Appendix 1 (as supplied by the authors): Supplementary methods

Incentive Design

The first incentive payment (billing code: K187) pays psychiatrists a 15 percent premium on specified service codes for providing outpatient care within 30 days of discharge from a psychiatric hospital admission. The code is payable when paired with one of the following service codes: K195, K196, K197 or K198. The second incentive (billing code: K188) pays psychiatrists a 15 percent premium for service that occurs during the 180 days following a suicide attempt. This bonus is payable when paired with one of the following services codes: A190, A191, A192, A195, A197, A198, A695, A795, K195, K196, K197 or K198. The third incentive (billing code: K189) pays psychiatrists a one-time $200 fee for each patient they follow-up with in the community in the four week period following discharge (assuming that patient had not been seen by that psychiatrist during the inpatient admission). The bonus is payable when delivered in combination with a service described by A190, A195, A695 or A795. K189 is limited to one per physician per patient per 12 month period.

Data

We used administrative data collected by the Ontario Ministry of Health and Long-Term Care and shared, via contractual agreement, with the Institute for Clinical Evaluative Sciences (ICES). Relevant datasets included the Corporate Provider database and the ICES physician database, which we used to identify practicing psychiatrists and their characteristics; the Ontario Health Insurance Plan (OHIP) database, which we used to track physician claims; the Registered Persons Database, which we used to identify individuals eligible for publicly insured health services; the Ontario Mental Health Reporting System, which we used to track admissions to designated mental health hospital beds; the Discharge Abstract Database, which we used to track hospital discharges; and the National Ambulatory Reporting System, which we used to track emergency department visits. We also used data from the Statistics Canada Census for geographical and socioeconomic variables. These datasets were linked using unique encoded identifiers and analyzed at ICES.

Appendix to: Rudoler D, de Oliveira C, Cheng J, et al. Payment incentives for community-based psychiatric care in Ontario, Canada. *CMAJ* 2017. DOI:10.1503/cmaj.160816.

We used these datasets to capture monthly observations on three distinct cohorts from September 2009 to August 2014. At the psychiatrist-level, we captured data on a cohort of all psychiatrists who practiced in Ontario during the study period. We excluded 321 psychiatrists who did not appear before and after the implementation of the incentives. Our sample included 1,921 unique psychiatrists, who were followed over a 60-month period (111,924 monthly observations). We also conducted sensitivity analysis on a balanced panel that contained only psychiatrists who were observed for the full 60 months (1,705 unique psychiatrists) without material changes to our findings. Another sensitivity analysis was conducted using only full-time psychiatrists to ensure our findings were not sensitive to the inclusion of part-time psychiatrists. Again, this did not produce material changes in our findings.

For our patient-level data, we aggregated two patient-level cohorts. The first of these cohorts captured all patients with a psychiatric discharge during the study period ("discharge cohort") (304,574 observations on 187,657 unique patients). The third cohort captured all patients with an emergency department visit for self-harm ("self-harm cohort") (78,375 observations on 63,966 unique patients). If patients were hospitalized following a suicide attempt, then they were included in both the discharge and self-harm cohorts. We excluded patients who were under the age of 16, those not eligible for public insurance, those without an Ontario postal code, and those with missing information on key variables. Patients were also excluded if they had a subsequent ED visit or hospitalization due to transfer from one hospital to another. There were patients who had multiple observations in a given 30 day period. To avoid counting the same patient multiple times for the same event, we only included the last of these observations. As sensitivity analysis using all observations did not alter our conclusions.

Descriptive statistics for our self-harm and discharge cohorts are provided in Appendices 2 and 3. Patients who had a follow-up visit post-discharge and post-suicide attempt had more visits with a psychiatrist than those without a follow-up visit. The likelihood of a follow-up visit may be related to having prior access to a psychiatrist. Those with a follow-up visit post-discharge also tended to live in wealthier neighbourhoods.

