

## Automated Traffic Control (ATC) System-A Potential Model to Reduce Pediatric Trauma and Fatality due to Motor Vehicle Crashes (MVC)

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### Abstract

### Original Research Article

Motor Vehicle Crashes (MVC) formed one of the leading causes of fatalities in KSA. In order to reduce the number of fatalities Government of KSA introduced Automated Traffic Control(ATC) system called, "SAHAR" in Arabic in AD 2009. Objective of the study was to assess the impact of ATC on the incidence of pediatric trauma and fatality due to MVC in Riyadh, KSA. For this retrospective cross sectional study, all the pediatric MVC subjects(n=1030) reported to King Abdulaziz Medical City(KAMC) five years before and five years after the introduction of ATC (AD 2004-2014) were selected. Data with respect to demography, details of injury, Glasgow Coma Scale (GCS) and hospital outcome were collected and analyzed by using SPSS Version 22. For data analysis Mean  $\pm$  SD, frequencies, percentages, chi-square tests and students't test were employed at 5% level of significance. Logistic regression analysis was performed to ascertain the effects of age, sex, cause of injury and GCS with overall fatality rate with Odds ratio at 95% Confidence Interval (CI).Results of the study indicated that ATC was effective in reducing MVC and severity of injuries. It also, put a notion to the vehicle manufacturing companies to improve burn safety to prevent fire from spreading to the passenger compartment.

**Keywords:** Automated Traffic Control (ATC), Motor Vehicle Crashes, Pediatric Trauma, Pediatric fatality, Severity of Injuries.

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## INTRODUCTION

KSA was ranked 33 globally for having road traffic accidents and deaths. Road traffic accidents and trauma due to motor vehicle crashes formed one of the major causes of mortality in KSA [1]. According to world health report [2] in 2010 road traffic injuries have been identified as the ninth most common cause of disability adjusted life years (DALYs) lost for all age and gender categories.

Motor vehicle crashes (MVCs) are a prominent cause of injury-related deaths in children worldwide [3]. Globally, an estimated 1.2 million individuals are killed in road crashes each year [4]. Reports from Saudi Arabia reported that 16% to 20% of MVCs victims were children [5, 6]. In Saudi Arabia, MVCs affect 3.5% of the total population, a figure equivalent to one person killed and four injured every hour [6]. Studies

showed that head trauma after MVCs were frequently involved in children. The pattern of injury related to MVCs changes as children advances on age. In children older than 5 years in addition to head trauma, thoraco - lumbar and extremities injury owing to MVCs were more prevalent. In children more than 10 years, the pattern of injury mimic the adults' pattern as the car seating and seat belt positioning follows the adults and subject them to more spinal injury[7].

A lot of efforts have been done to decrease the incidence of MVC by several countries trying to make the roads safer including: identification of hazardous locations and the creation of policies to improve high-risk sites, the creation of lanes for passing along rural roads, and building pedestrian passage ways at crossings [8].

Due to the High prevalence of MVC related injuries and fatalities in Saudi Arabia, preventive strategies such as introduction of Automated Traffic Control system called "SAHER"(meaning "Watchful") has been implemented in 2009. SAHER is an "Automated System" for the management of traffic via e- systems covering major roads in Saudi Arabia using digital cameras network technology connected to the National Information Center (NIC). The system aims to improve the level of traffic safety, raise the efficiency of existing road networks, implement traffic regulations strictly and continuously to have a safe traffic environment [9].

Despite the efforts to reduce motor vehicle fatalities and injuries by improving traffic safety and awareness of the use of safety devices, severe injuries and fatalities continue to be one of the most frequent causes of death and disability among children [4]. Hence the present study was conducted to compare the trends in pediatric trauma during pre and post period of induction of Automated Traffic Control system in Riyadh city of Kingdom of Saudi Arabia.

## MATERIALS AND METHODS

The Automated Traffic Control system was introduced in AD 2009 in Riyadh. Hence a study period of 5 years before and 5 years after the introduction of ATC i.e., from AD 2004 to 2014, was chosen to conduct this retrospective study in King Abdulaziz Medical City (KAMC), Riyadh which is a tertiary care teaching hospital.

