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# The Potential Impact of Ending the Ryan White HIV/AIDS Program on HIV Incidence: A Simulation Study in 31 U.S. Cities

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**Background:** With antiretroviral therapy, people with HIV can live a normal lifespan and not transmit HIV. The Ryan White HIV/AIDS Program provides care for over half of people with HIV in the United States.

**Objective:** To estimate how many HIV infections could result from cessation of Ryan White services or interruptions lasting 18 to 42 months.

**Design:** A compartmental HIV transmission model was used to simulate epidemics and Ryan White service use.

**Data Sources:** The researchers calibrated model transmission to surveillance data from the U.S. Centers for Disease Control and Prevention in each city and calibrated the number of Ryan White clients to program reports. Ryan White clinic directors and administrators were surveyed to estimate how many clients would lose viral suppression if services stopped.

**Target Population:** Simulated HIV epidemics in 31 high-burden U.S. cities.

**Time Horizon:** Through 2030.

**Perspective:** Not applicable.

**Intervention:** The researchers projected HIV incidence under the following 4 scenarios: continued services, cessation in July 2025, interruption until January 2027, and interruption until January 2029.

**Outcome Measures:** Projected excess HIV infections from 2025 to 2030.

**Results of Base-Case Analysis:** Ending Ryan White services in July 2025 could result in 75 436 additional infections (95% credible interval [CrI], 19 251 to 134 175 infections) through 2030—a 49% (95% CrI, 12% to 86%) increase. Increases ranged from 9% (Riverside, California) to 110% (Baltimore, Maryland). Interruptions of 18 and 42 months yielded 19% and 38% more infections, respectively.

**Results of Sensitivity Analysis:** A "conservative" analysis with lower simulated loss of suppression from observational studies projected 34 051 excess infections (95% CrI, 23 902 to 45 147 infections).

**Limitation:** The loss of suppression if Ryan White services end may be misestimated by survey responses and observational studies.

**Conclusion:** Disrupting Ryan White services could sharply increase HIV incidence, highlighting their critical public health value.

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The Ryan White HIV/AIDS Program provides comprehensive HIV medical care, treatment, and support services for over half of the 1.2 million people living with HIV in the United States (1). With antiretroviral therapy, people with HIV can expect to live a normal lifespan and do not transmit HIV (2–4). Ryan White often serves as a "payer of last resort" for those who would otherwise be unable to access care and is instrumental in helping clients maintain viral suppression.

Most Ryan White services fall into 1 of 3 categories: 1) the AIDS Drug Assistance Program (ADAP), where grants pay for antiretroviral therapy directly, pay premiums for health insurance, and help with medication copays; 2) direct funding to HIV care facilities for outpatient ambulatory health services; and 3) provision of nonmedical support services, such as case management, transportation assistance, adherence support, and housing assistance (5) (**Supplement Figure 1**, available at Annals.org).

Ryan White clients have higher viral suppression rates than people with HIV who do not receive Ryan White services (6). However, only 1 study has examined discontinuation of services: Erly and colleagues (7) found that viral suppression dropped from 83% to 69% among Ryan White clients who were disenrolled from ADAP in Washington state (7) and from 82% to 64% among those who did not reenroll within a year (Erly S. Unpublished data.). Another study by Diepstra

**See also:**

*Web-Only*
Supplement

and colleagues (8) examined suppression rates by service category (with no discontinuation) and found that people with HIV receiving Ryan White medical services had 1.5- to 2.9-fold greater odds of viral suppression than those without; clients receiving support services had 0.8 to 2.3 times the odds of suppression.

Widespread disruptions to Ryan White services could have significant consequences. Mathematical models of disease transmission are an important tool for forecasting impacts of health policy. Prior studies have estimated that without Ryan White, new infections would increase by 16% to 22% in specific states over 5 years and 18% nationally over 50 years (9, 10). However, the U.S. HIV epidemic is driven by local dynamics, and simulations of large geographic regions may obscure local heterogeneity. We sought to use a city-level model of HIV transmission to quantify the number of excess HIV infections in U.S. cities that would result from cessation or interruption of Ryan White services.

## METHODS

### Model Structure

The Johns Hopkins Epidemiologic and Economic Model (JHEEM) is a dynamic, compartmental model of HIV transmission. The model represents variable transmission across strata of the adult population by age, race/ethnicity, sex, and risk factors for HIV acquisition (11). Demographic groups are categorized by HIV infection status, awareness of HIV status, and use of preexposure prophylaxis (**Supplement Figure 1**).

To represent the Ryan White program, we expanded each compartment of people with diagnosed HIV to include the proportion receiving Ryan White services in 3 nonoverlapping categories: any AIDS drug assistance, outpatient ambulatory health services but not AIDS drug assistance, and any other Ryan White services (**Supplement Figure 2**, available at Annals.org). We also modeled the proportion who were virally suppressed among Ryan White clients receiving each class of services in each compartment, such that decreases in suppression among clients would lead to greater transmission. We represented proportions using a logistic model with terms for time, age, race, sex, and HIV acquisition risk factor.

### Study Setting

The JHEEM simulates HIV epidemics at the level of a metropolitan statistical area: geographic designations with a core city and its surrounding counties. The U.S. Ending the HIV Epidemic initiative highlights 48 counties with high disease burden, which fall into 32 distinct metropolitan statistical areas (12). We excluded Cincinnati, Ohio, for which the city-level number of Ryan White clients is not reported, and studied the remaining 31 cities.

### Model Calibration

The calibration of JHEEM has been described previously (11); we generated simulations for each city by running an adaptive Metropolis sampler for 1 000 000 iterations across 4 chains. We retained a sample of 1000 simulations per city, which match local epidemiologic targets, including new diagnoses, prevalence, and overall viral suppression (**Supplement Table 1**, available at Annals.org).

