APR0799

International Journal for Consumer Safety 0929-8347/95/US$ 3.50

International Journal for Consumer Safety–1995, Vol. 2, No. 4, pp. 191-207

Buren (The Netherlands) 1995

Accepted 5 August 1995

Economic impact of a regulation imposing full-face protectors on adult recreational hockey players

Guy Régnier[1]
Claude Sicard[2]
Claude Goulet[1]

[1] Régie de la sécurité dans les sports du Québec and [2] Société de l'assurance automobile du Québec, Quebec, Canada

Abstract In 1988, the Government of Quebec adopted a regulation imposing the use of a full-face protector (FFP) on the 100,000 adult recreational ice hockey players of the province. After one year of enforcement, the FFP use rate increased from 25% to 88%. Compliancy rates then dropped steadily to reach 76% by 1993. Based on those rates and on epidemiological data on facial injuries, health care costs and efficiency of FFPs in preventing such injuries, it was estimated that the regulation resulted so far in a net saving of $1.9 million in health care costs alone. The savings/cost ratio for the regulation is 1.87:1. If the regulation had imposed a visor instead of a full-face protector, the net savings in health care costs for the same period would have been only $96,277, for a savings/cost ratio of 1.04:1. If no regulation had been adopted at all, it is estimated that voluntary use of FFPs would have resulted in $665,912 of savings while voluntary use of visors would have resulted in a saving of $497,023. It is concluded that a governmental regulation imposing the use of FFPs on adult recreational players was economically justifiable.

Keywords ice hockey, protective equipment, cost-savings analysis, Quebec.

Correspondence to: Guy Régnier, Ph. D. Conseil d'évaluation des technologies de la santé
Tour de la Bourse 42[e] Étage
800, Place Victoria, C.P. 215
Montréal (Québec) H4Z 1E3,
Tel.: +1-(514) 873-2563,
Fax.: +1-(514) 873-1369

Introduction Ice hockey is one of the leading contributors to sports-related injuries in Canada[1-5] and, to a lesser extent, in the United States[6] and certain countries of Europe.[7-9] Nevertheless, this fast-paced collision sport provides the sport and public health communities with an impressive success story of injury prevention: the quasi-elimination of eye and facial injuries through the use of face protectors.

In the mid-seventies, Canadian and American (U.S.) ophthalmologists documented a significant incidence of serious eye injuries in hockey players.[10-13] This public awareness brought together safety specialists, amateur hockey governing bodies and sport equipment manufacturers in an attempt to im-

prove available eye and face protective equipment and to increase its routine use.

These efforts led to the adoption of a Canadian and an American (U.S.) standard on face protectors for ice hockey players.[14,15] The standards led in turn to the adoption of regulations imposing the use of a certified full-face protector (FFP) for all minor league players in the United States starting with the 1976 season, and in Canada starting with the 1978 season. The International Ice Hockey Federation has also required the use of full-face protectors in all international tournaments for players under 20 years of age since 1985.

The effects of this 'injury control' intervention have been well documented in Canada[16-21] and in the United States.[22-24] For instance, Pashby[17] reports that no eye injuries have been recorded for a player wearing a full-face protector certified by the Canadian Standard Association (CSA). But the most eloquent demonstration of the effectiveness of full-face protectors is reported again by Pashby;[18] based on reports from Canadian ophthalmologists, the average age of hockey players suffering from an eye injury in Canada in 1974-75 was 14 years. In 1983-84, five years after full-face protectors were imposed on all minor league players (18 years and under) by the Canadian Amateur Hockey Association (CAHA), the average age of the victims rose to 24 years. From these results, Pashby concluded that the main population at risk of eye injury in hockey had become the thousands of adult recreational hockey players participating in organized leagues not subject to the CAHA regulation.

Purpose of the Study The purpose of this study was to evaluate the net savings in direct health care costs resulting from the governmental regulation adopted in the province of Quebec in 1988 by which all hockey players over 18 years of age participating in an organized league have to wear a CSA-certified full-face protector.

