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The effect of Center High Mounted Stop Lamp (CHMSL) on rear-end accidents in Israel

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Abstract

This paper examines the effect of the use of Center High Mounted Stop Lamp (CHMSL) on rear-end accidents, as reflected in Israeli police records from calendar years 1991–2002. The basic analysis, similar to that used in previous CHMSL studies, compares the involvement in accidents of passenger cars of model years 1994–1996 that are equipped with CHMSL with passenger cars of model years 1991–1993 that are not equipped with CHMSL. The number of involvements as the struck vehicle in a rear-end accident was used as the relevant measurement and the number of involvements as the striking vehicle in a rear-end accident was used as the reference measurement. The results yielded an odds ratio of 0.93. The explanation that the CHMSL is responsible for the 7% decrease is intuitively appealing and is consistent with previous findings. However, the strength of this evidence is marginal ($p = 0.07$).

Additional analyses evaluated the model year effect in greater detail, in order to determine whether there exists a change point between 1993 and 1994 as would be expected from a CHMSL effect, or whether the effect is spurious. Detailed analyses were performed on the ratio of struck to striking involvements as well as the rates of involvement of both types. These analyses showed that (1) the chosen reference measurement is an appropriate one, but (2) the 0.93 odds ratio is quite possibly due to other reasons unrelated to the CHMSL, thus further limiting the confidence in CHMSL effectiveness.

Keywords: Rear-end accidents; Road safety; Comparison group; Exposure

1. Introduction

The Center High Mounted Stop Lamp (CHMSL) is a red lamp located on the vertical centerline of the rear of the vehicle, typically higher than regular stop lamps that are located on the sides of the vehicle. The CHMSL is activated together with the regular stop lamps when the driver presses the brake pedal and it remains off at other times. The purpose of CHMSL is to enhance the stop signal to the following driver, thus reducing the reaction time of the following driver to the braking of the vehicle in front, and eventually prevent some of the rear-end accidents or at least diminish their severity.

The CHMSL evolved over a long period of research dating back to the late 1960s. The research examined the effects of several variants of rear brake lights on driver reaction times and on accidents (Digges et al., 1985). The effectiveness of the current version of the CHMSL was demonstrated in three fleet studies, two sponsored by the National Highway Traffic Safety Administration and one sponsored by the Insurance Institute for Highway Safety. Taxicabs and utility company vehicles in three different cities constituted the fleets. Remarkably, all three studies demonstrated approximately a 35% reduction in "relevant" rear-end accidents. "Relevant" accidents were defined as accidents in which there was evidence that the lead vehicle was in the process of braking at the time of the accident, and thus "braking by the struck vehicle is a critical factor". Across the three studies these accidents constituted approximately 65% of all rear-end accidents, so relative to all rear-end accidents the CHMSL was associated with a 23% reduction in accidents (Digges et al., 1985).

The fleet studies did not directly investigate the reasons why the CHMSL was effective but some of the explanations

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that have been offered are that (1) the CHMSL is located closer to the driver's modal area of visual fixations (Rockwell, 1972), (2) it allows drivers to perceive – through the windshields and rear-windows – the brake lights of several vehicles ahead, (3) it adds one more conspicuous light to the existing brake lights and that (4) the drivers are responding to the 'novelty effect' of a new brake light configuration.

The CHMSL was introduced to the general fleet in the United States by amendments of Federal Motor Vehicle Safety Standard 108 requiring that all passenger cars of model year 1986 and later be equipped with CHMSL. On the basis of subsequent research by McKnight and Shinar (1991), the CHMSL was mandated for all light trucks of model year 1994 and later as well.

