The Effect of Postcard Reminders on Vaccinations Among the Elderly: A Block-Randomized Experiment

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Abstract:
The behavioral sciences suggest that reminders can be an effective way to encourage behavior change. Reminders may be particularly helpful in encouraging the elderly to vaccinate; while children maintain well-recorded vaccination schedules, adults often do not and thus miss important vaccinations. We analyze the effect of a postcard reminder sent by the Louisiana Department of Health to 208,867 residents of Louisiana aged 65-70 who are listed as overdue at least one of four vaccines in the Louisiana Immunization Information System. We use block randomization and a stepped wedge design to study the effect of the postcard reminder. Individuals are blocked by their current vaccine record and randomized to receive the postcard in one of four consecutive months. We also explore treatment effects for each of the four vaccines -- flu, tetanus, pneumonia, and shingles. More generally, our study shows different ways to study an intervention when pure parallel trials are not possible.

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Introduction

In this paper, we study the effectiveness of a postcard reminder intended to increase vaccination rates among 65-70 year-old Louisiana residents. The study was carried out with methods particularly applicable in real-world public health interventions where a “pure” control group may not be feasible, and may therefore speak to a broader audience of researchers who operate in contexts where the treatment cannot be fully withheld from any study participants. In addition to this general applicability, our study speaks to substantive audiences in public health and behavioral insights. First, we speak to the public health literature by adding to the existing literature regarding the effectiveness of individual reminders in medical settings. Second, we speak to the behavioral insights literature, by presenting the results of a study in which the stimulus postcard has several features discussed in this literature, such as simple messaging, a call to immediate action, and a message originating with a trusted source.

The study we describe was carried out in the 2017-18 flu season in Louisiana. We worked together with the Louisiana Department of Health to evaluate the effectiveness of a vaccination reminder postcard sent to Louisiana residents ages 65-70. The postcard is sent during the winter season to all residents in this age bracket, who also appear as being (over)due one or more recommended vaccines in the Louisiana Immunization Information System (IIS). Due to ethical considerations, we could not withhold the postcard from a control group of Louisianans. However, due to logistical reasons the postcards could not be sent out all at once, but rather needed to be staggered over a period of four months. We used the staggered nature of the mailings to randomly assign at what point in the season eligible Louisianans received the postcard. The result is a stepped wedge research design, in which we can identify the causal effect of the postcard on the probability that recipients receive any of the four vaccinations that are recommended for people ages 65-70.

We find that the postcard positively affected the average number of four recommended vaccines received by the recipients; the effect appears to be substantively largest and detectable among individuals who receive the vaccination in October. In addition to these main findings, we explore the effect of the postcard reminder on each of the four types of vaccines.

Encouraging Vaccination

We study an intervention intended to increase compliance with the schedule of recommended vaccinations for 65-70 year old United States residents. The CDC recommends that people in this age range should receive vaccinations against four illnesses: the influenza, tetanus, pneumococcal pneumonia, and herpes zoster (shingles) (CDC, 2018a). However, vaccination rates in the United States lag behind the recommendations made by the Centers for Disease Control and Prevention (CDC) as part of the Healthy People 2020 immunization targets. Specifically, Healthy People 2020 identifies goals around increasing immunization rates to 30% of adults over age 60 receiving the zoster (shingles) vaccine, 90% of adults over age 65 receiving a pneumococcal vaccine, and 90% of adults over age 65 receiving a seasonal influenza vaccine (U.S. Department of Health and Human Services, 2018). Rates of compliance with the recommendations vary, and it is in this context of imperfect compliance that we evaluate the effectiveness of a mail-based reminder to increase compliance. In the section below, we review the recommendations.
for these vaccinations in more detail, to establish the public health relevance of the intervention evaluated in this study.

The influenza (flu) vaccine reduces the risk of getting the seasonal flu; the effectiveness of the vaccine varies significantly from year to year, but one study estimated average effectiveness across years to be around a 59% (measured as reduction in the risk of contracting the flu) (Osterholm 2012). The CDC’s initial calculations for the 2017-2018 influenza vaccine estimates a 36% reduction in risk among the vaccinated compared to those unvaccinated, with a confidence interval of 27% to 44% (CDC, 2018b). This effectiveness is higher than was expected earlier this year, in which we have seen a more dangerous flu season than usual (McNeil, 2018). Prior cost-benefit analyses have indicated that provision and uptake of the flu vaccine is typically cost-effective (Lee, 2010).