The study will also evaluate what would have been the savings if no regulation had been imposed or if the regulation had imposed the use of a visor instead of a full-face protector.

Situation in the Province of Quebec The *Sport Eye Injury Surveillance System*, operated in the province of Quebec by the Quebec Sport Safety Board (QSSB)* and the Quebec Association of Ophthalmologists (QAO), had also pinpointed the higher risk population of adult players.

* The QSSB is a provincial governmental agency with quasi-judiciary powers whose mandate is to 'look after the safety and the integrity of sports participants'. It is unique in Canada.

Between 1982 and 1986, the surveillance system continously revealed ice hockey as the number one cause of sports-related eye injuries, the mean age of the victims being 24.5 years.[25]

This situation can be ascribed to the fact that only 110,000 of the 200,000 hockey players involved in organized leagues in Quebec are members of the Quebec Ice Hockey Federation (QIHF), the provincial branch of the CAHA: 100,000 minor leaguers under 18 years old and only 10,000 adult recreational players. In 1987, the remaining 90,000 adult recreational hockey players participated in organized leagues outside the jurisdiction of the

QIHF, thus not subject to the regulation imposing full facial protection. Observations in a representative sample of arenas in Quebec revealed that only 25% of these players wore facial protection in 1987 in spite of previous social marketing campaigns promoting the voluntary use of FFP.[26]

These results confirm Pashby's conclusion as to the vulnerability of adult recreational players not wearing full facial protection. To address this problem, the government of the province of Quebec, through the QSSB, enacted a regulation imposing full-face protectors on all adult hockey players participating in an organized league, whether the league be a member of the QIHF or not.[27]

It is important to note that the regulation specifically imposed the use of a FULL-face protector, the only model of ice hockey facial protector then certified by CSA.[15] The so-called *visor* that covers only the upper part of the face was not certified by CSA until 1990, when the agency modified its standard to include specifications on other types of protectors.[28]

However, it is important to note that because of obvious differences in design and protective capability, the visors do not have to meet the same performance criteria as the FFP to receive certification from the CSA. For instance, the puck speed used for the FFP to test its resistance to deformation is 112 km/h compared to only 36 km/h for the visor. The facial areas on which these impact tests as well as the 'resistance to penetration' test are performed, are also much smaller for the visor, being limited to the upper face.[28] At least one independent study has also clearly demonstrated that visors are not as resistant to deformation as the FFP.[29]

As can be seen in Figure 1, the regulation imposing FFP had an immediate and long-lasting effect on the use rate of full-face protectors among adult recreational hockey players in Quebec. The effects of the sharp increase in FFP use were quickly detected by the *Sport Eye Injury Surveillance System.* Figure 2 shows that the rate of 'ice hockey-related eye injuries for every participating ophthalmologist' decreased sharply after 1987.[30] The relatively few eye injuries still reported involve adult players who choose not to comply with the regulation and young participants in non-organized situations.[31]

Methods

SOURCES AND NATURE OF DATA According to Rice, MacKenzie *et al.*,[32] 'determination of the net savings to society if any one intervention were implemented depends on estimates of level of incidence reduced, the cost of injury severity reduced, the estimated cost of implementing or increasing the intervention, and the extent to which the intervention would be applied.' (p. 112)

An estimate of the total net savings resulting from the regulation was calculated for the six-year period following enactment of the regulation, *i.e.* from the 1988 to the 1993 season. The data used for this cost-savings analysis were, for the 'savings' component: 1) the number of facial injuries before the regulation; 2) the cost of medical treatment for facial injuries before the