All pediatric MVC (n=1030) related casualty (Automobile occupants/pedestrians) arrived/admitted/treated in the Emergency Department of KAMC, Riyadh, KSA during the study period formed the subjects for the study. Patients with injury mechanisms as fall, bicycle or motorcycle accidents were excluded from the study. The data was gathered from trauma registry of KAMC which is a prospectively recorded database. Retrospective cross sectional data with respect to demographic data, type of injury, cause of injury, Glasgow Coma Scale (GCS), Hospital outcome were collected by using structured data collection sheet.

The data was analyzed by using SPSS version 22. Descriptive analysis was conducted to describe the patients by frequencies and proportion for categorical variables. Mean and Standard deviation (SD) was determined for continuous variables. Pearson chi square tests and student's t test were employed at 5% level of significance. Logistic regression analysis was performed to ascertain the effects of age, sex, cause of injury and GCS with overall fatality rate of the cases along with Odds Ratio(OR) at 95% Confidence Interval(CI).

The study was approved by the Institutional Review Board (IRB) of King Abdullah International Medical Research Centre (KAIMRC).

## RESULTS AND DISCUSSION

Pediatric trauma is a growing public health concern [10]. The mean age of the subjects was 7 years and 8 months. Children in this age group are naturally at an increased risk of vehicular trauma, since they are often taken on car trips by their parents or relatives [11].

The mean( $\pm$ SD) ages of the male and female children who met with MVC /pedestrian injuries pre induction period of ATC were 7.90( $\pm$ 3.94) and 6.77( $\pm$ 3.47) years respectively whereas during the post induction period of ATC the mean ( $\pm$ SD) age of the children with injuries due to MVC was 8.45( $\pm$ 4.04) years for males and 6.77( $\pm$ 3.820) years for females.

Gender wise distribution of casualties due to various mode of injury (Table 1) indicated that there was significant (Chi square = 9.996; p = 0.002) reduction in male child pedestrian casualties [12]. In many developed countries, there is a high incidence of pedestrian mortality among males. However, even though the injuries on female child pedestrians were halved there was a significant increase in injuries due to MVC on females (Chi square= 14.8; p value= 0.001). According to a WHO report, males involving in pedestrian fatalities accounted for 70% and 61% in the US and Singapore, respectively [12]. Among child pedestrians injured with MVC, boys are usually involved in more incidents than young girls. This is because boys are more likely than girls to cross roads unaccompanied by an adult [12].

**Table-1: Genderwise distribution of casualties due to different modes of injury (n=1030)**

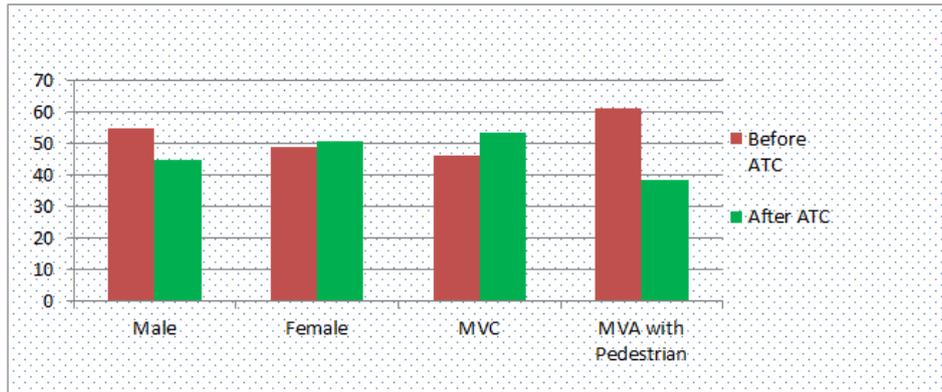
Mode of Injury	Males		Total	Females		Total
	Pre induction period of ATC	Post induction period of ATC		Pre induction period of ATC	Post induction period of ATC	
Pedestrian	244 <sub>(60.55)</sub>	159 <sub>(39.45)</sub>	403 <sub>(100)</sub>	60 <sub>(65.22)</sub>	32 <sub>(34.78)</sub>	92 <sub>(100)</sub>
MVC	179 <sub>(49.18)</sub>	185 <sub>(50.82)</sub>	364 <sub>(100)</sub>	69 <sub>(40.35)</sub>	102 <sub>(59.65)</sub>	171 <sub>(100)</sub>
Total (n=1030)	423 <sub>(41.07)</sub>	344 <sub>(33.40)</sub>	767 <sub>(74.47)</sub>	129 <sub>(12.52)</sub>	134 <sub>(13.00)</sub>	263 <sub>(25.53)</sub>