Among adults in the United States, vaccination rates are particularly low for the influenza (flu) vaccine: an estimated 43% of adults received the influenza vaccine during the 2016-2017 flu season compared with an estimated 59% of children in the same period (CDC, 2017). The flu becomes more serious as people age; among the elderly, the flu is associated with increased risks of complications and mortality. Flu vaccine uptake among the elderly is higher than among adults ages 18-64: an estimated 65% of adults over 65 years received the flu vaccine during the 2016-2017 flu season compared with an estimated 38% of adults aged 18-64 years (CDC, 2017). However, flu vaccination rates continue to lag behind the recommended levels of 90% of adults over 65 and 80% of adults between 18-64 (U.S. Department of Health and Human Services, 2018).

Elderly adults (adults over 65) are, in addition to the annual flu vaccine, recommended to receive vaccines against shingles, pneumonia and tetanus (Td/Tdap). The exact recommended sequence varies by the patient’s individual vaccination history and risk factors (CDC 2018a), making it more difficult for patients to know when they are due a given vaccine. For example, the pneumococcal vaccine can protect against diseases including pneumonia, meningitis and sepsis, and comes in two forms: 13-valent pneumococcal conjugate (PCV13) and 23-valent pneumococcal polysaccharide vaccine (PPSV23). The type and number of doses of vaccines recommended varies by age, previous vaccination history and underlying medical conditions (CDC, 2015). While there was an increase in adults over 65 estimated to receive the pneumococcal vaccine from 60% in 2012 to 64% in 2015, vaccination rates still lie well below recommended rates of 90% (Williams, 2017; U.S. Department of Health and Human Services, 2018), indicating an opportunity for behavioral interventions to help increase rates.

Reasons for Low Compliance
The reasons for low vaccine uptake can range from cost and accessibility barriers to attitude-based reluctance and refusals. For example, some people may hesitate to get vaccinated due to concerns about vaccine safety or low perceived susceptibility to the diseases that vaccines protect against. Dubé et al. (2013) noted that vaccine attitudes often fall on a continuum from strong refusers to individuals who actively demand vaccinations, and place vaccine hesitant individuals somewhere in between.
While some decisions to not get the flu vaccine are based on misconceptions surrounding vaccine safety, vaccine efficacy, disease susceptibility, or the belief that the flu vaccine can cause the flu (CDC, 2013), there is also evidence that significantly more people intend to get a flu shot than actually do each year (Galarce et al. 2011). While it is possible to increase flu vaccine uptake rates through financial incentives and/or mandates (Pitts et al. 2014), this avenue may not always be practically feasible or ethical (Bronchetti et al. 2015). In addition, general education campaigns have mixed results, sometimes achieving substantial increases (Kimura et al. 2007), but sometimes not creating any change at all (Dey et al. 2001, Chamberlain et al. 2015).

One study on barriers to adult immunization, including tetanus, influenza and pneumococcal immunizations, found that adults reported that a lack of physician recommendations and mistaken assumptions affected their decisions around vaccination. Healthcare providers cited lacking an effective reminder system and patient concerns, including around side effects, as additional barriers to increasing immunization rates, indicating that behavioral interventions may lead to improved rates (Johnson et al. 2008).

In sum, given that failure to follow through on intentions may play a significant role in low flu vaccine uptake rates, flu vaccine uptake is a promising area for behavioral interventions. While reminders and other behavioral interventions usually do not reduce cost and accessibility barriers, they may nonetheless be effective insofar as they help individuals act on their intentions, reduce forgetfulness, increase awareness of recommendations, or help overcome slight hesitancy (for example by conveying an endorsement of the vaccine schedule from a trusted medical authority).