Analytic Approach

The P4P incentives for community-based psychiatric care were implemented simultaneously for all psychiatrists in Ontario. Therefore, no suitable control could be generated with provincial data. To estimate the impact of the incentives, we used an interrupted time-series design [1]. Using the psychiatrist cohort, we estimated the impact of the incentives on the quantity of eligible outpatient services delivered. An eligible service was defined as one provided within 30 days of a hospital discharge, or 180 days post-suicide attempt, where a billing code eligible for an incentive payment was applied by the physician.

At the patient-level, we aggregated the discharge and self-harm cohorts to the population mean to estimate the likelihood of an eligible outpatient psychiatrist visit within 30 days of discharge from a psychiatric admission, or 180 days post-suicide attempt.

We estimated an generalized linear model $y_t = \beta_0 + \beta_1 t + \beta_2 x_t + \beta_3 x_t * t + \epsilon_t$, where y_t is the aggregated outcome over t months, and $x = 1$, after the implementation of the incentives. β_0 is the y-intercept, β_1 is the pre-intervention slope of the trend, β_2 is the immediate effect of the incentive implementation (i.e., where $x = 1$), and over β_3 is the change in the slope of the trend after the implementation of the incentives. 95% confidence intervals were generated using bootstrap standard errors with 1,000 repetitions.

Since we had panel data (i.e., repeated observations) at the psychiatrist-level, we also estimated a panel model. We also attempted to address the nonlinearity of the outcome variable by using a count data model. We estimated our outcomes using a population-averaged Poisson model (using the *xtpoisson* command in Stata 13) with bootstrapped standard errors (using 1,000 repetitions). The Poisson model is used to account for non-negative outcomes and over-dispersion (i.e., the sample variance was greater than the sample mean) was accounted for via bootstrapping [2,3]. Since we had an unbalanced panel, we also adjusted for a number of time-varying covariates, including psychiatrist age, number of outpatient visits, outpatient panel size, full-time, and number of outpatients seen each year with a hospitalization in the previous 12 months. We also accounted for seasonality by including month dummies. Outpatient panel size was calculated annually by

assigning patients to the psychiatrist they visited the most over the previous year. To control for unobserved psychiatrist characteristics that were correlated with our covariates, all time-varying covariates were differenced by the psychiatrist-specific means and the psychiatrist-specific means were included as controls [2]. The coefficients on the mean differenced variables represent the within-psychiatrist effects, and the coefficients on the psychiatrist-specific means represent the between-psychiatrist effects. The estimates produced by this model are provided in the table below. The results produced are similar to those generated by the linear model with 3 notable exceptions: 1) In the estimates for the number of visits 30 days post-discharge, the pre-incentive trend was statistically significant, whereas it was not significant in the linear model; 2) The change in the level of the trend for the number of visits 30 days post-discharge was positive and significant, whereas it was not significant in the linear model. However, the magnitude of the effect is less than 0.1 visits per month. 3) The pre-incentive trend for the number of visits 180 following a suicide attempt not significant, whereas it was significant in the linear model. The figures below present these results graphically. Despite the differences between these models, they did not lead us to change our conclusions about the effect of the payment incentives on psychiatrist behaviour.

To check the robustness of our estimates to estimator selection, we also applied a pooled zero-inflated negative binomial estimator with cluster robust standard errors (using the *zinb* command in Stata 13), as well as a population averaged and conditional likelihood negative binomial estimator (using *xtnbreg* with the *pa* and *fe* options in Stata 13). These estimators did not produce material changes to our results (not reported), and therefore, did not alter our conclusions. We also several correlation structures, including first-order autocorrelation, exchangeable and second-order autocorrelation without material changes to our results (not reported). In the main paper, we present the results of the generalized linear model to maintain consistency between the psychiatrist- and patient-level analyses, and to improve the interpretability of our results.

For all analyses we stratified our results to determine if the incentives had differential effects on psychiatrists who supplied eligible services in the pre-incentive period versus those who did not. We stratified psychiatrists into 1st – 3rd and 4th – 5th quintiles. This is an arbitrary bifurcation that was used to ease the

presentation of our results. However, we also ran our regressions stratifying psychiatrists into individual quintiles, and achieved very similar conclusions

References

1. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. J Clin Pharm Ther. 2002;27:299–309.