The incidence of MVC before and after implementation of ATC is provided in Fig.1. It was observed that there was a decreasing trend of incidence

of MVC among male children. However, the trend of incidence of MVC among females indicated an inconsequential increasing trend. As depicted in figure

1, injuries due to MVC were increased during the post implementation period of ATC. However injuries on pedestrians were reduced after introducing ATC. Chi

square test indicated that introduction of ATC had a highly significant influence on the cause of injury ( $\chi^2 = 23.443$ ;  $p < 0.05$ ).



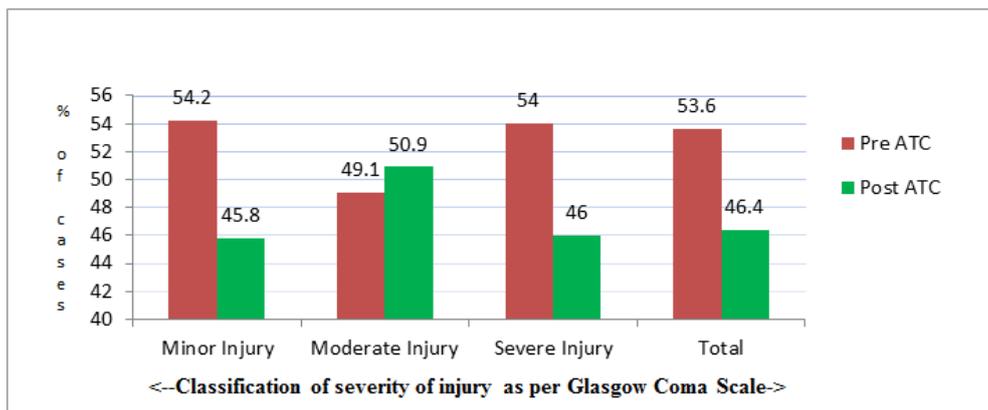
**Fig-1: Incidence of MCV and cause of injury before and after implementation of ATC in Riyadh, KSA**

The type of injuries before and after the installation of ATC (Fig.2a and 2b) showed that most prevalent type of injury due to MVC for children of 1-3 and 9-14 year old was of multiple natures during the pre-introduction period of ATC which was later altered to Upper Leg injury for 3 year olds during the post-introduction of ATC. Incidence of injuries due to burns among 5 year olds showed an increasing trend from 76.2% during pre-ATC and 90% during post-ATC. During Pre-ATC major (37.7%) type of injury among 7 year olds was of multiple natures which was shifted to lacerations, truncal and multiple injuries during post-ATC (26.8%). For 9 year olds also multiple type of injuries (30.6%) during the pre-ATC give way to increased incidence of lacerations (42.9%) post-ATC. Earlier studies also reported that lower limb injuries

were the most common lesions among trauma due to MCV [11, 13, 14].

Trauma due to burns also showed an increasing trend from 76.2 % to 90%. Frontal and high-energy impacts are associated with a frequency of burns [15] which is a potential threat to pedestrians and other nearby road users [16]. This scenario indicated that the drivers try to stop the accelerating motor vehicle while seeing the ATC which triggered the frontal high energy impact by the adjacent vehicles.

The mean Glasgow Coma Scale of the victims indicated that there was insignificant difference between pre and post ATC times and they had moderate trauma in pre and post ATC period. The severity of injury based on GCS before and after introduction of ATC in Riyadh, KSA is provided in Figure 3.



**Fig-3: Severity of injury before and after introduction of ATC in Riyadh, KSA**

It was observed that during the pre ATC period there was an increasing trend in the incidence of severe injuries caused by MVCs which later displayed a decreasing trend in the post ATC period. As per Glasgow Coma Scale (GCS), the severity of the injuries was reduced during the post-introduction period and the

study confirms that the introduction of ATC helped to reduce the fatality among pediatrics by 50%.

Logistic regression analysis of different variables and the mortality along with the Odds ratio (OR) is given in Table 2.