Reminders as Tools in Health Care

Prior research gives us theoretical reasons to expect that reminders may be an effective way to increase compliance with vaccine schedules. For example, many adults who get vaccinated are not highly informed about vaccines (Dube 2013); instead of actively demanding vaccines, they get vaccinated due to provider recommendations or due to social norms (perceptions that getting vaccinated is the common thing to do). For people in this category, reminders may be an effective way to convey recommendations, social norms, and to generally increase the salience of the need to get vaccinated. In addition, Betsch (2015) points out that since people with strong anti-vaccine beliefs are a relatively small minority, it may be most productive to focus scarce vaccine promotion resources on the larger group of complacent or forgetful individuals.

Empirical research has validated that reminder-based interventions can improve healthcare related compliance, including medication adherence and health promoting behaviors (Fenerty et al. 2012, Fry et al. 2009). Stone et al. (2002) show that reminder/recall initiatives are an effective way to increase compliance with vaccine schedules, probably because these initiatives successfully reduce rates of forgetfulness and complacency. In the specific context of flu vaccines, McCaul et al. (2002) found that sending reminder letters to elderly individuals who did not get a flu shot in the previous year increased their uptake of the flu vaccine by 8.6 percentage points from a baseline of 20%. However, the overall
positive impact does not mean that reminders are always effective: Bourgeois (2008) found that sending personalized reminders to employees with a baseline rate of flu vaccination at 19% resulted in a statistically insignificant increase in uptake (5 percentage points).

While many variables may affect the effectiveness of reminders, one element that may be consequential is the content and design of the reminder. For example, prior research has shown that vaccine uptake is significantly affected by physician recommendations (Bratic et al. 2016). While the most effective recommendations are likely made by one’s own doctor in person, it is possible that highlighting healthcare providers’ recommendation more generally on a reminder helps increase its effectiveness. The postcard circulated in this experiment includes a reminder that the vaccine sequence is recommended by the CDC. Another factor that may cause people to fall behind on their vaccination schedule could be failure to follow through on intentions. One way to increase follow-through is to ask people to act immediately rather than putting off the intended action to an indeterminate future time (Milkman 2011, Hagger & Luszczynska 2014). The postcard circulated in this experiment encourages the recipient to “call your healthcare provider today”; this may help increase follow-through on intentions to get vaccinated.

Given that reminders have been proven to be effective and are a low-cost intervention, they may become increasingly widely used. Therefore, it will be important to understand the longer-term effects of reminders on consumer behavior and health outcomes. One initial study demonstrated improved compliance with many (but not all) preventive medicine screening guidelines persisted five years after introducing computer-based reminders (Morgan et al. 1998). However, there is a lack of literature around long-term effects of reminders and prompts on behavior change for health promotion, including for vaccination (Fry et al. 2009). In our study, we can start exploring the question of treatment longevity, as we can measure whether treatment effects are present not only in the first month after postcard receipt, but also in month two after postcard receipt.

The Setting

In the 2016-17 flu season, 58% of Louisiana adults age 65 and over received the flu vaccine (the Louisiana State’s Healthy People 2020 target is 70% and the national target is 90%). 73.1% of Louisiana adults age 65 and over had received the pneumococcal vaccine (the national Healthy People 2020 target is 90%). The Louisiana Department of Health is doing ongoing work to increase vaccination rates in the state, and we worked with them to evaluate one aspect of this effort: a reminder postcard.

For the second year in a row, the Louisiana Department of Health has sent out a postcard reminder to Louisiana adults aged 65–70. See Figure 1 for an image of the postcard. The postcard mentions all four of the vaccines recommended by the CDC for 65–70 year olds to receive (influenza, pneumococcal, zoster, tetanus). The postcard is sent only to individuals who show as being (over)due at least one of these four

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5 2016 immunization rates from the CDC’s AdultVaxView data service at [https://www.cdc.gov/vaccines/imz-managers/coverage/adultvaxview/index.html](https://www.cdc.gov/vaccines/imz-managers/coverage/adultvaxview/index.html); accessed 18 February 2018. The CDC’s data do not include state-specific estimates of compliance with the tetanus and zoster vaccines among Louisiana’s elderly population.
vaccines in the Louisiana Immunization Information System (IIS, also referred to as the registry). The card was designed by Pfizer, who has also funded postcard distribution in both the 2016-17 flu season (no evaluation of the effort occurred that season) and in the 2017-18 flu season (under consideration here). The postcard initiative was ongoing and had in the past been sent to all Louisianans who met the inclusion criteria mentioned above; as a result, we were constrained in research design because we could not ethically withhold the information treatment from recipients. However, logistical constraints meant that the postcards needed to be sent in batches, which allowed us to capitalize on the staggered nature of the intervention and randomly assign the timing of postcard receipt.

