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Effect of mobile phone proliferation on crash notification times and fatality rates☆

Jimmy L. Stickles, MD *, James M. Kempema, MD, Lawrence H. Brown, PhD

Emergency Medicine Residency Program, Department of Surgery and Perioperative Care, Dell Medical School at the University of Texas-Austin, United States

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ABSTRACT

Introduction: The purpose of this study was to evaluate whether increased proliferation of mobile telephones has been associated with decreased MVC notification times and/or decreased MVC fatality rates in the United States (US).

Methods: We used World Bank annual mobile phone market penetration data and US Fatality Analysis Reporting System (FARS) fatal MVC data for 1994–2014. For each year, phone proliferation was measured as mobile phones per 100 population. FARS data were used to calculate MVC notification time (time EMS notified – time MVC occurred) in minutes, and to determine the MVC fatality rate per billion vehicle miles traveled (BVMT). We used basic vector auto-regression modeling to explore relationships between changes in phone proliferation and subsequent changes in median and 90th percentile MVC notification times, as well as MVC fatality rates.

Results: From 1994 to 2014, larger year-over-year increases in phone proliferation were associated with larger decreases in 90th percentile notification times for MVCs occurring during daylight hours ($p = 0.004$) and on the national highway system ($p = 0.046$) two years subsequent, and crashes off the national highway system three years subsequent ($p = 0.023$). There were no significant associations between changes in phone proliferation and subsequent changes in median crash notification times, nor with subsequent changes in MVC fatality rates.

Conclusion: Between 1994 and 2014 increased mobile phone proliferation in the U.S. was associated with shorter 90th percentile EMS notification times for some subgroups of fatal MVCs, but not with decreases in median notification times or overall MVC fatality rates.

1. Introduction

Mobile phones play an ever-increasing role in society. People of all ages use them in a variety of environments and situations, including on the nation's roadways. In some ways mobile communication technologies make our highways more dangerous, particularly through increased distracted driving fatalities [1]. In other ways, however, mobile technologies might make our roadways safer, such as by improving access to Emergency Medical Services (EMS) through earlier reporting of motor vehicle crashes and better scene location data [2,3]. The purpose of this study was to explicitly evaluate whether increases in mobile phone proliferation have been associated with subsequent decreases in motor vehicle crash (MVC) notification times or decreased MVC fatality rates in the United States (US).

2. Methods

This retrospective ecological study used publicly available data from two unrelated sources: (1) The World Bank's World Development Indicators database reporting mobile cellular subscriptions per 100 people and (2) the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS).

The World Bank maintains data on multiple indicators of economic development for all countries collected from officially-recognized international sources, including mobile phone market penetration data from the International Telecommunications Union [4]. These data are reported as mobile phone subscriptions per 100 people and are available yearly from 1960 to 2015. Both postpaid and active prepaid subscriptions are included in this database. Voice communication must be included to qualify as a mobile phone subscription; no data-only subscriptions are included. For this analysis, we used the yearly mobile phone subscription data for the U.S. for 1994 through 2014.

The FARS database contains comprehensive information on all reported fatal MVCs within the 50 States, the District of Columbia, and Puerto Rico. To be included in FARS, a crash must involve a motor vehicle traveling on a roadway open to the public and must result in the death of at least one person—either an occupant of a vehicle or a non-

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* Corresponding author at: Emergency Medicine Residency Program, Dell Medical School at the University of Texas-Austin, 1400 N IH 35, Suite 2.230, Austin, TX 78701, United States.

E-mail address: jimmysticklesmd@gmail.com (J.L. Stickles).

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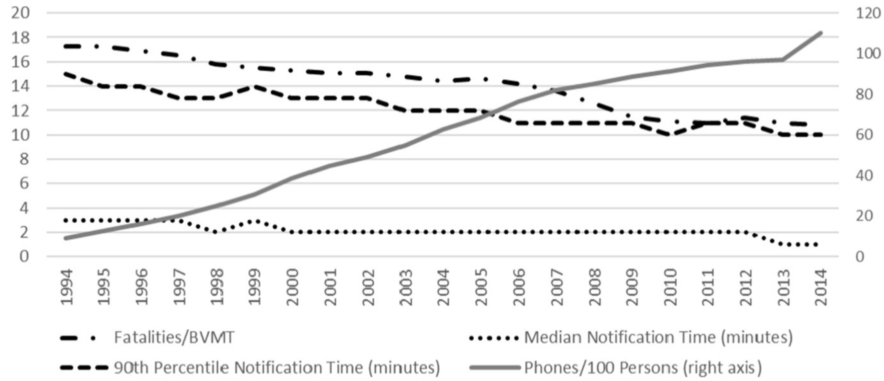

Fig. 1. 20-year trends in mobile phone proliferation, EMS notification times, and MVC fatality rates.

motorist/pedestrian—within 30 days of the crash [5]. For each included MVC, the FARS database includes the time the MVC occurred and the time EMS was notified; we defined the difference between these two time points as the EMS notification time for all crashes reported between 1994 and 2014. For each study year, we calculated the median and 90th percentile fatal MVC EMS notification time in minutes. We also used the FARS data to calculate the annual MVC fatality rate per billion vehicle miles traveled (BVMT).