We calibrated additional parameters representing receipt of Ryan White services and viral suppression among Ryan White clients, according to demographics and risk factors (**Supplement**, available at Annals.org). For each simulation, we ran an adaptive Metropolis sampler for 300 to 3000 additional iterations to calibrate the following measures of Ryan White use from 2017 to 2023 per Ryan White program reports (**Supplement Table 2**, available at Annals.org): the number of clients receiving any non-AIDS drug assistance services, the number of clients receiving outpatient ambulatory health services (13), the rate of viral suppression among outpatient ambulatory health services recipients (13), the ratio of ADAP clients to non-ADAP clients at the state level (13, 14), and the proportion of ADAP clients at the state level who were virally suppressed (15–18). Both our model and Ryan White reporting consider a "client" to be a person who has received services at any point during a calendar year.

### Modeled Scenarios

We represented the effect of stopping or interrupting Ryan White services as the proportion of currently suppressed Ryan White clients who lose suppression once services stop in each of the 3 service categories. We simulated the following 4 scenarios for each city. In the "continuation" scenario, Ryan White services continue at current levels and viral suppression continues its current trajectory. In "cessation," Ryan White services stop in July 2025; viral suppression among Ryan White clients decreases and never recovers. In "brief interruption," Ryan White services stop in July 2025; suppression among Ryan White clients begins to improve in January 2027 and recovers to prior levels by December 2027. In "prolonged interruption," Ryan White services stop in July 2025; suppression among Ryan White clients recovers from January 2029 to December 2029.

In all scenarios, we projected the HIV epidemic in each city to 2030. These projections continued current trends in transmission, suppression, testing, and preexposure prophylaxis uptake into the future, with randomly sampled variation (11).

The proportion of Ryan White clients who would lose suppression because of widespread cessation of services is unknown. We developed a survey and distributed it to clinic directors, administrators, and health officials with expertise in Ryan White programs and asked respondents to estimate the likely proportion of their clinics' Ryan White clients who would lose suppression for each of the 3 service categories (details in the **Supplement**). We also elicited estimates of the

proportion of patients from rural areas and the states from which patients came (**Supplement Figure 3**, available at Annals.org). The survey was distributed through mailing lists of HIV and Ryan White providers (the Ryan White Medical Providers Coalition and the HIV Medicine Association), message boards for the Infectious Diseases Society of America, and investigators' professional networks.

We based our primary analysis on these survey results, fitting 1 multivariate kernel density to arcsine-transformed survey responses using the ks package (19) for respondents from Medicaid nonexpansion states and a second kernel density for expansion state respondents. From these distributions, we simulated 1000 different values of the proportion of suppressed Ryan White clients who would lose suppression in each of the 3 service categories, conditional on Medicaid expansion status, and applied these proportions to the 1000 simulations in each of the 31 cities.

### Outcomes

Our primary outcome was the relative projected excess incident HIV infections from 2025 to 2030 that would be incurred by either cessation or interruption of Ryan White services versus continuation: $(infections_{cessation/interruption} - infections_{continuation})/infections_{continuation}$. We calculated the absolute number of excess infections from 2025 to 2030 as a secondary outcome. For both outcomes, we calculated the mean across 1000 simulations and the 95% credible interval (CrI; 2.5th and 97.5th percentiles) for each city and for the total across all 31 cities.

### Secondary Analyses

Because survey respondents may overestimate the effects of Ryan White disruptions, we conducted a secondary analysis that incorporated 2 studies on the effects of Ryan White on viral suppression. In this analysis, we treated the survey results as a prior distribution and conditioned on Erly and colleagues' estimate of suppression loss from ADAP disenrollment (7) and Diepstra and colleagues' associations between viral suppression and Ryan White outpatient medical or support services (8). We sampled the effects on viral suppression from this posterior distribution—which substantially reduced simulated losses in suppression (**Supplement**).

We also conducted a secondary analysis to examine the primary determinants of between-city variation. For each city, we calculated the average (across simulations) relative excess infections from 2025 to 2030 and evaluated this against the following 5 baseline variables in 2025: the proportion of people with HIV receiving Ryan White services; rates of transmission, suppression, and new diagnoses per population; and whether the city falls principally in a Medicaid expansion state. We calculated partial rank correlation coefficients (PRCCs) for each variable and made scatter plots of variables against relative excess cases (20).

### Sensitivity Analyses

We conducted probabilistic sensitivity analyses to identify influential parameters (20). We calculated PRCCs for parameters governing the proportion of people with HIV who receive Ryan White services, parameters governing the proportion of Ryan White clients who are virally suppressed, and proportions of Ryan White clients in each service category who would lose suppression if services end. We visualized the effect of highly influential parameters by ranking the simulations in each city by parameter value and comparing the outcomes from the 20% of simulations with the highest values of that parameter versus the 20% with the lowest.

### Web Tool

We present all results and customizable scenarios via a public web tool at www.jheem.org/ryan-white.

### Role of the Funding Source

This work was unfunded.