**Figure 1:** Postcard Reminder for Vaccinations
Showing inside of folded card on the left, and the outside of folded card on the right. Recipient’s address is printed in the blank space.

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**Experimental Design**

We employ a block-randomized stepped-wedge design to evaluate the postcard reminder intervention. We use the stepped-wedge design to identify the causal effect of the treatment in the context of an experiment where every individual must receive a postcard reminder and join the treatment group by the end of the experiment. We use block-randomization to increase the precision of our analysis, because we

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6 Pfizer provides the funds for postcard distribution, but does not access the medical records of Louisianans in the Immunization Information System.

7 The Louisiana Department of Health determined that the study at hand does not constitute human subjects research. No identifiable data was shared with any researchers outside the Louisiana Department of Health; the analysis was performed on completely anonymous data.
expect individuals with different vaccination histories to react differently to the postcard. The
stepped-wedge design, also called a waitlist design, allows us to evaluate a program that requires all
individuals to receive treatment (Gerber and Green 2012, Hussey and Hughes 2007, Brown and Lilford
2006).

Stepped-Wedge Design
In our stepped-wedge design, individuals are randomly assigned a month in which they receive treatment;
the months are October, November, December of 2017, and January of 2018. We consider individuals
randomized to the January 2018 month as the control group, as vaccination rates were analyzed for the
full sample excluding vaccinations that occurred during and after January 2018. Individuals assigned to
October, November, and December 2017 months are compared to individuals assigned the January 2018.
Table 1 visualizes the stepped-wedge design.

<table>
<thead>
<tr>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>October Treatment Group</strong> (n=52,217)</td>
<td>Control</td>
<td>Intervention</td>
<td></td>
</tr>
<tr>
<td><strong>November Treatment Group</strong> (n=52,216)</td>
<td></td>
<td>Control</td>
<td>Intervention</td>
</tr>
<tr>
<td><strong>December Treatment Group</strong> (n=52,217)</td>
<td></td>
<td>Control</td>
<td>Intervention</td>
</tr>
<tr>
<td><strong>January Control Group</strong> (n=52,217)</td>
<td></td>
<td></td>
<td>Control</td>
</tr>
</tbody>
</table>

Table 1. Stepped Wedge Design. “Control” indicates month in which a group is in the control
condition. “Intervention” indicates month in which a group is in the treatment condition. n = number
of individuals in each group, and as a result, the number of individuals who move from the control to
treatment conditions each month. Groups are made up of each of the 4 blocks of vaccination “types”.
Probability of treatment assignment is the same across blocks, though block sizes within treatment
groups are different.

Block-Randomization
We block treatment receipt by vaccination history and expect the postcard reminder to have different
effects depending on the individuals’ vaccination histories. Individuals come into this experimental pool
with different vaccination histories. Since Louisiana sends postcard reminders to people who are (over)due at least one vaccination only, complete vaccinators are not part of our study pool. Even so, because the recipients were based on vaccination status early in the 2017-18 flu season, the sample includes individuals who are up-to-date on most of their vaccinations, with the only exception being the 2018-19 influenza shot which they may not (yet) have received. Others might have not been up to date on their vaccinations for decades. Yet others might be up-to-date on some vaccinations and behind on others.

We expect that these different vaccination histories will be informative about the individuals’ propensity to take up vaccinations. For example, if individuals have not been up to date on vaccinations for decades, they may have made a conscious decision to not vaccinate, which would be unlikely to change as a consequence of our intervention. On the other hand, among those individuals who are up-to-date on some vaccinations but not others, we may find a higher proportion of individuals who are not opposed to vaccinations, but have simply forgotten they are due a vaccination or have not gotten around to acting on a general desire to get vaccinated. We might expect postcard reminders to work well for those individuals.