To determine the actual and long-term effectiveness of the CHMSL, relative to the short-lived 'novelty effect', periodic evaluations of the CHMSL were mandated by Congress. These evaluations demonstrated a positive but diminishing contribution to roadway safety, from 36% in the first study (Malone et al., 1978) to 4.3% in the most recent study (Kahane and Hertz, 1998). In all of these studies the effectiveness was evaluated by comparing accident involvements of selected car models in the year before the CHMSL was mandated versus accident involvements in the year after it was mandated. The cars selected were those in which no significant design, engineering, or safety changes were introduced in the changeover period. Given that by now most of the US fleet is equipped with CHMSL, the database for such comparisons has diminished greatly so that additional analysis of recent US data cannot contribute to the evaluation of CHMSL.

Nonetheless, such an evaluation is possible in Israel. Following the initial positive experience in the US, the Israeli Ministry of Transport issued a similar regulation that requires all passenger cars and certain vans of model year 1994 and later to be equipped with CHMSL. Since in Israel a significant portion of all vehicles are of model years 1993 or earlier, their accident involvements can be compared to that of the newer CHMSL-equipped models. Thus, the purpose of this research is to further examine the contribution of CHMSL to safety, using Israel as a case study.

The remainder of the paper is organized as follows. Section 2 presents the general methodology. Results according to the regular comparison group technique are presented in Section 3. Section 4 examines the model year effect and particularly with respect to involvement rates. Conclusions are presented in Section 5.

2. Methodological approach and rationale

Similar to previous post-regulation CHMSL studies, our basic approach follows the conventional observational comparison group analysis. This type of analysis, in general, considers two groups of subjects: a *treated* group, which receives the treatment, and a *comparison* group that does not receive the treatment.

Two types of measurements are made on each group: *relevant* and *reference*. The treatment is expected to affect the relevant measurement, but not the reference measurement. A typical situation is a before-and-after study, where the reference measurement is made before the treatment and the relevant measurement is made after the treatment. In other variants of comparison group analysis, both relevant and reference measurements are made after the application of the treatment. For example, to examine the effect of intersection streetlights on accidents, the relevant measurement can be the number of night-time accidents and the reference measurement can be the number of daytime accidents.

Comparison group analysis examines for each group (treated and comparison) an *odds* value, which is the ratio between the relevant measurement and the reference measurement. The treatment effect is estimated by the odds ratio, which is the treated group odds divided by the comparison group odds. The premise of this analysis is that the effect of confounding factors is proportional in both groups of subjects; therefore, if the treatment has no effect, then the two odds values will be the same and the odds ratio will be 1. The validity of this proportionality assumption depends on the choice of measurements (relevant and reference) and groups (treated and comparison). This is a critical consideration in comparison group study design.

In our CHMSL study, subjects are vehicles. Treated vehicles are those equipped with CHMSL, that is, of model year 1994 and later, and the comparison group is vehicles without the CHMSL, that is, of model year up to 1993. Since subjects are vehicles, the variable of interest is the number of vehicle involvements in accidents, particularly in rear-end accidents. Note that there may be several vehicles involved in a single accident, some belong to the treated group while others belong to the comparison group. Thus the same accident may contribute to more than one measurement (unlike the simpler case, in which variables of interest are numbers of accidents and each accident contributes to one measurement only).

The relevant measurement in our study is the number of involvements as the struck vehicle in rear-end accidents. The tricky part in this study design is to choose the reference measurement. The reference measurement in previous CHMSL studies (Kahane, 1987, 1989; Kahane and Hertz, 1998) was the total number of involvements in accidents of all types. We preferred to use an alternative reference measurement, which is the number of involvements as the *striking* vehicle in a rear-end accident, as opposed to involvements as the *struck* vehicle that define the relevant measurement. This useful distinction between the striking vehicle and the struck vehicle (the vehicle at-fault versus the "innocent victim") has been used in various safety evaluation studies, such as quasi-induced exposure studies (Thorpe, 1967; Carr, 1970; Haight, 1970; Stamatiadis and Deacon, 1997, etc.).

A proper reference measurement should satisfy three conditions: (1) the reference measurement should not be affected