## RESULTS

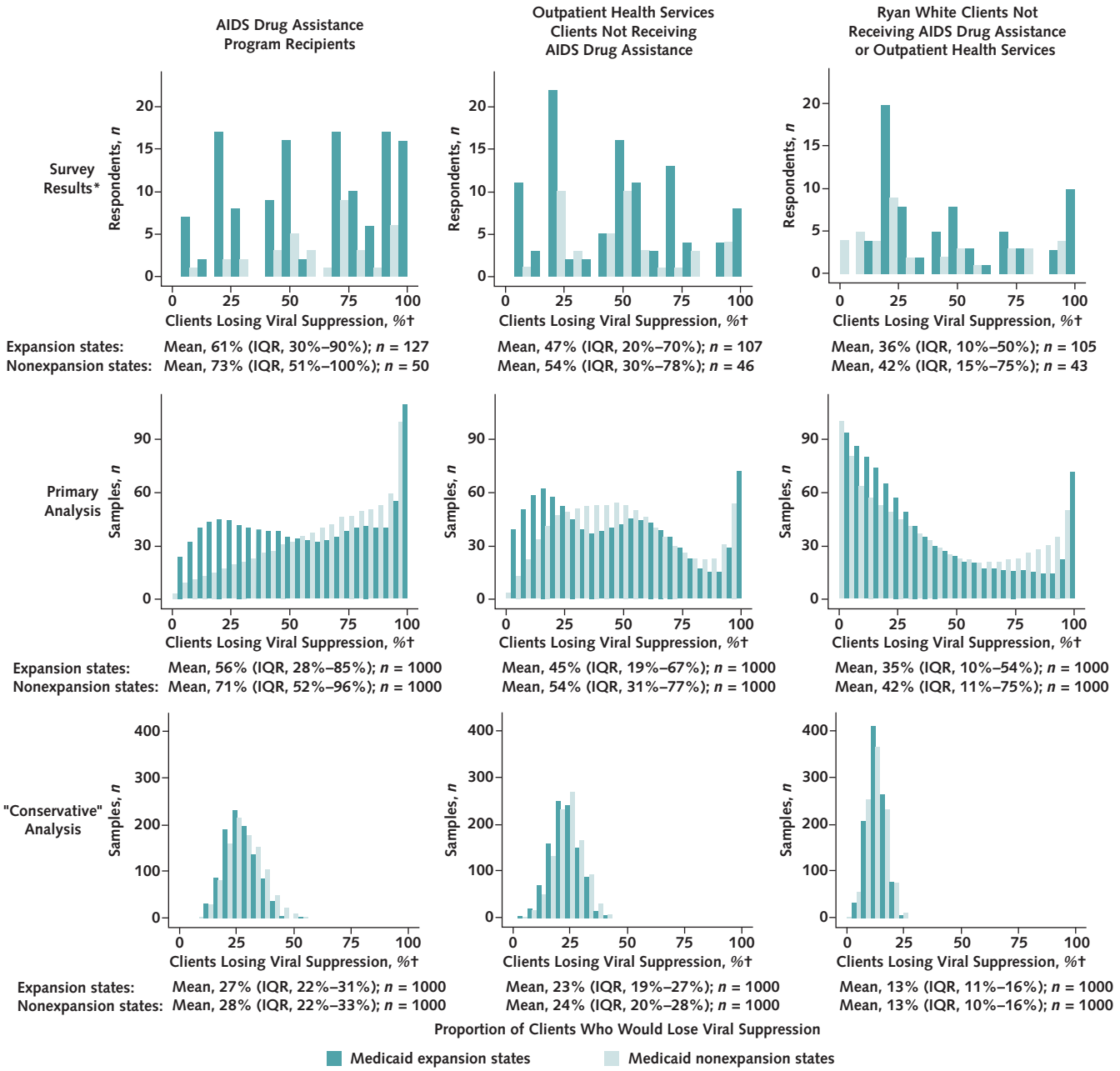
### Survey of Ryan White Clinic Directors, Administrators, and Health Officials

One hundred eighty Ryan White clinic directors, administrators, and health officials completed our survey; 135 cared for patients from 33 Medicaid expansion states plus Washington, DC, and 54 cared for patients from 8 Medicaid nonexpansion states (**Supplement Figure 4**, available at Annals.org). The median reported proportion of clients from rural areas was 20%.

Expected losses in suppression varied widely among respondents, ranging from 0% to 100% in all service categories (**Figure 1**). On average, respondents expected 65% losses in suppression (IQR, 40% to 90%) among recipients of AIDS drug assistance, 49% (IQR, 25% to 70%) among outpatient ambulatory health services recipients not receiving AIDS drug assistance, and 37% (IQR, 10% to 60%) among Ryan White clients receiving other services. Expected losses were significantly greater among respondents from Medicaid nonexpansion states (for ADAP clients) and among respondents with at least 50% rural patients (for ADAP and outpatient ambulatory health services). Results did not differ significantly by geographic region (**Supplement Table 3**, available at Annals.org). Respondents who did not complete the survey estimated greater losses in suppression on the questions they did answer than respondents who completed the survey (**Supplement Figure 5** and **Supplement Table 4**, available at Annals.org).

The sampled effects on viral suppression in our "conservative" analysis, which incorporated data from 2 studies, were substantially lower than the effects sampled directly from smoothed survey responses (**Figure 1**).

***Figure 1.*** Loss of viral suppression from survey of 180 Ryan White clinic directors, administrators, and health officials and sampled suppression effects.




Histograms of 180 survey responses (*top row*) plus the 1000 suppression reductions sampled from a kernel density for the primary analysis (*middle row*) and the "conservative" analysis (*bottom row*), shaded by Medicaid expansion status.

* Respondents had the option of replying "I don't know," so individual questions have fewer than 180 responses.

† Estimated proportion of Ryan White clients who would lose viral suppression if services end.

