these findings suggest that office-based prescribing is a particularly important treatment pathway in rural communities, where fewer specialty providers and more formidable geographic barriers might limit access to other forms of OUD care (*5*,*6*). Dispensing declined in both urban and rural counties after 2021, likely reflecting multiple factors such as changes in health care use and increasing days' supply per prescription, whereas persistent barriers to access might have constrained the overall number of persons who received treatment (*3*).

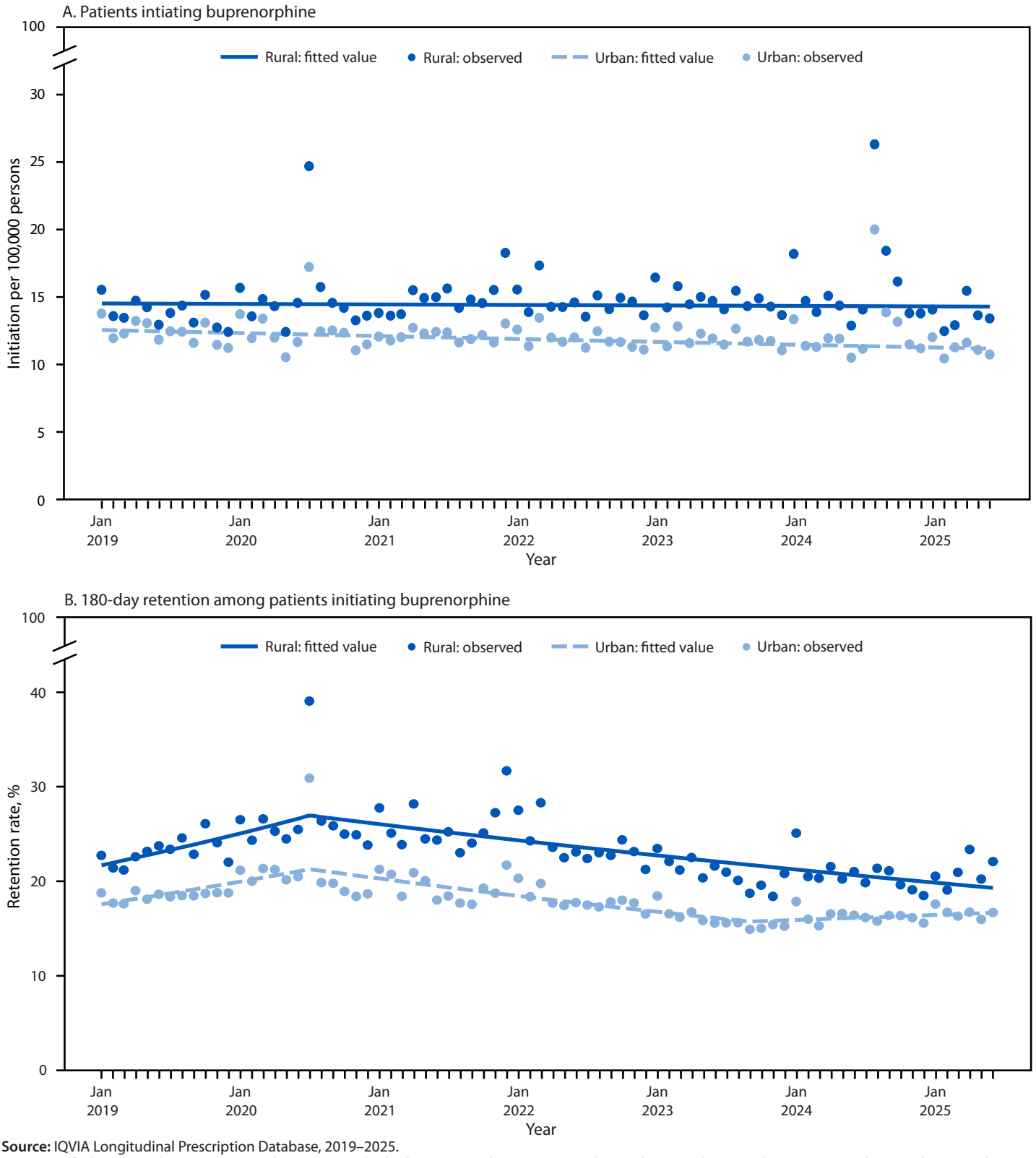
Average days' supply increased both in urban and rural counties, possibly reflecting evolving clinical practice and policy changes, including removal of previous authorization for medication for OUD in several states (*7*). Longer prescription durations might improve treatment continuity by reducing refill frequency, particularly in rural areas with more barriers to access (*5*). Higher retention in rural counties might reflect both more days' supply and selection effects, because patients who successfully overcome more formidable access barriers might be more likely to remain engaged in care. Although treatment duration should be individualized, sustained engagement in buprenorphine treatment is associated with improved outcomes, underscoring the importance of ongoing patient-provider discussions to guide treatment duration and support continued engagement in treatment.