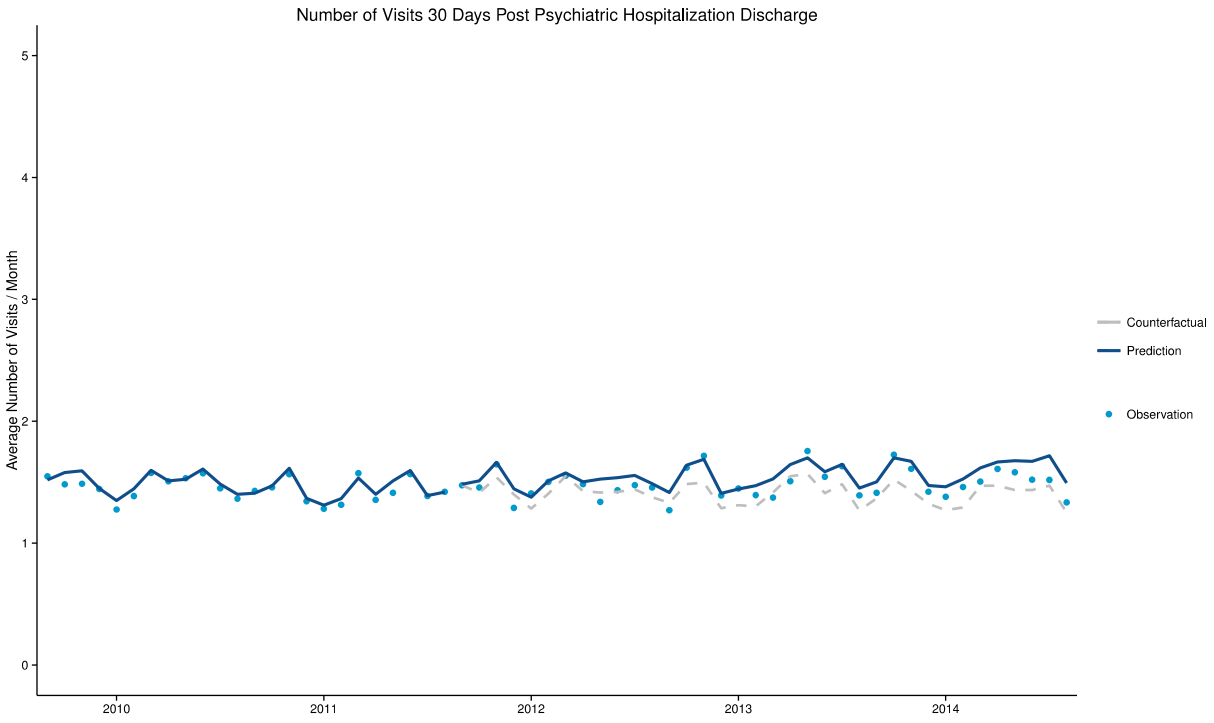
2. Allison PD. Fixed effects regression models. Vol. 160. SAGE publications; 2009.