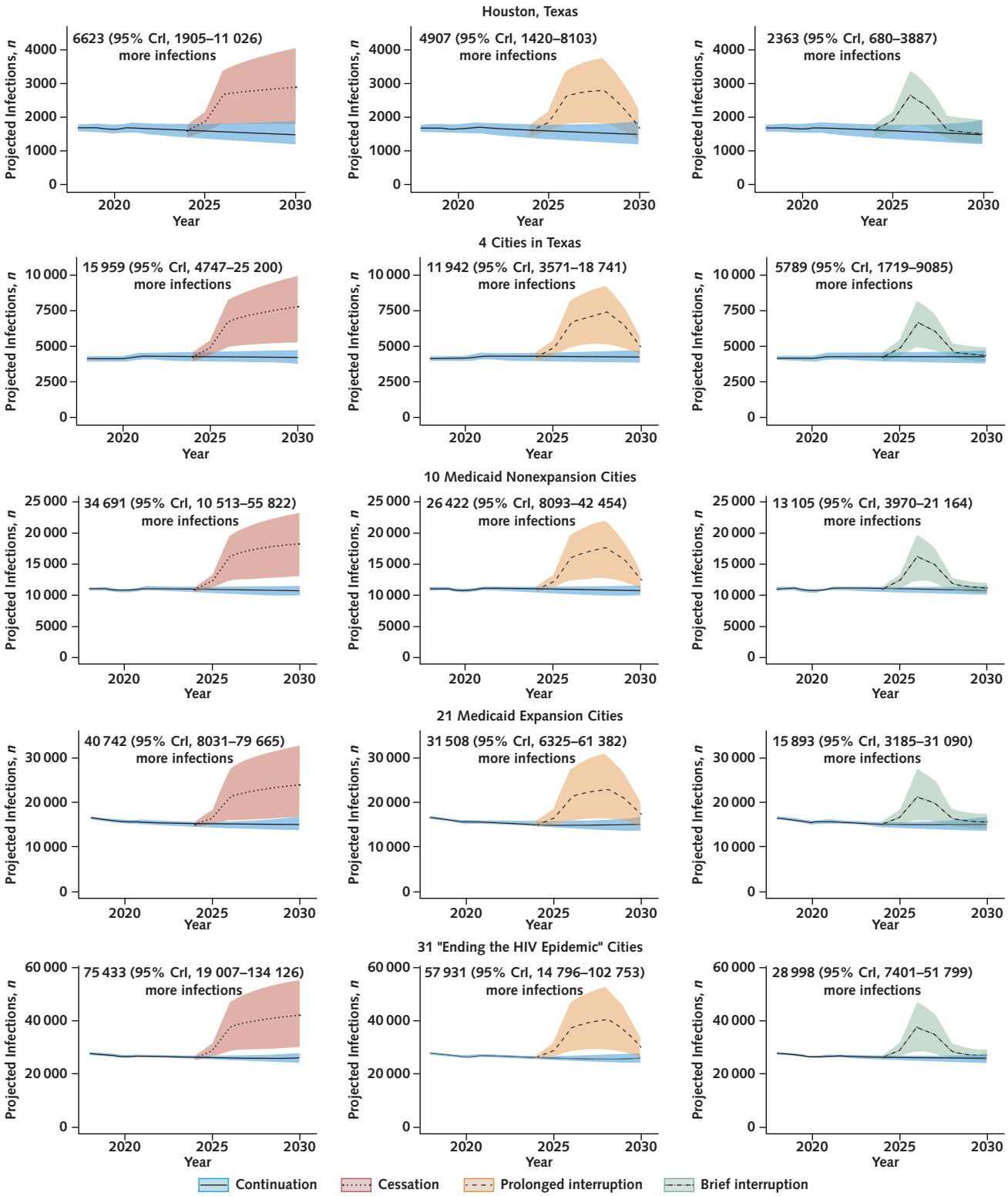
## Overall Impact of Ryan White Program Cessation or Interruption

Our simulations closely matched the proportions of city residents who were receiving Ryan White services and the proportions of Ryan White clients who were virally suppressed (see **Supplement Figure 6** for Houston, Texas, as an example and www.jheem.org/ryan-white for the other cities).

If Ryan White programs continue uninterrupted, we project 154 429 incident HIV infections (95% CrI, 147 165 to 161 767 infections) from 2025 through 2030 across all 31 cities (see **Figure 2** for Houston and **Figure 3** for all 31 cities).

In our primary analysis, after a halt to Ryan White services in July 2025, average viral suppression across all cities was projected to decrease from 74% (95% CrI,

***Figure 2.*** Projected HIV incidence if Ryan White programs end or are interrupted.




Sample projections for Houston, Texas; 4 cities in Texas (Austin, Dallas/Forth Worth, Houston, and San Antonio); and totals across cities. Curves denote the mean across 1000 simulations; ribbons give the 95% CrI. Blue with a solid line represents uninterrupted continuation of Ryan White services. In the other scenarios, Ryan White services stop in July 2025. In the cessation scenario (*left column*), viral suppression among Ryan White clients never recovers. In prolonged interruption (*middle column*), viral suppression recovers from January to December 2029. In brief interruption (*right column*), viral suppression recovers from January to December 2027. CrI = credible interval.