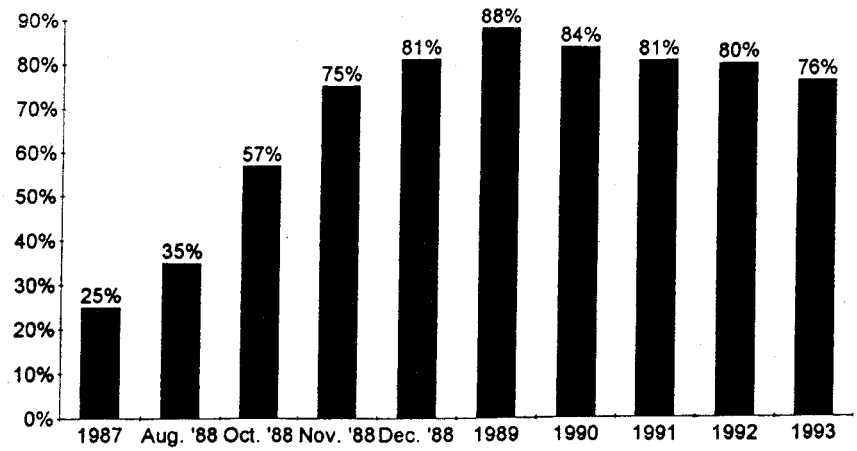

Fig. 1. Compliancy rate of full-face protectors among adult recreational hockey players, Quebec, 1987-93.
Sources: 26,51-54
Note: The compliancy rate for 1992 is missing. It was assigned the value 80% based on data from previous and following years.

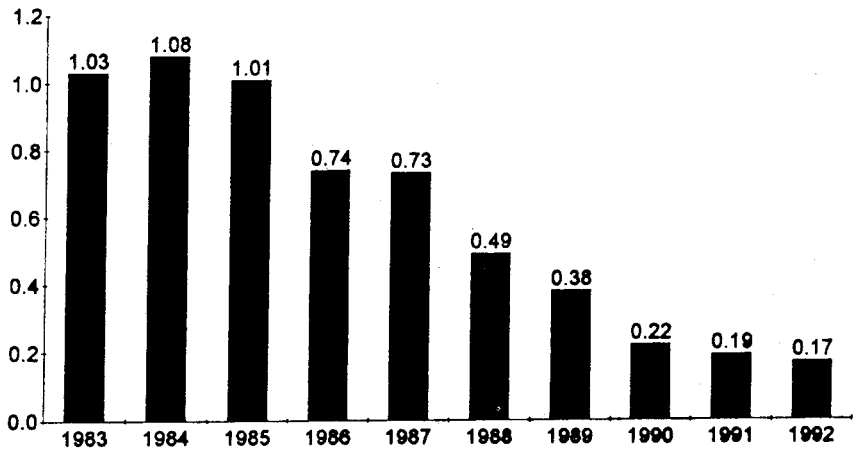

Fig. 2. Number of ice hockey-related eye injuries reported per ophthalmologist, Quebec, 1983-92.
Sources: 30,55

regulation; 3) the efficency of FFPs and visors in preventing facial injuries; and 4) the compliancy rate before the enactment of the regulation and for each of the following six seasons. The data needed to estimate the 'cost' component were: 1) the cost related to the development of the regulation; 2) the cost related to its enforcement; and 3) the cost incurred by the participant to comply with the regulation. Table 1 presents the figures for all the parameters used in the cost-savings analysis as well as the sources they were taken from. More details on calculation procedures are presented in the following sections.

NUMBER OF FACE INJURIES BEFORE THE REGULATION *Estimated Number of Ice Hockey Injuries.* A survey done for the QSSB estimated the number of ice hockey players who suffered an injury requiring a medical consultation in Quebec in 1987[33] at 20,000. Of that number, 75% sought treatment at an emergency room, 14% at an outpatient clinic, 4% from a general practitioner in a private office and 7% from a specialist (including dentists).