Because the recommendations for the pneumococcal vaccine depend on the individual’s health history and are composed of several different shots, our data do not allow us to decide conclusively which individuals are overdue pneumococcal vaccines. Therefore, by necessity, we rely on prior vaccination records for shingles, tetanus, and influenza to block recipients based on vaccination history.

Individuals who are part of one block are randomly assigned to receive the postcard in one of the four months. The four blocks are defined as follows:

1. **Vaccinated**: individuals who are up-to-date on tetanus and shingles vaccines and also received the flu shot in the year prior to our experiment.
2. **Non-vaccinated**: individuals who are overdue on tetanus and shingles and did not receive the flu shot in the year prior to our experiment.
3. **Under-vaccinated (all but flu)**: individuals who are up-to-date on tetanus, shingles, and but did not receive a flu shot in the year prior to the experiment.
4. **Under-vaccinated (mixed)**: individuals who were overdue some combination of tetanus, shingles, and flu vaccines.

The block sizes are different, but within each block, individuals have an equal (0.25) probability to be assigned to each of the four months. Table 2 gives further detail on the blocks and numbers of individuals within each block. In total, approximately 50,000 individuals received the postcard reminder every month.
### Table 2. Blocking scheme by vaccination history.

<table>
<thead>
<tr>
<th>Block</th>
<th>Description of Block*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccinator (n=7,657)</td>
<td>Up-to-date on flu (last year), shingles, tetanus</td>
</tr>
<tr>
<td>Non-vaccinator (n=99,669)</td>
<td>Overdue on flu, shingles, tetanus</td>
</tr>
<tr>
<td>Partial vaccinator (all but flu) (n=5,457)</td>
<td>Up-to-date on shingles, tetanus, overdue on flu</td>
</tr>
<tr>
<td>Partial vaccinator (mix) (n=96,084)</td>
<td>Mix of up-to-date/overdue on flu, shingles, tetanus</td>
</tr>
</tbody>
</table>

*Pneumococcal vaccination histories were not part of the blocking scheme. Vaccinations for pneumococcal are included in analysis and results.

### Data

Our data are drawn from the Louisiana Immunization Information System from the Louisiana Department of Health. Our experimental pool includes 208,867 elderly individuals between the ages of 65-70 in Louisiana who are overdue at least one vaccination at the time of the beginning of the experiment, September 9, 2017. Table 3 presents baseline descriptive statistics about vaccinations in the experimental pool. From the start of the experiment, more individuals are up-to-date on the flu vaccine compared to tetanus and shingles vaccine.

#### Table 3. Baseline Data - Vaccinations. N = 208,867. Dataset includes individuals without vaccination data. All percentages include individuals with no data.

<table>
<thead>
<tr>
<th>Vaccine</th>
<th># of Individuals</th>
<th>% of Individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up-to-date on flu vaccine (Last flu shot between 9/1/2016 - 9/30/2017)</td>
<td>68,259</td>
<td>33%</td>
</tr>
<tr>
<td>Up-to-date on TD/Tdap vaccine (Last TD/Tdap booster between 9/1/2007 - 9/30/2017)</td>
<td>44,413</td>
<td>21%</td>
</tr>
<tr>
<td>Up-to-date on Zoster vaccine (Received the shingles vaccine)</td>
<td>39,551</td>
<td>19%</td>
</tr>
</tbody>
</table>

8 No identifiable data were shared with the research team. Louisiana Department of Health handled all identifiable details; we worked with de-identified data that only included vaccination-relevant fields.
Missing Data

The Louisiana Immunization Information System records the last vaccination date of each vaccine by individual. Vaccination records are compiled by doctors and pharmacists in Louisiana. However, reporting vaccination dates is voluntary. While a number of individuals may have received their vaccinations, they may not have reported the data in this system.