Average daily buprenorphine dose increased modestly, possibly reflecting increased recognition that some patients exposed to fentanyl, now the predominant opioid in the illegal drug supply, might benefit from higher buprenorphine doses (*8*). In 2024, FDA clarified that buprenorphine labeling does not specify a maximum dose and that dosing should be individualized based on patient need. Pharmacy availability of buprenorphine also increased in urban and rural counties and might be especially important in rural areas, where a higher reliance on pharmacies for the medication and limited access can constrain treatment across larger geographic areas.

The number of buprenorphine prescribers increased, whereas patients per prescriber and prescriptions per prescriber declined. This trend suggests broader distribution of prescribing capacity after elimination of the buprenorphine waiver requirement in December 2022 (*9*), although prescribing remained concentrated among high-volume prescribers. However, lower prescriber density in rural areas highlights persistent workforce shortages and the need to strengthen rural workforce capacity.

ED-administered buprenorphine increased in both urban and rural counties, likely reflecting growing awareness, supportive policies, and implementation strategies such as provider education, peer support, and clinical decision support tools (*10*). Despite these gains, adoption remained low, particularly in rural counties, where only one in 10 EDs in the sample had adopted buprenorphine in 2025. Low adoption suggests missed opportunities for treatment and persistent implementation barriers, such as limited behavioral health support, care coordination infrastructure, and staffing needed to implement protocols for OUD medication administration (*6*,*10*). ED-based administration can strengthen linkage to care by connecting patients directly to follow-up treatment before discharge, providing support from trained peer recovery specialists with lived experience, and offering case management to help coordinate ongoing services (*10*).

**FIGURE 1. Buprenorphine initiation* (A) and retention† (B) in urban and rural settings, by month — United States, 2019–2025**