***Figure 3.*** City-level excess HIV infections from 2025 to 2030 if Ryan White programs are stopped or interrupted.

| | Continuation | Cessation | | Prolonged Interruption | | Brief Interruption | |
|---|---|---|---|---|---|---|---|
| City | Mean Incident Infections (95% CrI), *n** | Mean Excess Infections (95% CrI), *n*† | Relative Excess Infections (95% CrI), %*‡ | Mean Excess Infections (95% CrI), *n*† | Relative Excess Infections (95% CrI), %*‡ | Mean Excess Infections (95% CrI), *n*† | Relative Excess Infections (95% CrI), %*‡ |
| Baltimore, MD | 1579 (1257–1965) | 1720 (343–3429) | 110 (21–229) | 1331 (264–2654) | 85 (17–174) | 668 (131–1352) | 43 (8–86) |
| New Orleans, LA | 1162 (940–1452) | 1045 (193–2156) | 91 (17–193) | 787 (145–1616) | 68 (13–145) | 392 (72–808) | 34 (6–73) |
| Boston, MA | 2961 (2466–3685) | 2309 (441–4688) | 79 (15–160) | 1743 (343–3514) | 59 (11–120) | 851 (170–1699) | 29 (6–58) |
| Seattle, WA | 3014 (2458–3810) | 2320 (450–4789) | 78 (14–162) | 1752 (344–3584) | 59 (11–120) | 839 (165–1713) | 28 (5–57) |
| Miami/Fort Lauderdale FL§ | 9171 (7367–11 116) | 6983 (2121–12 226) | 77 (23–130) | 5468 (1676–9548) | 60 (18–101) | 2810 (861–4944) | 31 (9–51) |
| Houston, TX§ | 9211 (7648–10 904) | 6623 (1905–11 026) | 72 (20–125) | 4907 (1420–8103) | 54 (15–92) | 2363 (680–3887) | 26 (7–44) |
| Austin, TX§ | 1878 (1544–2296) | 1301 (355–2193) | 70 (19–121) | 983 (275–1644) | 53 (14–91) | 480 (136–795) | 26 (7–44) |
| Chicago, IL | 6139 (5273–7122) | 4003 (744–7677) | 66 (12–128) | 3084 (581–5901) | 50 (9–99) | 1569 (296–3013) | 26 (5–51) |
| New York, NY | 14 232 (11 110–20 471) | 8380 (1570–17 086) | 60 (12–128) | 6526 (1192–13 346) | 47 (9–97) | 3367 (610–7111) | 24 (5–50) |
| Philadelphia, PA | 5743 (4405–7391) | 3338 (575–6821) | 59 (10–124) | 2560 (438–5207) | 46 (8–95) | 1273 (216–2586) | 23 (4–47) |
| Dallas/Fort Worth TX§ | 11 414 (9403–13 295) | 6727 (2037–10 933) | 59 (18–96) | 5041 (1535–8118) | 44 (13–72) | 2439 (738–3928) | 21 (6–35) |
| Columbus, OH | 2203 (1706–2807) | 1161 (222–2289) | 54 (10–115) | 911 (179–1774) | 42 (8–88) | 466 (92–913) | 22 (4–44) |
| Indianapolis, IN | 2106 (1769–2522) | 1105 (223–2214) | 53 (10–108) | 857 (172–1694) | 41 (8–82) | 432 (85–848) | 21 (4–41) |
| Baton Rouge, LA | 982 (796–1219) | 488 (100–994) | 50 (9–106) | 357 (70–734) | 37 (7–79) | 169 (31–361) | 18 (3–39) |
| Memphis, TN§ | 1871 (1547–2289) | 883 (287–1421) | 48 (15–81) | 675 (219–1090) | 36 (11–62) | 338 (104–557) | 18 (6–32) |
| San Antonio, TX§ | 2781 (2204–3410) | 1308 (364–2307) | 47 (13–84) | 1010 (286–1771) | 36 (10–63) | 507 (145–867) | 18 (5–31) |
| Charlotte, NC | 3452 (2733–4045) | 1565 (275–3137) | 46 (8–92) | 1204 (214–2383) | 35 (7–70) | 603 (107–1174) | 18 (3–34) |
| San Francisco, CA | 3107 (2420–3901) | 1388 (268–2919) | 45 (9–91) | 1066 (211–2247) | 34 (7–69) | 519 (104–1100) | 17 (3–34) |
| Tampa, FL§ | 4474 (3482–5303) | 1940 (576–3373) | 44 (13–77) | 1513 (457–2604) | 34 (10–60) | 781 (232–1357) | 18 (5–31) |
| Atlanta, GA§ | 14 608 (12 199–16 871) | 6056 (1682–10 541) | 42 (11–77) | 4639 (1306–8035) | 32 (9–59) | 2323 (651–4086) | 16 (4–29) |
| Detroit, MI | 2334 (1880–3016) | 899 (158–1938) | 39 (7–89) | 689 (120–1470) | 30 (5–68) | 336 (57–739) | 15 (2–34) |
| Phoenix, AZ | 4,678 (3948–5600) | 1771 (341–3641) | 38 (7–81) | 1367 (268–2780) | 30 (6–62) | 686 (137–1391) | 15 (3–31) |
| Jacksonville, FL§ | 3167 (2618–3578) | 1178 (364–2021) | 37 (12–63) | 846 (261–1463) | 27 (8–46) | 362 (105–637) | 11 (3–20) |
| Washington, DC | 4743 (3737–5810) | 1696 (281–3647) | 36 (6–77) | 1322 (220–2848) | 28 (5–59) | 645 (108–1385) | 14 (2–29) |
| San Diego, CA | 3605 (2884–4376) | 1294 (239–2537) | 36 (7–71) | 996 (186–1986) | 28 (5–54) | 496 (90–1012) | 14 (3–27) |
| Sacramento, CA | 2425 (1900–2894) | 852 (147–1750) | 35 (6–74) | 667 (116–1361) | 28 (5–57) | 337 (58–693) | 14 (2–29) |
| Cleveland, OH | 1999 (1120–3466) | 631 (133–1323) | 35 (6–92) | 486 (103–1000) | 27 (4–72) | 236 (45–516) | 14 (3–37) |
| Los Angeles, CA | 10 241 8929–12 439 | 3372 (597–7038) | 33 (6–68) | 2680 (469–5610) | 26 (4–54) | 1411 (246–3002) | 14 (2–28) |
| Orlando, FL§ | 6163 (4828–7417) | 1693 (500–2906) | 28 (8–47) | 1339 (393–2293) | 22 (6–37) | 701 (202–1196) | 11 (3–19) |
| Las Vegas, NV | 5239 (4345–6202) | 774 (139–1538) | 15 (2–31) | 618 (112–1234) | 12 (2–25) | 326 (58–656) | 6 (1–13) |
| Riverside, CA | 7747 (5056–10 073) | 633 (111–1384) | 9 (1–23) | 509 (88–1118) | 7 (1–18) | 273 (48–596) | 4 (1–10) |
| Medicaid expansion cities | 89 690 (83 648–95 859) | 40 745 (8033–79 786) | 45 (9–89) | 31 511 (6320–61 449) | 35 (7–68) | 15 894 (3183–31 174) | 4 (4–35) |
| Medicaid nonexpansion cities | 64 739 (61 248–67 872) | 34 691 (10 513–55 822) | 54 (16–85) | 26 422 (8093–42 454) | 41 (12–65) | 13 105 (3970–21 164) | 20 (6–32) |
| Total | 154 429 (147 165–161 767) | 75 436 (19 251–134 175) | 49 (12–86) | 57 933 (14 995–102 827) | 38 (10–66) | 28 999 (7507–51 820) | 19 (5–33) |