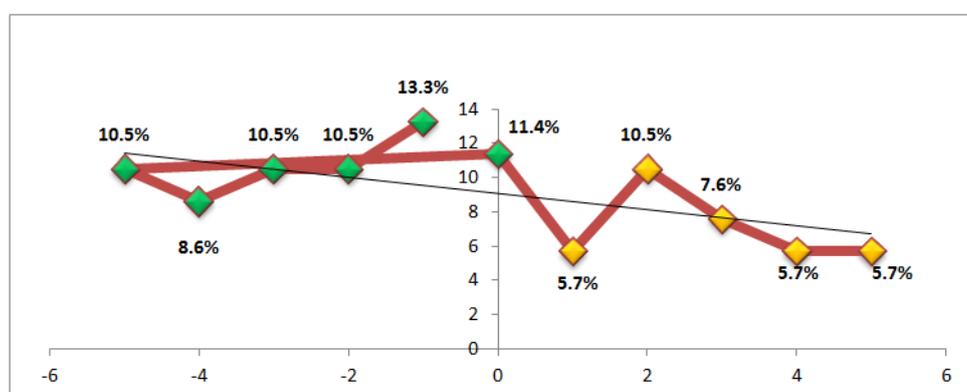
**Table-2: Logistic regression analysis of different variables and the mortality along with the Odds ratios (OR)**

Name of Variable	Alive* (n <sub>A</sub> = 925)	Dead* (n <sub>D</sub> = 105)	OR	95% CI for OR	p value**
Age(Mean ± SD)	7.84 ± 3.92	7.41 ± 4.20	0.985	(0.88, 1.11)	0.807
Sex					
Male	689 (74.5)	78 (74.3)	1.092	(0.40, 2.97)	0.864
Female	236 (25.5)	27 (25.7)			
Total	925 (100)	105 (100)			
Cause of injury					
MVC	486 (52.5)	49 (46.7)	1.428	(0.59, 3.47)	0.431
MVC with Pedestrian	439 (47.5)	56 (53.3)			
Total	925 (100)	105 (100)			
Trauma Scores					
Glasgow Coma Scale(GCS)	12.65 ± 3.73	3.88 ± 2.38	0.862	(0.76, 0.98)	0.020*

\*Numbers in parenthesis indicate percentage \*\*Significant at p = 0.05%

It was observed that a decrease in GCS score was associated with significant likelihood of fatality with an OR of 0.862 at 95% CI for OR as (0.76, 0.98) at

p= 0.020. The study indicates that the fatality rate (Fig.4) among the pediatrics, five years after the induction of ATC was reduced by 50 per cent.



**Fig-4: Pediatric fatality rate before & after induction of ATC in Riyadh city as reported by KAMC Trauma registry**

A logistic regression model, *Logit (hospital outcome) = 1.825 + 0.016 (age) + 0.009 (gender, males) - 0.571 (GCS) + 1.128 (Cause of Injury, MVC)*, was developed based on the study variables such as hospital outcome, age, gender, GCS and cause of injury. A significant (p=0.020) association was observed between GCS coefficient and fatality. Further the risk of pediatric fatality increase with a decrease in GCS by 0.565.

## CONCLUSION

Car is the major mode of conveyance in Riyadh the capital city of Kingdom of Saudi Arabia. High levels of car ownership and car use made the motor vehicle crashes as one of the leading causes of death in KSA. The study was conducted among the pediatric subjects with a mean age of 7 years and 8 months who succumb to trauma during the pre and post induction period of Automated Traffic Control System in Riyadh city of KSA. The study indicated that after the introduction of ATC, male child pedestrian casualties were decreased significantly whereas MVC on female children was increased and ATC had a highly

significant influence on the cause of injuries such as Motor vehicle Crashes or Motor Vehicle Accidents with child pedestrian. It was observed that the type of injury varies with the age of the child. The most common type of injury to 1-3 and 9-14-year-olds was of multiple natures during the pre-introduction period of ATC which shifted to the upper leg injury during the post-intervention period.

Automated Traffic Control was found effective in reducing the MVCs and severity of injuries. However, the study calls for providing awareness about the prevention of MVCs in Saudi Arabia among school children and drivers of both genders and child safety for parents. Use of child safety seats and seat belts are to be encouraged so as to reduce the severity of injuries.