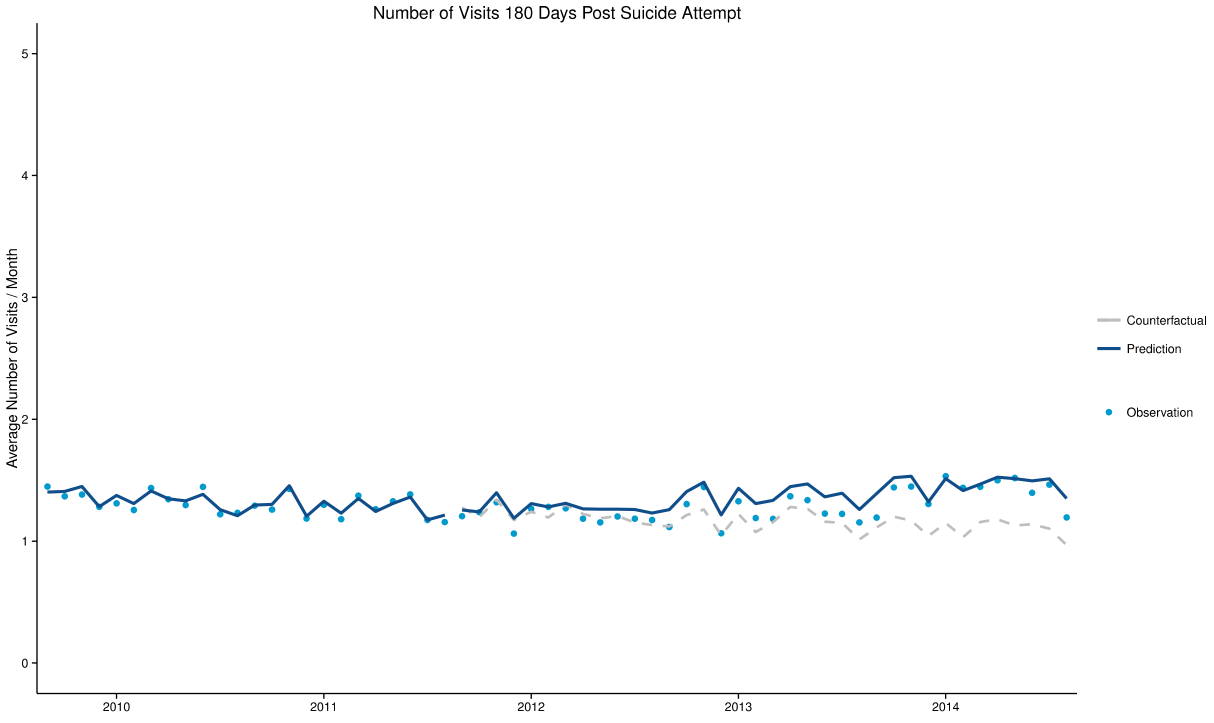
3. Cameron AC, Trivedi PK. Microeconometrics: methods and applications. Cambridge university press; 2005.

Table: Effect of the Intervention on Psychiatrist Supply of Incentive Eligible Visits

Outcome	**Num. of eligible post-discharge visits provided per month per psychiatrist** (95% confidence interval)			**Num. of eligible post-suicide attempt visits provided per month per psychiatrist** (95% confidence interval)		
Model estimates (Reported as Average Marginal Effects)	Full sample	1-3 quintile provider	4-5 quintile provider	Full sample	1-3 quintile provider	4-5 quintile provider
Pre-incentive trend[a]	-.1705 (-.2265, -.1146)	-.0445 (-.0811, -.0080)	-.3635 (-.4866, -.2404)	.0368 (-.0242, .0977)	.0254 (-.0098, .0606)	.0516 (-.0959, .1991)
Change in level after introduction of incentives[b]	.0981 (.0058, .1904)	.0984 (.0513, .1456)	.1099 (-.0906, .3105)	.0066 (-.0918, .1050)	.0769 (.0162, .1376)	-.0938 (-.3278, .1402)
Change in trend after the introduction of the incentives[c]	-.0055 (-.0142, .0033)	-.0107 (-.0215, .00005)	-.0036 (-.0224, .0151)	.0100 (.0008, .0191)	.0073 (-.0032, .0178)	.0151 (-.0058, .0360)

Interpretation of estimates:
a. The monthly change in the mean number of visits prior to the introduction of the incentives (pre-incentive trend).
b. The level change in the mean monthly number of visits after the introduction of incentives.
c. The change in the trend in the mean monthly number of visits after the introduction of the incentives, compared with the monthly trend before the introduction of the incentives.
All model estimates reported as average marginal effects. Confidence intervals on model estimates calculated with bootstrap standard errors (using 500 replications). All estimates are conditional on other model covariates (not reported).


Number of Visits 30 Days Post Psychiatric Hospitalization Discharge
Average Number of Visits / Month
0
1
2
3
4
5
2010
2011
2012
2013
2014
Counterfactual
Prediction
Observation


Number of Visits 180 Days Post Suicide Attempt
Average Number of Visits / Month
0
1
2
3
4
5
2010
2011
2012
2013
2014
Counterfactual
Prediction
Observation