0% 100%

*Continued on following page*

***Figure 3***–Continued.

Cells are shaded according to the relative excess infections. CrI = credible interval.
* Across 1000 simulations, projected incident HIV infections from 2025 to 2030 if Ryan White programs continue uninterrupted.
† Excess HIV infections expected from 2025 to 2030 under 3 scenarios where Ryan White programs are stopped in July 2025: cessation (viral suppression among Ryan White clients never recovers), prolonged interruption (viral suppression recovers from January to December 2029), and brief interruption (viral suppression recovers from January to December 2027).
‡ Percentage change in projected incident infections, relative to continuation.
§ Denotes cities in Medicaid nonexpansion states. (Others are in Medicaid expansion states.)

72% to 75%) in 2025 to 49% (95% CrI, 27% to 68%) in 2026. If viral suppression among Ryan White clients never recovers ("cessation"), we project 75 436 additional infections (95% CrI, 19 251 to 134 175 infections) across all 31 cities from 2025 to 2030, an excess of 49% (95% CrI, 12% to 86%).

Excess infections varied widely across cities, ranging from 9% (95% CrI, 1% to 23%) in Riverside, California, to 110% (95% CrI, 21% to 229%) in Baltimore, Maryland (**Figures 3** and **4**). The projected increase in infections differed by Medicaid expansion status, with the 10 cities in nonexpansion states projected to experience 54% (95% CrI, 16% to 85%) more infections, compared with 45% (95% CrI, 9% to 89%) more in the 21 cities in expansion states.

In the "brief interruption" scenario, where Ryan White services cease in July 2025 but viral suppression recovers gradually from January through December 2027, we project 28 999 additional infections (95% CrI, 7507 to 51 820 infections) from 2025 to 2030—an excess of 19% (95% CrI, 5% to 33%). In the "prolonged interruption" scenario, where Ryan White services cease in July 2025 but viral suppression does not recover until January through December 2029, we project 57 933 incident infections (95% CrI, 14 995 to 102 827 infections) through 2030—an excess of 38% (95% CrI, 10% to 66%).

Under the "cessation" scenario, increased infections will occur principally among adults younger than 25 years: a 65% increase (95% CrI, 17% to 113%) from 2025 to 2030, compared with 45% (95% CrI, 12% to 79%) among those older than 25 years. Infections will also increase more among men who have sex with men than other risk groups: 57% (95% CrI, 14% to 100%), versus 35% (95% CrI, 9% to 63%) for all other risk groups combined. We did not find large differences in excess infections by race: 47% (95% CrI, 13% to 83%) for Black city residents; 50% (95% CrI, 12% to 89%) for Hispanic residents; and 49% (95% CrI, 12% to 91%) for non-Black, non-Hispanic residents.

### "Conservative" Secondary Analysis

In the "conservative" secondary analysis that informed the potential effect of Ryan White disruptions with 2 observational studies of Ryan White clients, the model projected a shallower drop in viral suppression from 76% in 2025 to 63% (95% CrI, 59% to 67%) in 2026. Permanent cessation of Ryan White services resulted in 34 051 excess infections (95% CrI, 23 902 to 45 147 infections), a 22% (95% CrI, 15% to 29%) increase—ranging from 4% (95% CrI, 2% to 8%) in Riverside to 55% (95% CrI, 34% to 80%) in Baltimore (**Supplement Figures 7** and **8**, available at Annals.org).

Results for the other 2 scenarios were similarly attenuated. The "brief interruption" scenario projected 13 166 excess infections (95% CrI, 9290 to 17 439 infections), an increase of 9% (95% CrI, 6% to 11%). The "prolonged interruption" scenario projected 26 336 additional infections (95% CrI, 18 477 to 34 908 infections), an excess of 17% (95% CrI, 12% to 23%).

### Secondary Analysis of Between-City Variation

The 2 most influential variables in explaining between-city variation were the proportion of people with HIV receiving any Ryan White services in 2025 (PRCC, 0.69) and the average transmission rate in 2025 (PRCC, 0.47). **Figure 5** and **Supplement Figure 9** (available at Annals.org) illustrate the relationship between these variables and the excess infections incurred by ending Ryan White programs.

