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Preliminary communication

Does the installation of blue Lights on train platforms shift suicide to another station?: Evidence from Japan

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ABSTRACT

Background: Installing physical barriers at suicide hotspots is known as an effective strategy for suicide prevention. However, the effectiveness of physical barriers may be nullified by the substitution phenomenon, i.e., that restricting access to a particular place induces people at risk to look for a nearby place for suicide.

Methods: This study tests whether the substitution phenomenon exists in the case of railway and metro suicides. We focused on the prevention effort by a Japanese railway company that installed blue light-emitting-diode (LED) lamps on railway platforms to prevent people from diving to a running train. Using panel data of 71 train stations between 2000 and 2013, we compared the number of suicides before and after the installation of the blue lights at 14 stations where the lights were installed and at neighboring five stations on the same railway line, using the number of suicides at all other stations without the intervention as a control group.

Findings: Our regression analysis shows that the introduction of blue lights decreased the number suicides by 74% (CI: 48–87%) at stations where the blue lights were installed, while it did not result in a systematic increase in the number of suicides at the neighboring stations.

Interpretation: The installation of blue lights generated no systematic substitution phenomenon at nearby stations.

1. Introduction

Restricting access to suicide hotspots is known as an effective strategy for suicide prevention (Florentine and Crane, 2010; Yip et al., 2012). This is typically implemented by creating physical barriers at high sites (e.g., bridges) from which people jump or at train platforms where people jump in front of trains. A recent article by Cox et al. (2013) reviewed 9 articles and found consistent evidence that the presence of barriers at these hotspots was associated with reduction in the number of suicides.

Nevertheless, the effectiveness of physical barriers at hotspots may be nullified by the substitution phenomenon, i.e., that restricting access to a particular place induces people at risk to look for a nearby place for suicide, resulting in no major reduction in the overall number of suicides after implementation. This possibility has been widely studied in the case of suicide by jumping from high sites (e.g., Law et al., 2014). After reviewing related studies, Pirkis et al. (2013) concluded that the physical barriers to prevent jumping from bridges or cliffs increased suicides at nearby sites by 44%, while the prevention effort generated an overall reduction in suicides by 28% at the study cites.

Less is known about the possibility of the substitution phenomenon in the case of railway and metro suicides. Despite increasing efforts to install physical barriers to prevent railway and metro suicides (Ladwig et al., 2009; Law and Yip, 2011; Mishara, 2007), only a single study has examined whether the installation of physical barriers generates the substitution phenomenon. Law et al. (2009) showed that the installation of platform screen doors prevented suicide with no substitution phenomenon in the subway system of Hong Kong.

This study offers another test for the possibility of the substitution phenomenon in the case of railway suicides. We focused on the prevention effort by a Japanese railway company that installed blue light-emitting-diode (LED) lamps on railway platforms to prevent people from diving in front of a running train. This company, whose service is provided in the metropolitan area in Japan, installed blue lamps on platforms at some, but not all, of its stations and railways crossings in the last several years with the expectation that they have a calming effect on people who are agitated and ultimately stop them from jumping in front of trains.

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Matsubayashi et al. (2013) evaluated the effect of these blue lights on the number of suicides by using panel data of 71 train stations between 2000 and 2010. It found that the introduction of blue lights resulted in a decrease in suicides by 83% (CI: 14–97%) at stations where blue lights were installed.

Using an updated data set from the period of 2000 to 2013, we examined the possibility that the installation of blue lights at a particular station shifted the incidents of suicide to its neighboring stations. We compared the number of suicides before and after the intervention with the blue light at 14 stations where the lights were installed and at the neighboring five stations on the same railway line, using the number of suicides at all other stations without the intervention as a control group.

2. Data

We obtained data on railway suicides and the installation of blue lights from the aforementioned railway company. Following the company's request, the name of the railway company remains anonymous in this study. The data include information on the location and timing of the installation of blue lamps as well as the number of suicides each year at 71 stations between 2000 and 2013. The year in this data set refers to the Japanese fiscal year, which runs from April to March. Thus, the data cover the period from April 2000 to March 2014. Hereafter, we mean the fiscal year when referring to a particular year. We used yearly data for our analysis, and our unit of observation is the station-year. The total number of station-year observations equals 994 ($=71$ stations $\times$ 14 years).