Estimated number of face injuries. A study done by the QSSB and the Public Health Department of the Maisonneuve-Rosemont Hospital (MRH) in Montreal on all sports injuries treated at the emergency room in 1987, showed that 20% of ice hockey-related injuries were to the face of the victim.[34] Similar results were found in other studies done in comparable condi-

	Parameter	*Source*
Eye injuries (1987)		
Number of injuries	600	30,33-36,38
Average cost of professional fees ($)	260	34,43
Hospitalization rate (%)	14.0	33
Average length of stay in hospital (days)	5.0	33
Cost per day of hospitalization ($)	374	48
Emergency room visits rate (%)	91.0	33
Number of emergency room visits per victim	2.1	33
Cost per emergency room visit ($)	36	44,45
Total cost ($)	354,000	
Teeth injuries (1987)		
Number of injuries	500	33,34,39-41
Average cost of professional fees ($)	225	46
Hospitalization rate (%)	N/A	
Average length of stay in hospital (days)	N/A	
Cost per day of hospitalization ($)	N/A	
Emergency room visits rate (%)	N/A	
Number of emergency room visits per victim	N/A	
Cost per emergency room visit ($)	N/A	
Total cost ($)	112,000	
Other facial injuries (1987)		
Number of injuries	2900	4,33-36,38
Average cost of professional fees ($)	99	34,43
Hospitalization rate (%)	1.5	55
Average length of stay in hospital (days)	5.0	55
Cost per day of hospitalization ($)	374	48
Emergency room visits rate (%)	95.0	55
Number of emergency room visits per victim	1.7	55
Cost per emergency room visit ($)	36	44,45
Total cost ($)	537,000	
Full-face protector cost ($)	30	Retailers
Duration of full-face protector (years)	6	Estimation
Compliancy rates		
Initial compliancy (1987) (%)	25.0	26
Compliancy for each season (%)		
1988	81.0	52
1989	88.0	52
1990	84.0	53
1991	81.0	54
1992	80.0	Estimation
1993	76.0	51
Estimated FFP efficiency (%)		
Eye injuries	100.0	25,28,38,48
Other upper-face injuries	100.0	25,28,38,48
Teeth injuries	100.0	25,28,38,48
Other lower-face injuries	95.0	25,28,38,48

TABLE 1. Parameters Used in Cost-Savings Analysis

	Parameter	Source
Estimated visor efficiency (%)		
Eye injuries	89.0	25,28,38,48
Other upper-face injuries	89.0	25,28,38,48
Teeth injuries	0.0	25,28,38,48
Other lower-face injuries	0.0	25,28,38,48
Inflation rates (%)		
1988	3.7	47
1989	4.2	47
1990	4.3	47
1991	7.4	47
1992	1.8	47
1993	1.4	47

TABLE 1, *continued*

tions in different parts of Canada.[35-38] From that percentage and from the 20,000 estimated ice hockey injuries reported in the Gollin study,[33] it was estimated that the number of ice hockey-related face injuries that needed medical treatment in 1987 was 4000.

Estimated number of eye injuries. The same QSSB-MRH emergency room study showed that 15% of all ice hockey-related face injuries were to the eyes.[34] It was thus estimated that 600 of the 4000 face injuries affected the eyes. This number is considerably larger then the 225 eye injuries reported for the same period by the joint study of the QSSB and the Quebec Association of Ophthalmologists referred to earlier.[30] This difference can be explained by the fact that many victims of minor eye injuries who seek treatment at an emergency room will never be referred to an ophthalmologist. The QSSB-MRH study[34] recorded all types of eye injuries, whereas the QSSB-QAO study[30] only recorded the more severe injuries seen by an ophthalmologist. According to the Gollin survey,[33] 91% of the victims who suffered from an eye injury sought treatment at an emergency room, an average of 2.1 times each. The hospitalization rate was 14% and the average stay was 5 days.

Estimated number of teeth injuries. Based on three studies reporting the percentage of teeth injuries among face injuries,[32,39,40] it was estimated that teeth injuries represented 12% of the 4000 face injuries, for a total number of 500.

Estimated number of other face injuries. Other face injuries included fractures, contusions and lacerations affecting evenly the lower and the higher part of the face.[34,35,40,41] According to the Gollin survey,[33] 95% of the victims who suffered from a face injury (other than to the eye), sought treatment at an emergency room, an average of 1.7 times each. The hospitalization rate for those injuries was only 1.5%, *i.e.* 10 times lower than for eye injuries. However, the average stay was the same, *i.e.* 5 days.