Our data indicate that the following outcomes are missing for individuals:
- Flu: 28% of individuals are missing vaccination records
- Pneumonia: 74% of individuals are missing vaccination records
- Tetanus: 68% of individuals are missing vaccination records
- Shingles: 81% of individuals are missing vaccination records

Missing data are present in both treatment and control conditions. In this study, we choose to treat missing vaccination records as if the individual did not receive a vaccination in this study. With this choice, we are estimating the average treatment effect of individuals who take up the vaccine in a recorded way vs. individuals who do not take up the vaccine or take it up in a non-visible way to us.

Measurement

Our main outcome of interest is the proportion of vaccinations received out of all vaccinations. For example, if an individual received two out of four vaccines (e.g. flu and shingles) in the month before receiving the intervention, the individual’s baseline outcome is 0.5. If the individual receives an overdue vaccine (e.g. tetanus) after receiving the postcard, the post-treatment outcome is 0.75. We also analyze the results for each vaccine separately.

Method

We use linear regression to estimate the average treatment effect of the postcard reminder, as seen in Equation 1. Where $Y_{bi}$ is the proportion of vaccines out of 4 that individual $i$ in block $b$ received between September 9, 2017 – January 9, 2018. $Z$ is the treatment indicator for whether an individual in a block was treated in October, November, or December, $X$ is a matrix with a mean-deviated covariate for the number of vaccines individual, $i$, received between September 8, 2016 – September 8, 2017, and the mean-deviated block for individual, $i$. This saturated regression reduces bias that could be induced from the blocks or covariates on the estimate of the average treatment effect (Lin 2013).

$$Y_{bi} = \beta_0 + \beta_1 Z_{b,i,Oct} + Z_{b,i,Oct} \times X_{b,i,Oct} + \beta_2 Z_{b,i,Nov} + Z_{b,i,Nov} \times X_{b,i,Dec} + \beta_3 Z_{b,i,Dec} + Z_{b,i,Dec} \times X_{b,i,Dec} + \epsilon_{bi}$$ (1)

Results

Results from our experiment suggest that the postcard reminder had a small, but detectable effect on the vaccinations among the elderly who received the postcard in October. Table 4 reports results from

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9 Because the outcome includes multiple comparisons, the significance levels are reported after using the Holm-Bonferroni method to adjust for multiple comparisons.
The first set of results show the average treatment effect for individuals who received the postcard in October. The results estimate that individuals in the October group had received 0.27 percentage points more vaccinations (563 vaccinations) than individuals in the control group. Individuals in the November group had received 0.15 percentage points more vaccinations (313 vaccinations) than the control group. Individuals in the December group had received 125 vaccinations than the control group. Results from the November and December groups are not statistically significant.

Table 4. Effect of Postcard Reminder on Vaccination Rates among Elderly

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Prop of vacs received (October)</th>
<th>Prop of vacs received (November)</th>
<th>Prop of vacs received (December)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>0.0027** (0.0008)</td>
<td>0.0015 (0.0008)</td>
<td>0.0005 (0.0008)</td>
</tr>
</tbody>
</table>

*p < 0.1, **p < 0.05, ***p < 0.01
Obs: 208,511
P-values adjusted with Holm-Bonferroni procedure to adjust for multiple comparisons.

The results in Table 4 shows that during the study period of October through December, individuals who received the postcard in October had higher vaccination rates than individuals who did not receive a postcard. In addition, individuals who received postcards in November and December also had higher vaccination rates compared to those who did not receive a postcard, though these results are not statistically significant. These results lead to follow up questions. Do we see these results because the postcard was particularly effective for one type of vaccination? Also, do we see these results because sending the postcard for the month of October is particularly effective? Alternatively, perhaps these results are not contingent on the month in which an individual receives a postcard, but the length of time during which an individual has a postcard. Specifically, perhaps we see these results because individuals who receive the postcard for 3 months (the October group) have the highest vaccination rates, individuals who receive a postcard for 2 months (the November group) have lower vaccination rates, and individuals who receive a postcard for 1 month (the December group) have the lowest vaccination rate. We explore questions about the type of vaccination and how month or length of time might affect vaccination rates.

Effects by Vaccine Type

The postcard may be particularly effective with certain types of vaccines. We estimate the effect of the postcard on each type of vaccine and report results in Table 5. Overall, the results indicate that individuals received the flu vaccine at higher rates than all other vaccines during this study when compared to the control group. This suggests that the increase in vaccination rates is primarily due to flu vaccinations.