The dependent variable is the number of suicides per station-year. The average number of suicides per station-year is 0.16 (s.d.$=0.44$). The maximum is 3, while the minimum is zero. For the study period, 853 observations were associated with no suicide. The station with the largest number of suicides had a total of 10 suicides during the study period.

The independent variables represent (1) whether or not a station had blue lights on the platform in a particular year and (2) whether or not a station is located nearby a station where blue lights were installed. The first variable is created in accordance with Matsubayashi et al. (2013) analysis. It is given the value of 1 when a station had blue lights on the platform in a particular year and 0 otherwise. The variable is coded 0 if a station had no blue light for the entire study period.

Because the unit of analysis is the station-year, the following adjustment of the data set was necessary when stations had cases of suicides in the same year that they installed blue lights. During the period of our study, we found six cases of suicides that happened at four stations where blue lamps were eventually installed in the subsequent month of the same year. Because these stations set up blue lights at the very end of the fiscal year, we recoded the year of the blue light installation as the following year. For example, in one case, a suicide happened in July 2009 and the blue light was installed in February 2010 at the station where the suicide happened. In this case, we recoded the year of blue light installation for this station as the 2010 fiscal year (April 2010–March 2011), not the 2009 fiscal year (April 2009–March 2010). This recoding ensures that the data set reflects the fact that the suicide happened before the blue light installation.

The number of stations where the blue lights were installed was 1 in 2008, 4 in 2009, 6 in 2010, 1 in 2011, 0 in 2012, and 2 in 2013. At all stations, blue lights were installed at the edges of the platforms. In addition, at some stations, blue lights were also installed in the middle of the platform. The lights are on from sunset to sunrise. Thus, the effectiveness of blue lights should be limited to the hours after dusk. However, the following statistical analysis did not take into account whether suicides occurred during the day or at night. This is because the data provided by the railway company did not contain information on the dates and times of suicides in most cases; only suicides that happened at stations with blue lights were recorded with the date and time of the incidents.

Using the variable on the installation of blue lights described above, we created a second set of independent variables that equal 1 if a station is located near a station with blue lights and 0 otherwise. For example, if there are three neighboring stations, A, B, and C and station B had blue lights installed in 2009, this variable assigned the value of 1 for A and C in 2009 and in the subsequent years. If the substitution phenomenon existed and people at risk looked for a nearby place for suicide, we should be able to see an increase in the number of suicides at stations A and C after blue lamps were installed at station B. Because the stations of the railway company in our study were located close to each other (it typically takes a few minutes to move to the next station), we considered the possibility that people at risk might go up to five stations away from the station with blue lamps on the same railway line. Thus, ultimately, we created five indicator variables in total that denote whether a station was located within one to five stations away from the station with blue lamps in either direction.

3. Descriptive analysis

We first report the average number of suicides per year before and after the installation of blue lamps. The averages were calculated for six groups of stations. The first group contains stations that had blue lights installed during the study period. The second group contains stations that were located next to the station with blue lights installed. The third to sixth groups contain stations that were located two to five stations away from the station with blue lights. The last group contains stations that had no station with blue lights within five neighboring stations in each direction of the same line. If the installation of the blue lamps generated the substitution phenomenon, there should be a decrease in the average number of suicides at the stations where the lamps were installed, while there should be an increase in the average number of suicides at nearby stations.

Table 1 presents the average number of suicides per year for each group of stations before and after the installation of blue lights. The number of station-years is shown in parentheses. The shaded column refers to the group of stations that installed blue lights between 2008 and 2013. At these stations, the average number of suicides per year decreased from 0.435 to 0.189. The decrease in the post-installation period is consistent with Matsubayashi et al. (2013). The number in the post-installation

Table 1
The average number of suicides before and after the installation of blue lights.