COST OF INJURIES BEFORE THE REGULATION Cost estimates for ice hockey-related facial injuries were based on the method described by Sicard

and Daigle[4] and by Tolpin *et al.*.[42] Only direct treatment costs were included. These costs include: 1) professional fees for medical doctors and dentists and 2) operating expenses and fixed-assets costs of public health services. Costs related to temporary or permanent incapacity and to productivity losses were not considered because of a lack of data.

Cost of eye and face injuries. The costs of eye and face injuries for 1987 were computed using the following formula:

$$C_i = n\,(C_{pf} + [H_r \times D_h \times C_h] + [ER_r \times N_{erv} \times C_{erv}])$$

where: C_i = Total cost for type of injury i;
n = Number of injuries;
C_{pf} = Average cost of professional fees;
H_r = Hospitalization rate;
D_h = Average length of stay in hospital (days)
C_h = Cost of operation and fixed assets per day of hospitalization;
ER_r = Emergency room visits rate;
N_{erv} = Number of emergency room visits per victim;
C_{erv} = Cost of operation and fixed assets per emergency room visit.

The data needed to compute these costs are presented in Table 1. The average cost of professional fees (C_{pf}) was computed from the 383 ice hockey cases reported in the QSSB-MRH study.[34] Since in Quebec the professional fees are covered by a public health insurance plan, it has been possible to obtain all professional fees billed to the Quebec Health Insurance Board (QHIB) for these cases during the 12-month period following the first visit of the victim.[43] The data included the number of medical interventions per victim and, for each intervention, the type of action performed, the institution where it was performed, the type of specialist who performed it, and its cost. Data from the QHIB included claims for the first visit at the ER of MRH and for all subsequent visits, whether they were at MRH or at any other private or public institution in the province.

Treatments received by the victim during the 12-month period that were not related to the ice hockey injury were eliminated by comparing the original diagnosis with the type of medical intervention performed. Moreover, for injuries not resulting in hospitalization, it was agreed that if there was a two-month delay between two visits, the subsequent claims were not related to the ice hockey injury.

The cost of operation and fixed assets for emergency room visits (C_{erv}) and for hospitalization (C_h) were obtained from the Quebec Health and Social Services Depeartment[44] and Statistics Canada.[45] The average cost of operation and fixed assets for 1987 was $36.34 per ER visit and $374 per day of hospitalization. As can be seen in Table 1, the total cost of ice hockey-related eye injuries in 1987 was estimated at $354,000 while the total cost of other facial injuries (except dental injuries) was estimated at $537,000. The cost of eye injuries is relatively high considering the lower incidence of this type of injury. This can be explained by the higher rate of hospitalization and professional fees generated by eye injuries compared to other facial injuries.

Cost of dental injuries. The cost of dental injuries was estimated more simply by multiplying the number of dental injuries by the average treatment cost of such injuries. The average treatment cost was obtained from a previous study done by the QSSB in collaboration with the Quebec Association of Dentists.[46] Using a surveillance system relying on a representative sample of 440 dentists over a 12-month period in 1990, the study yielded an average cost of $255 for treating an ice hockey-related dental injury. Since that figure was for 1990, it had to be adjusted to 1987 dollars to permit comparisons with the rest of the data. Taking into account the inflation rate from 1987 to 1990,[47] the average cost for the treatment of an ice hockey-related dental injury in 1987 was estimated at $225. The total cost for the estimated 500 dental injuries suffered in 1987 by ice hockey players was thus estimated at $112,000.

Total cost of eye, face and dental injuries. The total cost for eye, face and dental injuries suffered by ice hockey players in Quebec in 1987 amounted to $1,003,000.