Increase in burns after MVC indicated that automobile construction companies have to improve the burn safety to prevent flames from spreading from the motor compartment to the passenger compartment. There should be speed limits in local crash hot spots. Further studies are to be conducted to find out gender-

specific trauma outcome, types and mechanisms of injuries.

### Limitations of the study

This retrospective study included only those patients who were admitted to King Abdul-Aziz Medical City and excluded those who sought medical care in other health facilities. The area of the study was also limited to Riyadh region of KSA only. There was paucity of data in the Emergency Department about whether the victims were wearing seat belts or sitting in the front seat or back seat.

### REFERENCES

1. <http://www.worldlifeexpectancy.com/country-health-profile/saudi-arabia> viewed on 20-03-2018 at 2.15pm
2. World Health Organization. Global Health Observatory (GHO) data. World Health Statistics 2010. Geneva (CH): World Health Organization. 2010. Available from: [www.who.int/gho/publications/world\\_health\\_statistics/en/](http://www.who.int/gho/publications/world_health_statistics/en/)
3. Crankson SJ. Motor vehicle injuries in childhood: a hospital-based study in Saudi Arabia. *Pediatric surgery international*. 2006 Aug 1;22(8):641-5.
4. Alghnam S, Palta M, Hamedani A, Remington PL, Alkelya M, Albedah K, Durkin MS. In-hospital mortality among patients injured in motor vehicle crashes in a Saudi Arabian hospital relative to large US trauma centers. *Injury epidemiology*. 2014 Dec;1(1):21.
5. Ansari S, Akhdar F, Mandoorah M, Moutaery K. Causes and effects of road traffic accidents in Saudi Arabia. *Public health*. 2000 Jan 1;114(1):37-9.
6. Alnasser M, AlSelaim N, Aldhukair S, Elbedah K, Tamim H, Alazzam S, AlTokhais T, Alenazi S, Zamakhshary M. Patterns of pediatric trauma in Ramadan: an observational study. *Annals of Pediatric Surgery*. 2012;8(1):9-11.
7. Newgard C, Jolly BT. A descriptive study of pediatric injury patterns from the National Automotive Sampling System. In *Annual Proceedings/Association for the Advancement of Automotive Medicine 1998* (Vol. 42, p. 1). Association for the Advancement of Automotive Medicine.
8. Mohammad R Rasouli, Vafa Rahimi-Movaghar, Radin Maheronnaghsh, Ali Yousefi and Alexander R Vaccaro. *World J Pediatr*. 2011;7(4): 311-317
9. Jan, Yaseen. Drivers' Perception of Saher Traffic Monitoring System in Jeddah, Saudi Arabia. 2014. Masters Theses & Specialist Projects. Western Kentucky University. Paper 1438;pp 1-53
10. Sengoelge M, Hasselberg M, Laflamme L. Child home injury mortality in Europe: a 16-country analysis. *European journal of public health*. 2010 Apr 29;21(2):166-70.
11. Figueiredo Junior I, Carvalho MV, Lima GM. Pediatric trauma due to motor vehicle accidents on high traffic roadway. *Einstein (São Paulo)*. 2012 Mar;10(1):29-32.
12. World Health Organization. Gender and Road Traffic Injuries. 2002. [http://www.who.int/gender/other\\_health/en/gendertaffic.pdf](http://www.who.int/gender/other_health/en/gendertaffic.pdf). Last access 24/03/2013
13. Laine JC, Kaiser SP, Diab M. High-risk pediatric orthopedic pitfalls. *Emerg Med Clin North Am*. 2010; 28(1):85-102
14. Enweluzo GO, Giwa SO, ObalumDC. Pattern of extremity injuries in poly trauma in Lagos, Nigeria. *Niger Postgrad Med J*. 2008;15(1):6-9
15. Brand S, Otte D, Stübig T, Petri M, Ettinger M, Mueller CW, Krettek C, Haasper C, Probst C. Mechanisms of motor vehicle crashes related to burns—An analysis of the German In Depth Accident Study (GIDAS) database. *Burns*. 2013 Dec 1;39(8):1535-40.
16. Lockhart PA, Cronin DS, Watson B. Frontal impact response for pole crash scenarios. *Traffic injury prevention*. 2013 Jul 4;14(5):509-19.