	(1) Station with blue lights Installed	(2) One station away	(3) Two stations away	(4) Three stations away	(5) Four stations away	(6) Five stations away	(7) Six and more stations away
Before	0.435 (115)	0.269 (182)	0.234 (201)	0.275 (189)	0.245 (200)	0.259 (220)	0.090 (546)
After	0.189 (53)	0.274 (84)	0.269 (93)	0.275 (91)	0.266 (94)	0.245 (102)	

Note: Table entries are the average number of suicides per year before and after the installation of blue lights with the number of station-year in parentheses. Data represent the number of suicides at 71 stations between 2000 and 2013. The total number of observations is 994.

period corresponds to 10 cases of suicides, among which nine incidents happened during the day when the blue lights were not on. The remaining single case occurred in the evening at a station with blue lights, but a person jumped from about 50 m from the edge of the platform and the station had blue lights at the end of the platform (0 to 15 m from the edge) and in the middle of the platform (80 m from the edge). Thus it is unlikely that the person was under the blue lamps. This means that effectively only one case of suicide happened at these stations when blue lights were on, and even this single case happened at a location on the platform where the lights were not lit. In contrast, the remaining columns show no major increase or decrease in the average number of suicides before and after the installation of blue lights at nearby stations. It is worth emphasizing that the average number of suicide prior to blue light installation was higher in column (1) than in columns (2)–(6), while the opposite is true after the installation.

4. Regression analysis

To obtain a precise estimate on the substitution effect, we used a Poisson regression model based on a difference-in-differences (DID) approach as in Matsubayashi et al. (2013). We regressed the number of suicides per year at each station on the indicator variable, which equals 1 if the station had blue lights as well as on the five indicator variables, which equal 1 if the station was located one to five stations away from a station with blue lights.

In addition, our regression model included two types of dummy variables. First, in order to take into account the differences among stations (e.g., the number of passengers, the population size of cities, and the types of platforms), we included station-specific dummy variables. By including these dummies, we could separate the effect of blue lights on suicide from that of these station-specific time-invariant unobserved factors. This method of estimation allowed us to estimate a temporal difference in the mean number of suicides before and after the installation of blue lights at the nearby stations. The regression coefficient obtained in this model ultimately reflects a difference in the change in the average number of suicides between two groups with and without the nearby stations where blue lights were installed. Second, because factors that vary over time (e.g., macroeconomic conditions) can also affect the total number of suicides, the model included dummy variables for each year. By including the year-specific dummies, the effect of such time-varying common factors was taken into account, enabling us to isolate the effect of blue lights from those of other factors.

Table 2 reports estimation results by Poisson regression. Note that the qualitative results reported below hold even when a linear model and spatial regression model were used instead (results not shown). The station- and year-specific dummy variables were included in the estimation, but they are not reported in the table. To address the potential heterogeneity and autocorrelation in the error terms within each station, standard errors were adjusted by using a heteroskedasticity-autocorrelation consistent estimator. We ran five regression models by adding each of the indicator variables on nearby stations sequentially. If the substitution phenomenon occurred, the coefficients on the variables of nearby stations were estimated to be positive.

Regardless of the specifications, the regression coefficients associated with the blue lamp dummy variable are consistently negative, indicating that the average number of suicides became lower after the installation of the blue lamps compared to the period before the installation. To interpret the substantive effect of the blue lights in model (6) with the full specification, we computed the Incidence Rate Ratio (IRR) to equal 0.258 with a 95% confidence interval 0.127–0.523. This suggests that the introduction of blue lights resulted in a decrease in the number of suicides by 74% (CI: 48–87%).

Columns (2) of Table 2 shows that the coefficient associated with the indicator variable of one station away from the station with blue lights are positive (=0.718) with a 95% confidence interval 0.380–1.398. Yet, the size of the coefficients on the same variable becomes smaller in the remaining columns and the confidence intervals overlap zero. In columns (3)–(6), the estimated coefficients on the nearby stations are small and their confidence intervals overlap zero. In short, we found no systematic evidence for the substitution phenomenon that the installation of blue lights increased suicides at nearby stations.