### Sensitivity Analyses

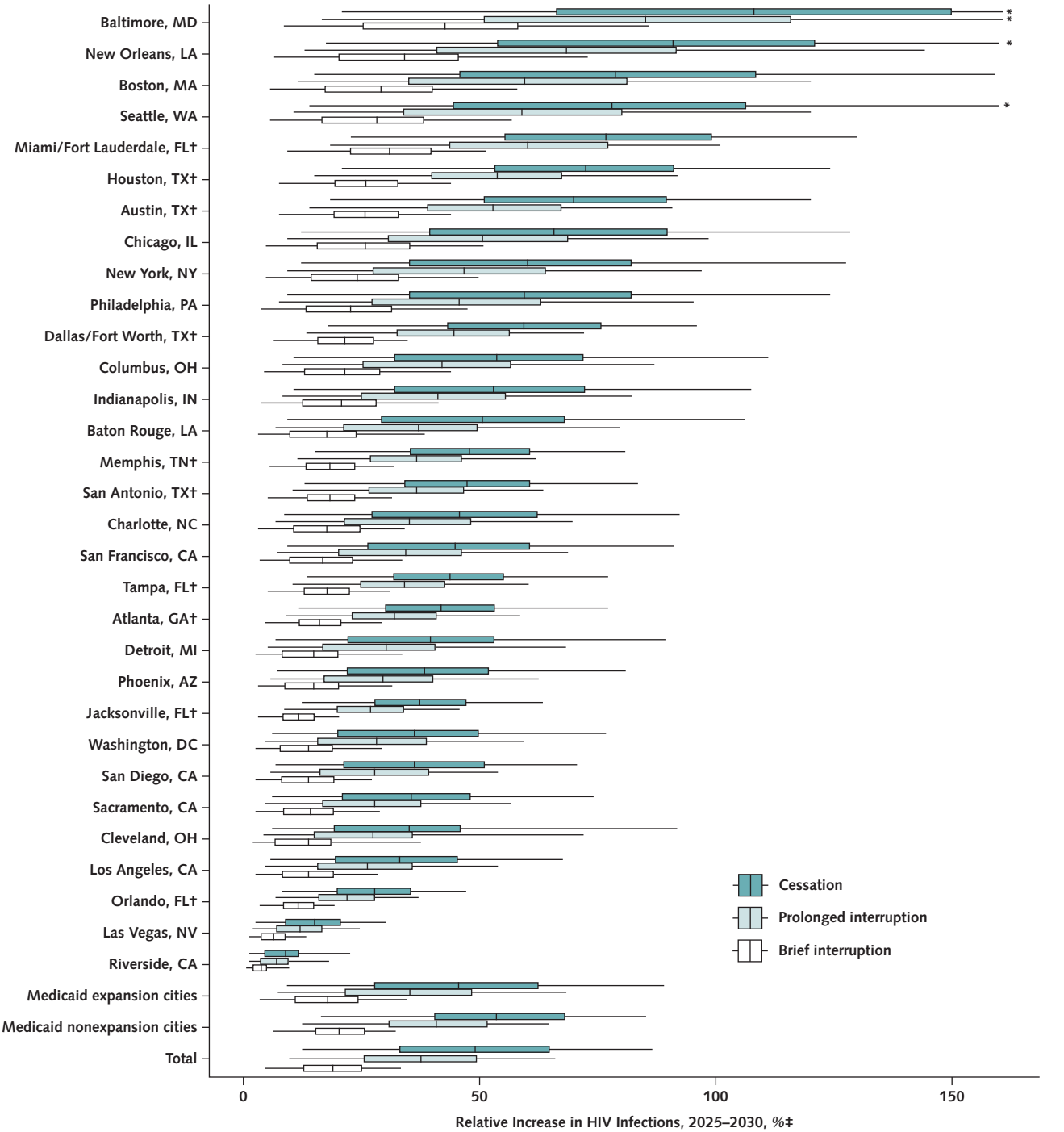
In our sensitivity analyses, the most influential parameters were those describing the effects of service cessation for Ryan White clients receiving AIDS drug assistance, outpatient health services, and other support services (**Supplement Figures 10** and **11**, available at Annals.org).

## Discussion

We used a mathematical model, informed by data from surveys, the U.S. Centers for Disease Control and Prevention, and Ryan White programs, to estimate the impact of disruptions of the Ryan White HIV/AIDS Program in 31 U.S. cities. Across all cities, we project that indefinite cessation of Ryan White services will cause an excess 75 436 infections (95% CrI, 19 251 to 134 175 infections) from 2025 to 2030, an increase of 49% (95% CrI, 12% to 86%). Temporary interruptions to Ryan White services would also result in substantial increases in new HIV infections: a 19% increase (95% CrI, 5% to 33%) if viral suppression among Ryan White clients begins to recover in January 2027, and a 38% increase (95% CrI, 10% to 66%) if viral suppression does not start to recover until January 2029. Projected increases in infections varied widely among cities, ranging from 9% in Riverside to 110% in Baltimore.

Differences between cities were driven by how many people receive Ryan White services in each city, whether Medicaid has been expanded, and the

***Figure 4.*** City-level relative excess HIV infections from 2025 to 2030 if Ryan White programs are stopped or interrupted.



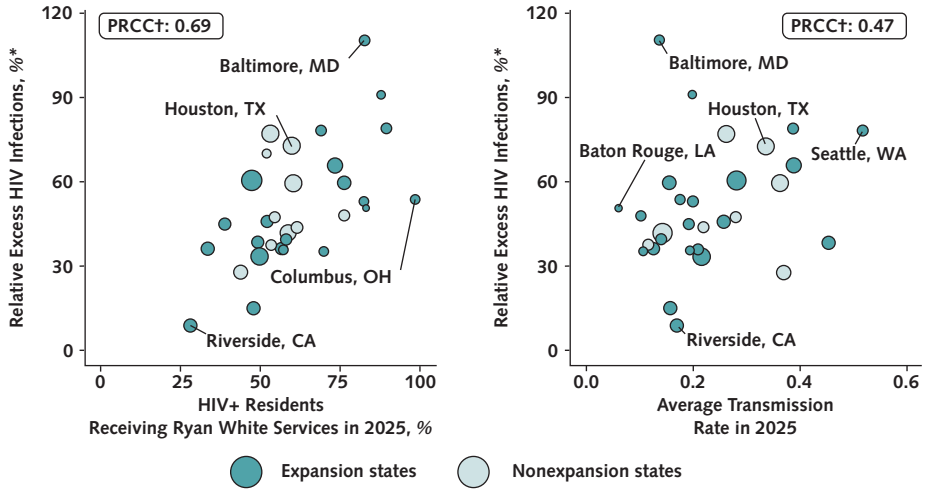

Box plots show the projected percentage increase in new infections under 3 scenarios in which all Ryan White services stop in July 2025: In the cessation scenario (*dark green*), viral suppression among Ryan White clients never recovers; in prolonged interruption (*light green*), viral suppression among Ryan White clients recovers from January to December 2029; and in brief interruption (*white*), viral suppression among Ryan White clients recovers from January to December 2027. The dark vertical lines indicate the median projection across 1000 simulations, the boxes indicate IQRs, and whiskers cover the 95% credible interval (CrI).