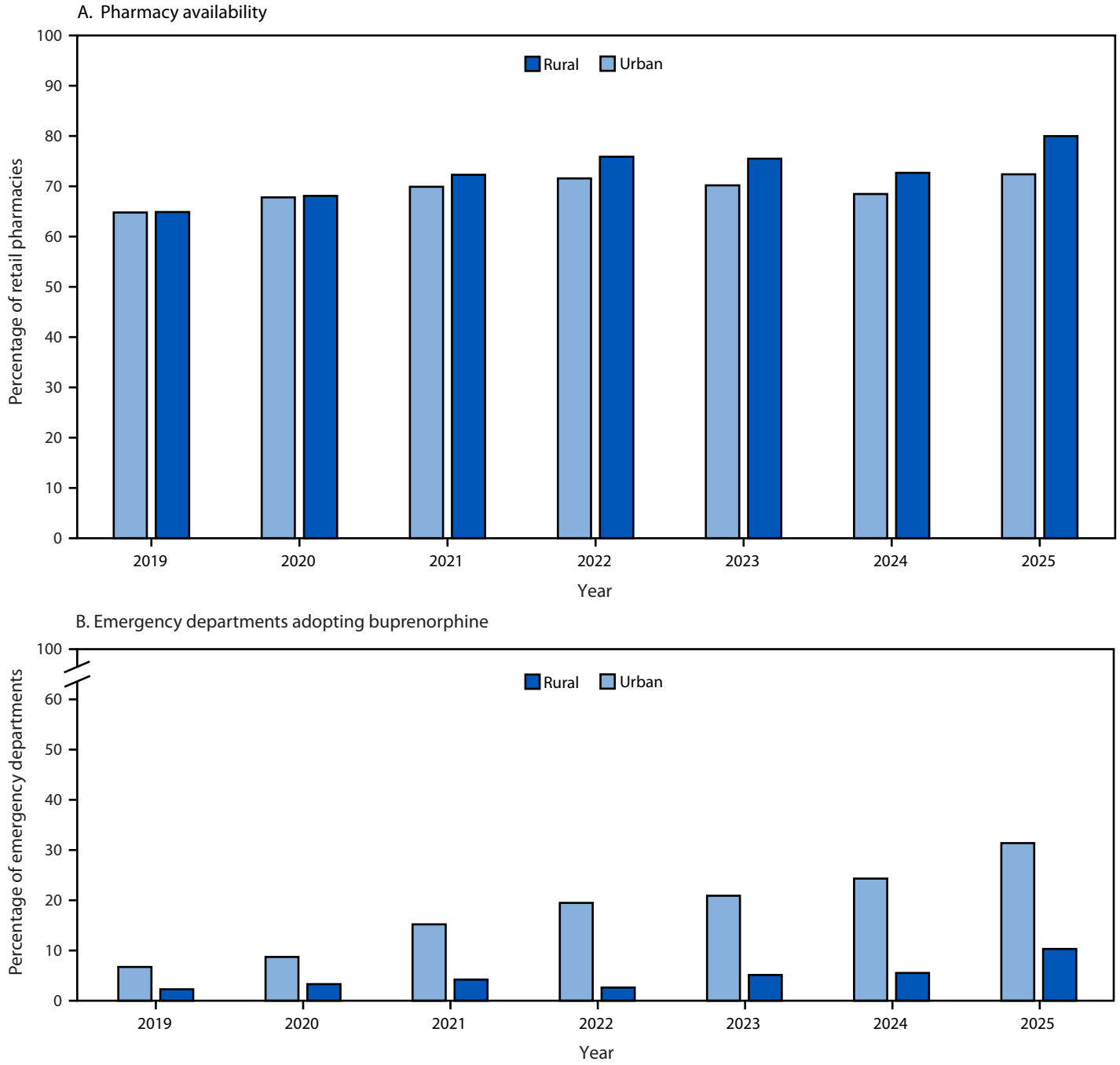



**Source:** IQVIA Longitudinal Prescription Database, 2019–2025.

* Receipt of a buprenorphine prescription by a patient who had not received a prescription during the preceding 180 days. Initiations during July–December 2025 were excluded to ensure 180 days of follow-up data for all patients.

† Continuous 180-day supply, which could be achieved through one or more prescriptions and refills, without a gap of >7 days.

**FIGURE 2. Retail pharmacy availability* of buprenorphine (A) and emergency departments adopting buprenorphine† (B) in urban and rural settings, by year — United States, 2019–2025**




**Source:** IQVIA Longitudinal Prescription Database and Premier Healthcare Database, 2019–2025.
* The dispensing of at least one prescription for buprenorphine during each month a pharmacy was in operation in a given year. Percentages were calculated by dividing the number of pharmacies dispensing buprenorphine by the total number of pharmacies in operation during the same year.
† Administration of buprenorphine to at least one person each month during which an opioid use disorder or overdose visit occurred during the year.

## Limitations

The findings in this report are subject to at least six limitations. First, prescriptions dispensed outside retail pharmacies (e.g., mail-order or clinic-based pharmacies) were not included in this analysis, which might have resulted in an underestimation of buprenorphine prescribing. Second, analyses were based on prescriber or ED location rather than patient residence, which could have resulted in misclassification of urban-rural treatment patterns if patients traveled across county boundaries to receive care. Third, Premier Healthcare

**Summary**

What is already known about this topic?

In 2024, a total of 54,045 persons died from opioid-involved drug overdoses in the United States. Buprenorphine, a Food and Drug Administration–approved medication for opioid use disorder, reduces opioid use and related deaths but remains underused.

What is added by this report?

Buprenorphine dispensing by pharmacies increased during 2019–2021, particularly in rural counties, before declining through 2025, although rates remained higher in rural than in urban counties. Emergency department (ED) adoption and administration of buprenorphine for opioid use disorder or nonfatal opioid overdoses also increased but remained consistently lower in rural counties.

What are the implications for public health practice?

Expanding access to buprenorphine in urban and rural counties, including increasing the number of prescriptions, improving availability in pharmacies, supporting ED-based treatment, and sustaining telehealth flexibilities, could improve treatment access and reduce overdose risk.

Database hospitals represent a large, geographically diverse sample but are not nationally representative; therefore, findings might not be generalizable to all U.S. EDs or fully reflect urban-rural differences. Fourth, the analysis was limited to buprenorphine for OUD and did not include methadone or extended-release naltrexone; therefore, the findings do not represent all medications for OUD access or prescribing practices. Fifth, pharmacy availability was based on consistent dispensing of buprenorphine as a proxy because pharmacy inventory data were not available; therefore, this measure might not represent real-time availability. Finally, the absence of prescribing indications limited insight into clinician decision-making.