5. Discussion

This study tested the possibility that efforts to prevent suicide at a railway station shift the location of suicide to a nearby station without such prevention efforts. It also reexamined the effectiveness of blue lights on suicide prevention with an update data set to verify the results in Matsubayashi et al. (2013) with more observations in the post-installation period. Our findings indicated that the installation of the blue lights triggered no systematic substitution at nearby stations, whereas the blue lights remained effective for suicide prevention during our study period. Almost no incidents of suicides happened at night at stations where blue lights are turned on during evening hours. It seems that the blue lights did not become less effective as people got used to seeing them at a station.

The size in the reduction of suicides found in this paper is smaller than the one in Matsubayashi et al. (2013). This may be due to the fact that nine incidences of suicides are recorded as post-installation suicides in our data set between 2011 and 2013, although most of them occurred during the day when the lights were not on. In contrast, only one incident was recorded as such in Matsubayashi et al. (2013) that studied cases in 2000 and 2010. The difference is partly because the post-installation period was relatively short in Matsubayashi et al. (2013), as compared to the current study in which up to five years' data are included in the post-installation period. However, we should not interpret our current results as blue lights becoming less effective. As described above, all of the cases of suicides except for one case happened during the day when the blue lights were not on, and the sole case of suicide was conducted from a place on the platform where the blue lights were not directly lit over the person who jumped in front of a train. Because our analysis treated all of these cases as suicides in the post-installation period, it is likely that the effectiveness of blue lights was underestimated. Ideally our analysis should take into account whether suicides happened during the day or at night, but this was not feasible due to the limitation of our data.

The present study contains several limitations. First, it did not consider the possibility that people might choose to jump in front of a running train at a railway crossing, not from a station platform, or the possibility that people might go to a station of a different railway company. Considering these possibilities was not possible due to the lack of data. Thus, we cannot conclude that the installation of blue lights resulted in an overall reduction in the number of suicides in the region.

Second, our findings do not imply that the blue lights are always effective for preventing railway suicide. They are expected to stop people at train platforms from jumping in front of trains at night, not during the daytime. In fact, as suggested by Ichikawa et al. (2014), suicide attempts at station platforms during the nighttime account for only 14% of all railway suicide attempts.

Table 2
The estimated effect of blue lights on the number of suicides.

	(1)	(2)	(3)	(4)	(5)	(6)
Blue lights	−0.983**	−1.256**	−1.278**	−1.318**	−1.321**	−1.356**
	(0.320)	(0.348)	(0.384)	(0.334)	(0.334)	(0.361)
One station away		0.718**	0.459	0.483	0.486	0.526
		(0.347)	(0.430)	(0.418)	(0.444)	(0.434)
Two stations away			0.510	0.387	0.391	0.379
			(0.455)	(0.475)	(0.465)	(0.471)
Three stations away				0.385	0.389	0.438
				(0.315)	(0.346)	(0.350)
Four stations away					−0.018	0.040
					(0.339)	(0.367)
Five stations away						−0.201
						(0.313)
Constant	−17.871**	−18.114**	−18.223**	−18.320**	−18.329**	−18.301**
	(1.050)	(1.053)	(1.062)	(1.064)	(1.062)	(1.063)
AIC	856.805	846.854	851.106	833.981	829.979	843.720

Note: Table entries are Poisson regression estimates. The dependent variable is the total number of suicide per station-year Data represent the number of suicides at 71 stations between 2000 and 2013. The total number of observations is 994. The station- and year-specific fixed effects are included in all estimations. Robust standard errors clustered by each station are shown in parentheses. * p-values < 0.05

** p-values < 0.01.

Thus, the installation of blue lights may contribute to suicide reduction, but it is not necessarily be the ultimate solution to the problem. There is a need to develop additional strategies to prevent suicide during the daytime and unintentional accidents.

Third, the generalizability of our findings remains limited. Our analysis relied on the data for a limited period of time from a single railroad company. Additionally, the findings did not reveal the underlying mechanism of why the installation of blue lights resulted in the smaller number of suicides at stations with the lights, while generating no substitution phenomenon at the nearby stations. Our findings are suggestive, but future research needs to examine the same hypothesis as ours with data from other railway companies that installed blue lights and explore the underlying mechanism from a psychological perspective. These future studies will help establish external validity of our findings.

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Conflict of interest

There is no conflict of interest.

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