* The CrI has been truncated at 160%.

† Denotes cities in Medicaid nonexpansion states. (Others are in Medicaid expansion states.)

‡ Compared with a scenario where Ryan White services continue uninterrupted.

***Figure 5.*** City-level variation in the projected relative increase in HIV infections if Ryan White programs end in July 2025.




Each circle represents 1 city. The size of the circle is proportional to the number of projected new diagnoses in 2024. Dark green shading indicates that the city falls principally in a Medicaid expansion state; light green shading indicates that the city falls principally in a nonexpansion state. PRCC = partial rank correlation coefficient.

* The average relative increase in projected HIV infections from 2025 to 2030 if Ryan White programs end in July 2025 vs. if they continue, averaged across 1000 simulations.

† A measure of the strength of the association between the variable and the outcome.

baseline transmission rate. These findings align with prior studies demonstrating that gaps in antiretroviral therapy access led to increased community viral load and transmission (4, 6, 11). Even short-term lapses in services could have long-term consequences for epidemic control.

Our projections depend on how many Ryan White clients would lose suppression if services end. Fundamentally, this quantity is unknown; there has never been a widespread halt to Ryan White services. In our primary analysis, we estimated the proportion of clients who would lose suppression by surveying clinic directors, administrators, and public health officials with expertise in Ryan White programs. Respondents' estimates varied widely, reflecting uncertainty about potential impacts of unprecedented, large-scale disruptions to Ryan White programs. Our model incorporated this uncertainty: Across the 1000 simulations in each city, some assumed almost no effect from Ryan White cessation, whereas others assumed nearly 100% losses of viral suppression for clients in some service categories. This variation was reflected in wide credible intervals.

It is possible that survey respondents, on average, overestimated the effects of Ryan White disruptions. We conducted a "conservative" secondary analysis, in which simulated impacts of Ryan White cessation were weighted heavily to 2 observational studies: Erly and colleagues (7) recorded a 22% decrease in viral suppression among ADAP clients who were disenrolled for a year, and Diepstra and colleagues (8) observed up to 2.9-fold greater odds of suppression among participants receiving Ryan White's outpatient medical or support services. These simulations, assuming a lower decrease in suppression, projected an average 22% increase in infections. However, the observational studies underpinning this analysis likely underestimate the causal effect of Ryan White programs; clients who do not reenroll in Ryan White may be less dependent on services than those who reenroll promptly, and clients receiving Ryan White services might have had lower suppression rates without those services than patients who were not eligible in the first place. Furthermore, observations of individuals in existing programs are unlikely to accurately characterize the consequences of comprehensive cessation of services. Consequently, our conservative analysis likely substantially understates the impact of Ryan White disruptions.

Two prior studies have estimated infections averted by Ryan White: Goyal and colleagues (9) used an agent-based model to project national trends, and Klein and colleagues (10) modeled representative "high-prevalence" and "low-prevalence" states. Both studies projected a 25–percentage point decrease in overall suppression, matching the average 25-point decrease in our primary analysis (and exceeding the 13-point drop in our conservative analysis). However, Goyal and colleagues projected 18% more infections over 50 years, and Klein and colleagues projected 16% and 22% increases over 5 years, versus 49% over 5 years in our primary analysis. These differences likely stem from how the analyses model transmission. Klein and colleagues calculated excess infections as the number of people who lose suppression multiplied by a preestimated transmission rate. In contrast, we modeled transmission dynamically—newly infected individuals infect others, who in turn infect others, and so on—

such that infections from Ryan White disruptions compound over time. Goyal and colleagues, who also modeled transmission dynamically, simulated the national environment, which has a lower average transmission rate and a smaller proportion of Ryan White clients than the 31 high-burden cities we studied. In addition, Goyal and colleagues projected a 31% increase in deaths over 50 years among people with HIV (foreclosing further transmission from those individuals and exceeding additional infections), whereas we project a lower 15% increase in mortality over 5 years.

As with any modeling study, our analysis has certain limitations. First, we did not consider effects on morbidity or quality of life for people currently living with HIV, which will likely worsen substantially for many Ryan White clients if services are terminated, nor did we do a cost-effectiveness analysis. Second, we assumed that cessation of Ryan White services will affect only Ryan White clients; in reality, a sudden cut to clinic funding is likely to have spillover effects on non–Ryan White clients living with HIV. Third, in interruption scenarios, we presumed that all clients would regain suppression within a year of programs restarting; some individuals would likely experience long-term loss to care. Fourth, we assumed that there are no concurrent major changes to insurance coverage or HIV prevention efforts. Last, we focused only on 31 cities. Although 60% of U.S. infections are diagnosed in these cities, these urban centers may not reflect dynamics in other parts of the country; future work should examine potential impacts at the state level and in rural areas.

Our approach has several strengths. First, we modeled HIV epidemics at the resolution of individual cities, allowing us to capture local dynamics. Second, our Bayesian calibration process robustly characterizes uncertainty about future epidemic trajectories. Finally, local decision makers can consider forecasts, available in detail at www.jheem.org/ryan-white, for their cities to inform planning for HIV epidemic control.

In summary, using a city-level model of HIV transmission in the United States, we estimated that even brief disruptions in the Ryan White HIV/AIDS Program could lead to 30 040 excess HIV infections in 31 U.S. cities by 2030. Full cessation of the program would be even more detrimental, generating an estimated 75 436 excess infections. Similar to the U.S. HIV epidemic itself, the effects are unevenly distributed across cities, with more severe effects in cities more reliant on Ryan White services and cities in Medicaid nonexpansion states. These findings illustrate the value of Ryan White programs in preventing the spread of HIV in the United States and illustrate the implications of even brief interruptions in Ryan White services at the municipal level.

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