We used vector auto regression (VAR) with Granger causality testing to explore relationships between changes in mobile phone proliferation and subsequent changes in median and 90th percentile MVC notification times, as well as MVC fatality rates. Briefly, VAR with Granger causality testing uses simultaneous equation models to explore whether evolutions in a given measure are better explained by that measure's past values alone, or by the combination of that measure's past values and another integrated measure [6]. That is, we explored whether evolutions in EMS notification times or MVC fatality rates were better explained by their past values alone, or by the combination of their past values and changes in mobile phone proliferation. To account for unit roots in the data, we analyzed second differences—that is, the difference between changes seen in a given year and the changes seen in the prior year—for all measures [6]. We allowed up to a three year time horizon for effects to manifest, and included subgroup analyses for MVCs that occurred in rural areas, on vs. off the national highway system, and during daytime vs. nighttime. We report the 95% confidence intervals for the observed coefficients, and the p-value for Granger causality testing when the confidence interval did not overlap zero. An alpha value of 0.05 was used to establish statistical significance.

3. Results

U.S. mobile phone subscriptions increased from 9.1 subscriptions per 100 people in 1994 to 110.2 subscriptions per 100 people in 2014. Over the same time period, there were 745,090 fatal MVCs with median EMS notification times decreasing from 3 min to 1 min, and 90th percentile EMS notification times decreasing from 15 min to 10 min. MVC fatality rates decreased from 17.3 to 10.8 per BVMT. (see Fig. 1)

Table 1 summarizes all of the study results. There were no statistically significant associations between changes in mobile phone proliferation and subsequent changes in median EMS notification times in the overall analysis or in any of the subgroups. There was also no statistically significant association between mobile phone proliferation and subsequent changes in overall 90th percentile EMS notification times. However, there were some significant findings in the subgroup analyses for 90th percentile notification time: larger year-over-year increases in phone proliferation were associated with larger subsequent decreases in 90th percentile notification times for MVCs occurring during daylight hours ($p = 0.004$) and on the national highway system ($p = 0.046$) after two years, and with larger subsequent decreases in 90th percentile notification times for crashes occurring off the national highway system after three years ($p = 0.023$). There were no statistically significant associations between mobile phone proliferation and subsequent changes in MVC fatality rates, either overall or in any of the subgroups.

4. Discussion

Mobile phones have proliferated to the extent that there is now more than one active subscription for every member of the U.S.

Table 1
Associations between increased mobile phone proliferation and subsequent changes in EMS notification times and MVC fatality rates.

Association with mobile phone proliferation	Coefficient confidence interval			Granger causality
	After 1 year	After 2 years	After 3 years	Significance
Median notification times				
Overall	−0.07 to 0.15	−0.12 to 0.08	−0.09 to 0.13	n/a
Rural only	−0.16 to 0.02	−0.04 to 0.14	−0.16 to 0.03	n/a
On national highway system	−0.18 to 0.004	−0.15 to 0.04	−0.12 to 0.06	n/a
Off national highway system	−0.01 to 0.15	−0.05 to 0.10	**0.02 to 0.18**	$p = 0.072$
Daytime	−0.01 to 0.16	−0.05 to 0.11	−0.03 to 0.14	n/a
Nighttime	−0.14 to 0.13	−0.17 to 0.09	−0.09 to 0.16	n/a
90th percentile notification times				
Overall	−0.12 to 0.31	−0.19 to 0.17	−0.20 to 0.16	n/a
Rural only	−0.14 to 0.44	−0.13 to 0.40	−0.43 to 0.01	n/a
On national highway system	−0.12 to 0.39	**−0.45 to −0.005**	−0.07 to 0.43	$p = 0.046$
Off national highway system	−0.22 to 0.09	−0.03 to 0.25	**−0.34 to −0.02**	$p = 0.023$
Daytime	−0.21 to 0.17	**−0.45 to −0.13**	−0.24 to 0.07	$p = 0.004$
Nighttime	−0.26 to 0.27	−0.29 to 0.17	−0.10 to 0.38	n/a
Fatality Rate	−0.01 to 0.02	−0.01 to 0.02	−0.03 to 0.001	n/a

Bolded results correspond with reported p values in the far right column.

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