Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.
eTable 1. National Drug Codes used to identify direct-acting antiviral HCV medications.

| Drug Name          | Active Ingredients                               | 11-Digit NDC       |
|--------------------|--------------------------------------------------|--------------------|
| Sovaldi            | Sofosbuvir                                       | 61958150101        |
| Sovaldi            | Sofosbuvir                                       | 61958150201        |
| Sovaldi            | Sofosbuvir                                       | 61958150202        |
| Sovaldi            | Sofosbuvir                                       | 61958150301        |
| Sovaldi            | Sofosbuvir                                       | 61958150401        |
| Sovaldi            | Sofosbuvir                                       | 61958150501        |
| Harvoni            | Ledipasvir/sofosbuvir                            | 61958180501        |
| Harvoni            | Ledipasvir/sofosbuvir                            | 61958180401        |
| Harvoni            | Ledipasvir/sofosbuvir                            | 61958180301        |
| Harvoni            | Ledipasvir/sofosbuvir                            | 61958180202        |
| Harvoni            | Ledipasvir/sofosbuvir                            | 61958180101        |
| Viekira Pak        | Ombitasvir/paritaprevir/ritonavir/dasabuvir       | 00074309328        |
| Viekira Pak        | Ombitasvir/paritaprevir/ritonavir/dasabuvir       | 00074309301        |
| Technivie          | Ombitasvir/paritaprevir/ritonavir                 | 00074308228        |
| Zepatier           | Elbasvir/grazoprevir                             | 00006307402        |
| Zepatier           | Elbasvir/grazoprevir                             | 00006307401        |
| Epclusa            | Sofosbuvir/velpatasvir                           | 61958220101        |
| Epclusa            | Sofosbuvir/velpatasvir                           | 61958220201        |
| Epclusa            | Sofosbuvir/velpatasvir                           | 61958220202        |
| Epclusa            | Sofosbuvir/velpatasvir                           | 61958220203        |
| Epclusa            | Sofosbuvir/velpatasvir                           | 61958220301        |
| Viekira XR         | Dasabuvir/ombitasvir/paritaprevir/ritonavir       | 00074006328        |
| Viekira XR         | Dasabuvir/ombitasvir/paritaprevir/ritonavir       | 00074006301        |
| Vosevi             | Sofosbuvir/velpatasvir/voxilaprevir              | 61958240101        |
| Mavyret            | Glecaprevir/pibrentasvir                         | 00074262528        |
| Mavyret            | Glecaprevir/pibrentasvir                         | 00074262501        |
| Mavyret            | Glecaprevir/pibrentasvir                         | 00074262556        |
| Mavyret            | Glecaprevir/pibrentasvir                         | 00074262580        |
| Epclusa authorized generic | Velpatasvir/sofosbuvir                     | 72626270101        |
| Harvoni authorized generic | Ledipasvir/sofosbuvir                    | 72626260101        |
eTable 2. Policy effective dates for HCV drug coverage changes in Medicaid.

| State             | Effective Date | Policy Change | Post Period   | URL               |
|-------------------|----------------|---------------|---------------|-------------------|
| Michigan          | 3/1/2016       | Carve-out     | Q2, 2016 – Q2, 2018 | https://bit.ly/3tc4HsH |
| New Hampshire     | 8/1/2016       | Carve-out     | Q3, 2016 – Q3, 2018 | https://bit.ly/3ciK4UT |
| Indiana           | 9/1/2016       | Carve-out     | Q4, 2016 – Q4, 2018 | https://bit.ly/3rBeeci |
| West Virginia     | 7/1/2017       | Carve-out     | Q3, 2017 – Q3, 2019 | https://bit.ly/30vKKAB |
| New Hampshire     | 9/1/2019       | Carve-in      | Q4, 2019 – Q2, 2020 | https://bit.ly/3rzConC |
### Table 3. States with nonzero weights in synthetic control models

| Control state       | Synthetic Indiana | Synthetic Michigan | Synthetic New Hampshire | Synthetic West Virginia |
|---------------------|-------------------|--------------------|-------------------------|-------------------------|
| Alabama             | 6.6               | --                 | --                      | 38.6                    |
| Arizona             | --                | 1.6                | --                      | --                      |
| Arkansas            | --                | 12.4               | 35.8                    | --                      |
| Colorado            | 31.8              | 50.6               | --                      | --                      |
| Florida             | --                | --                 | --                      | 11.6                    |
| Georgia             | 45.5              | --                 | 11.6                    | 9.4                     |
| Hawaii              | 3.9               | --                 | --                      | --                      |
| Kansas              | --                | 5.0                | 29.8                    | 20.7                    |
| Maryland            | --                | --                 | --                      | 2.9                     |
| Mississippi         | --                | --                 | --                      | 1.2                     |
| Nevada              | 6.3               | --                 | --                      | 7.7                     |
| New Mexico          | 3.1               | --                 | --                      | --                      |
| North Carolina      | --                | --                 | --                      | 4.7                     |
| Rhode Island        | 2.7               | --                 | --                      | 3.0                     |
| Texas               | --                | 2.1                | --                      | --                      |
| Utah                | --                | --                 | 18.7                    | --                      |
| Vermont             | --                | --                 | 4.0                     | --                      |
| Wisconsin           | --                | 28.3               | --                      | --                      |