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10 356 individuals attritted from the study.
In addition, Table 5 indicates that individuals who receive the postcard reminder in October tend to have the highest vaccination rates when compared to the control group across all vaccines. However, it is difficult to distinguish whether vaccination rates are higher in October because receiving a postcard reminder during the month of October is particularly effective, or because having a postcard reminder for 3 months instead of 2 or 1 month is particularly effective.

Table 5. Effect of Postcard Reminder by Vaccine Type

<table>
<thead>
<tr>
<th>Vaccine Type</th>
<th>Effect (October)</th>
<th>Effect (November)</th>
<th>Effect (December)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flu Vaccine</td>
<td>0.0071* (0.0026)</td>
<td>0.0039 (0.0026)</td>
<td>0.0030 (0.0026)</td>
</tr>
<tr>
<td>Tetanus Vaccine</td>
<td>0.0010 (0.0007)</td>
<td>0.0005 (0.0007)</td>
<td>0.0000 (0.0006)</td>
</tr>
<tr>
<td>Pneumonia Vaccine</td>
<td>0.0007 (0.0010)</td>
<td>0.0007 (0.0010)</td>
<td>-0.0008 (0.0010)</td>
</tr>
<tr>
<td>Shingles Vaccine</td>
<td>0.0016** (0.0005)</td>
<td>0.0004 (0.0005)</td>
<td>-0.0001 (0.0005)</td>
</tr>
</tbody>
</table>

*p < 0.1, **p < 0.05, *** p < 0.01  
Obs: 208,511 per vaccine  
P-values adjusted with Holm-Bonferroni procedure to adjust for multiple comparisons.

Our study is not designed to distinguish between the effect of October compared to the effect of having a postcard reminder for 3 months. However, we use descriptive data to help us understand whether postcard reminders sent in the month of October are most effective due to the month or the length of time.

Figure 2. depicts the number of vaccinations during the time of this study. Each color represents either the control group or the month in which an individual received the postcard reminder. We can observe that there are seasonal trends in the rate of vaccination in that individuals tend to vaccinate more in October than November or December. We can also observe weekly trends in that individuals tend to vaccinate during the weekday instead of the weekend.

Figure 2. shows us that it is difficult to compare monthly rates of vaccinations to determine if sending a postcard in October may be more effective or if the length of time with the postcard reminder may be more effective because vaccinations were highest in October. October is early on in the flu season and receiving a vaccination may be particularly salient for most people at that time.

These seasonal trends in vaccination suggest two ways to distinguish if the month of October is more important or if having the postcard reminder for a longer period of time is more important. If the number of months that an individual has a postcard is important, we would expect individuals who had the
postcard reminder for 21 days\textsuperscript{11} to have similar treatment effects, regardless of which month they had received the treatment. If the treatment effect in October is detectably different than the treatment effects in November and December, then this might suggest that the month of October is particularly important for sending out postcard reminders.

**Figure 2.** Daily vaccinations received by the elderly in Louisiana during course of study.

![Daily vaccinations received by the elderly in Louisiana during course of study.](image)

Figure 3 shows descriptive statistics that compare the proportion of individuals who had vaccinations within 21 days after the release of the postcard reminder in the October group, November group, and December group against their respective control group.\textsuperscript{12} If the postcard reminder is more effective due to

\textsuperscript{11} We choose 21 days because that is the number of days between when individuals in the December group postcard reminder was sent out the end of the study. By limiting this analysis to 21 days, we can consider outcomes from the October, November, and December groups.

\textsuperscript{12} The October treatment group outcome is the proportion of individuals who had vaccinations between October 17, 2017 to November 6, 2017 out of all individuals in the October group; the October control group outcome is the proportion of individuals who had vaccinations between October 17, 2017 to November 6, 2017 out of all individuals in the control group. Similarly, the November treatment group outcome is the proportion of individuals who had vaccinations between November 21, 2017 to December 11, 2017 out of all individuals in the November group; the November control group outcome is the proportion of individuals who had vaccinations between November 21, 2017 to December 11, 2017 in the control group. Finally, the December treatment group outcome is the proportion of individuals who had vaccinations between December 20, 2017 and January 9, 2018 out of all
the length of time that an individual received the postcard, we would expect the difference between treatment and control groups in Figure 3 to be fairly similar. However, Figure 3 seems to suggest that the difference between treatment and control groups is largest in October, and then increasingly smaller in November and December. This difference suggests that the postcard reminder was more effective in October in this study, not due to an individual’s exposure to the postcard for 3 months, but due to the month of October itself.