## Implications for Public Health Practice

Urban and rural counties showed distinct patterns of buprenorphine access. Pharmacy dispensing, initiation, and retention were higher in rural counties; however, the number of prescribers relative to the population and rates of ED-administered buprenorphine were higher in urban counties. These findings highlight opportunities to expand use of a low threshold for buprenorphine prescriptions, strengthen pharmacy availability, and, particularly in rural areas, support ED-based treatment administration and sustain telehealth flexibilities.

Corresponding author: Gery P. Guy Jr., gguy@cdc.gov.

[1]National Center for Injury Prevention and Control, Division of Overdose Prevention, CDC; [2]Public Health Infrastructure Center, Office of Rural Health, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

## References

1. Krawczyk N, Mojtabai R, Stuart EA, et al. Opioid agonist treatment and fatal overdose risk in a state-wide US population receiving opioid use disorder services. Addiction 2020;115:1683–94. PMID:32096302 https://doi.org/10.1111/add.14991
2. Dowell D, Brown S, Gyawali S, et al. Treatment for opioid use disorder: population estimates—United States, 2022. MMWR Morb Mortal Wkly Rep 2024;73:567–74. PMID:38935567 https://doi.org/10.15585/mmwr.mm7325a1
3. Guy GP Jr, Jones CM, Rikard M, Strahan AE, Zhang K, Olsen Y. Individuals dispensed buprenorphine in the US before and after federal policy changes aimed at increasing access. J Addict Med 2025;19:615–20. PMID:39969964 https://doi.org/10.1097/adm.0000000000001457
4. Ramdin C, McGowan T, Perrone J, Mazer-Amirshahi M, Nelson LS. Buprenorphine administration and prescribing at emergency departments: a national analysis from 2014–2021. J Addict Med 2025;19:254–9. PMID:39514888 https://doi.org/10.1097/adm.0000000000001402
5. Amiri S, Hirchak K, McDonell M, Denney J, Buchwald D, Amram O. Access to medication-assisted treatment in the United States: comparison of travel time to opioid treatment programs and office-based buprenorphine treatment. Drug Alcohol Depend 2021;1:224–26. https://doi.org/10.1016/j.drugalcdep.2021.108727
6. Morenz AM, Nance RM, Mixson LS, et al. Barriers to accessing medications for opioid use disorder among rural individuals. Int J Drug Policy 2025;140:104805. PMID:40252371 https://doi.org/10.1016/j.drugpo.2025.104805
7. Hu JC, Hutchings K, Jalali A, Kapadia S, Bao Y, Underhill K. State laws prohibiting prior authorization for medications for opioid use disorder in private insurance, 2015–2023. Health Aff (Millwood) 2025;44:1369–77. PMID:4118324 https://doi.org/10.1377/hlthaff.2025.00191
8. Snyder H, Chau B, Kalmin MM, et al. High-dose buprenorphine initiation in the emergency department among patients using fentanyl and other opioids. JAMA Netw Open 2023;6:e231572. PMID:36867410 https://doi.org/10.1001/jamanetworkopen.2023.1572
9. Guy GP Jr, Jones CM, Rikard SM, Zhang K, Olsen Y. Prescriber-level changes in buprenorphine dispensing in the USA before and after federal policy changes aimed at increasing prescribing. J Gen Intern Med 2025;40:4090–3. PMID:40562887 https://doi.org/10.1007/s11606-025-09655-8
10. Hawk K, Hoppe J, Ketcham E, et al. Consensus recommendations on the treatment of opioid use disorder in the emergency department. Ann Emerg Med 2021;78:434–42. PMID:34172303 https://doi.org/10.1016/j.annemergmed.2021.04.023

The *Morbidity and Mortality Weekly Report (MMWR)* Series is prepared by the U.S. Centers for Disease Control and Prevention (CDC) and is available free of charge in electronic format. To receive an electronic copy each week, visit *MMWR* at *https://www.cdc.gov/mmwr/index.html*.

Readers who have difficulty accessing this PDF file may access the HTML file at https://www.cdc.gov/mmwr/index2026.html. Address all inquiries about the *MMWR* Series to Editor-in-Chief, *MMWR* Series, Mailstop V25-5, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30329-4027 or to mmwrq@cdc.gov.



ISSN: 0149-2195 (Print)