**Notes:** The table displays the percentage that each state contributed to the synthetic control. Numbers may not sum to 100 due to rounding.

-- indicate a state received no weight in that synthetic control model.
Sample and Measurement of Outcome Variables

The pre-period for our analysis ran from January 1, 2015 to each state’s respective effective quarter for MCO medication carve-outs, and our post-period was the two years following the carve-out effective quarter (see Appendix II for effective dates and post-periods for each state). We included states in our analysis if they had at least one year of pre-period data following a HCV medication carve-out, provided criteria for HCV medication access publicly, and did not implement subscription-based payment models during the study period. Justifications for the exclusion of specific states are discussed in the main text.

Over final “donor pool” included the following: Alabama, Arizona, Arkansas, California, Colorado, Connecticut, District of Columbia, Florida, Georgia, Hawaii, Idaho, Kansas, Kentucky, Maine, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Utah, Vermont, Virginia, and Wisconsin.

Unadjusted Comparisons

Unadjusted changes in study outcomes were identified by comparing the four calendar quarters preceding carve-outs with the following eight quarters. Significance levels and confidence intervals were calculated using two-sided t-tests.

Synthetic Control Comparisons

The basic idea of synthetic control methods is to use a weighted average of each state’s donor pool, with the weights chosen so that pre-trends in outcomes were as similar as possible between the treated state(s) and synthetic control. We followed the approach outlined in Robbins, Saunders, and Kilmer (2016) and implemented in package ‘microsynth’ for R Statistical Software version 4.0.2. We estimated separate synthetic controls models for each treated state and study outcome.

Taylor series linearization (TSL) was then used to calculate estimates and 95% confidence intervals for the effects of SBPM implementation during the following year. This approach accounts for the complex weighting of control states used to create the synthetic control. TSL uses a linear function of the observed data to approximate the estimator, and the variance estimation formulae for a linear estimator can then be applied to the linear approximation. In general, this leads to a statistical consistent estimator of the variance. The TSL method tells us whether any differences in outcome between the treated states and their synthetic controls are statistically significant.

We also conducted a series of permutation tests to determine placebo effect sizes. This procedure occurs in three steps. First, we subset the donor pool of control states for a given treated state and outcome. We then iteratively reassign the “treatment” to each control state. Weights are then calculated to match the placebo treatment to a new synthetic control, and a placebo effect, sampling distribution and associated p-value are generated. Weights were selected to minimize not only outcome pre-trends, but also differences in state liver damage and sobriety restrictions during the pre-period. The number of permutation tests varied by state; individual permutation tests that could not achieve a suitable match during the pre-period were dropped when calculating results. This was defined as a mean squared error (MSE) between treated state and synthetic control of greater than 1. Any MSE cutoff is by definition arbitrary, thus we also tested thresholds of 0.5 and 1.5 and achieved highly similar results. We then use a two-sided t-test to determine whether the observed effect in the treated state is likely to have occurred by chance, given the distribution of placebo effect estimates.
References

1. Athey S, Imbens GW. The state of applied econometrics: Causality and policy evaluation. *J Econ Perspect*. 2017;31(2):3-32.

2. Robbins MW, Saunders J, Kilmer B. A framework for synthetic control methods with high-dimensional, micro-level data: evaluating a neighborhood-specific crime intervention. *J Am Stat Assoc*. 2017;112(517):109-126.

3. Lavrakas P. Encyclopedia of Survey Research Methods. 2008. doi:10.4135/9781412963947

4. Robbins MW, Davenport S. microsynth: Synthetic Control Methods for Disaggregated and Micro-Level Data in R. *J Stat Software; Vol 1, Issue 2*. January 2021. https://www.jstatsoft.org/v097/i02.
eFigure 1. Trends of Hepatitis C mortality per 100,000 residents in treated states and nationally.

Notes. Dotted lines indicate the quarter carve-outs occurred in treated states.
eFigure 2. Trends in HCV prescription fills per 100,000 enrollees per quarter for treated and individual control states.

Notes: Colored lines are treated states, gray lines are individual control states, and the dotted line indicates the beginning of the post period.