Figure 3. Proportion of individuals who had vaccinations within 21 days of receiving the postcard reminder by treatment month.

Discussion

Increasing vaccination rates among the elderly is an important goal for the Louisiana Department of Health and the CDC. This study shows that a simple, cost effective way to increase vaccination rates among the elderly is by sending out postcards to individuals to remind them that they are overdue at least one vaccine. Using behavioral insights to inform the postcard reminder, this intervention increased the number of vaccinations by several hundred in Louisiana.

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individuals in the December group; the December control group outcome is the proportion of individuals who had vaccinations between December 20, 2017 and January 9, 2018 out of all individuals in the control group.
The stepped-wedge design of this study also allowed us to learn more from the study while at the same time allowing all individuals in the study to receive the treatment. Specifically, by staggering the postcard reminders such that they are sent out in different months, we are also able to compare the effect of sending out the postcard across different months. From this study, we show that postcard reminders sent out in October yielded more vaccinations than postcard reminders sent out in November or December.

We also explore whether the postcard reminder was particularly effective for certain vaccinations. We find that the postcard reminder seems especially effective for the flu and shingles vaccines in October, but less effective for other vaccinations during the study. This result suggests that different postcard reminders could be used to encourage the elderly to be vaccinated for pneumonia or tetanus.

Finally, explore whether this effect is due to the month of October or due to having the postcard for 3 months instead of 2 months or 1 month. Though our study is not designed to determine whether the month of October is more effective or having the postcard for 3 months is more effective, the descriptive statistics about when individuals vaccinated in the first 21 days after receiving the postcard compared to their control group suggests that October may be the best month to send out postcard reminders. October is the beginning of the flu season and receiving vaccinations could be a particularly salient issue for individuals at that time.

This study provides further avenues for research about using postcard reminders and behavioral insights to encourage vaccinations. First, the current postcard seems most effective when its sent in October (though it is unclear whether this is due to something special about the month of October or because these individuals have the postcard reminder for 3 months in the study). This result suggests that perhaps different styles of postcards or more targeted postcards could be sent in November and December. Second, the current postcard seems more effective for flu and shingles vaccines, which suggests that a separate postcard that is targeted at pneumonia or tetanus might be more effective to increase vaccination rates for those vaccines. Third, October may be the best month in which to send out postcard reminders. A study designed to study whether October is the best month, such as having more individuals in a study that compares an October treatment and control group with a November treatment and control group only, could help confirm that October is the best month in which to send out postcard reminders. Finally, this study can be expanded to other states to determine if postcard reminders are particularly effective in Louisiana or if similar results can be found elsewhere.

Conclusion

As the behavioral sciences suggest, we find evidence that a postcard reminder sent by the Louisiana Department of Health to 208,867 residents of Louisiana aged 65-70 who are listed as overdue at least one of four vaccines resulted in more vaccinations among those individuals. By including a stepped wedge design and block randomization in our evaluation of the study, we were also able to compare effects across individuals with different vaccination histories and in different months.
We find that the postcard reminder sent in October has a small but detectable effect to increase vaccinations among the elderly who are missing at least one vaccination in Louisiana. Due to missing data, this result is interpreted as the effect of individuals who take up the vaccine in a recorded way vs. individuals who do not take up the vaccine or take it up in a non-visible way to us. In our exploratory study, we also detect an increase in flu vaccinations and shingles vaccinations as a result of receiving this postcard reminder in October. Descriptive statistics also suggest that future studies could focus on confirming that October is the most effective month in which to send out a postcard reminder. Finally, through this study, we suggest ways to evaluate an intervention when all individuals must be treated at the end of the study.
Citations:


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