EFFECTIVENESS OF FULL-FACE PROTECTORS AND VISORS The full-face protector is an effective device when adjusted and worn according to the specifications of the manufacturer. Pashby[18] reported no eye injuries to players using FFP in his annual survey of Canadian ophthalmologists. Injuries to the lower part of the face can happen but are very rare and usually not severe. For instance, of 190 ice hockey-related face injuries seen at two ER in Kingston, Canada, only one was to a player from a league where full facial protection was mandatory (pee-wee level).[38]

On the other hand, protection provided by visors is limited to the upper part of the face. Lorentzon *et al.*[48] report that visors can only prevent 52% of face injuries. Eleven percent of ice hockey-related eye injuries treated by Quebec ophthalmologists from 1982 to 1986 were suffered by players using a visor.[25] At least two players from the Quebec Major Junior Hockey League have suffered a blinding eye injury since 1991 when the league was granted an exception to the QSSB regulation on FFP and was allowed to let its players use a visor. Although the vast majority of visors sold in Canada are certified by the Canadian Standard Association (Type 4 protector), it is important to specify that, as was stated earlier, they do not have to meet the same performance criteria as the FFP to receive certification.[28]

Based on the preceding data, a percentage of 'protection effectiveness' was set for the visor and the FFP, both for the upper and the lower part of the face. These percentages are also presented in Table 1.

Cost-savings analysis In order to be able to calculate the real benefits of a regulation imposing the use of full facial protection on hockey players, two main sets of data are required. First, we need an estimate of the 'gross savings' resulting from the regulation, that is 'by how much did the regulation reduce the cost associated with the treatment of ice hockey-related facial injuries?'. Second, we need an estimate of the 'prevention cost', that is, 'how much did it cost the government to develop and enforce the regulation, and how much did it cost the players to conform to it?'.

GROSS SAVINGS Gross savings resulting from the regulation were estimated for a six-year period, from the 1988 to the 1993 season. They are reported in 1993 dollars, taking into account annual inflation rates for the province of Quebec (see Table 1). Gross savings were first estimated by assuming that every percentage of increase in the use of FFP after 1987 was a direct effect of the regulation. Savings that would have resulted from the expected increase in voluntary use rate if no regulation had been enacted were also estimated.

For comparison purposes, gross savings resulting from a regulation that would have imposed the use of a visor instead of the FFP were also computed under the same two conditions as described above. Annual gross savings from the regulation for each type of injury were computed using the following formula:

$$AGS_{i,y} = E_i \times C_i \times (CR_y - CR_{87})$$

Where: $AGS_{i,y}$ = Annual gross savings for type of injury *i* during year *y*;
E_i = Effectiveness of the face protector in preventing the type of injury *i*;
C_i = Cost for type of injury *i* in 1987;
CR_y = Compliancy rate for year *y*;
CR_{87} = Compliancy rate for 1987 (25%)

Table 2 presents estimates of the total gross savings for the six-year period between 1988 and 1993 for each type of injury. Calculations were done for savings resulting from the FFP regulation and from a hypothetical regulation that would have imposed a visor. To allow for comparisons, the initial compliancy rate for the visor was set at 25%, although it was probably a little higher.

The total gross savings from six years of enforcement of an FFP regulation are estimated at $4.1 million. The gross savings that would have resulted from a visor regulation under the same conditions are estimated at $2.3 million, 44% less. It is assumed that a regulation imposing a visor would have produced the same compliancy rates as for the FFP. It could be argued that the rates would have been higher since hockey players seem to accept the visor better than the FFP. But even with a 100% compliancy rate for the visor, the gross savings would 'only' be $3.1 million, still 24% less than the savings produced by the FFP regulation.

It is probable that even without any regulation, a certain number of players would still have voluntarily adopted the FFP sometime during the six-year period under study. Calculations were done to estimate what savings would have been achieved if no regulation had been adopted. It was assumed that the voluntary use rate of the FFP would have increased by 3% a year, thus reaching 43% by the 1993 season. Similar calculations were also done for the visor, now assuming a 4% yearly increase with a final use rate of 49% to account for its higher acceptance among adult recreational players. Calculations under these two 'no regulation' scenarios yielded gross savings of $665,912 for FFPs and $497,023 for visors.

Annual Savings with FFP–Actual Regulation (1993 dollars)

Year	Type of Injury					
	Eyes	*Teeth*	*Other upper face*	*Other lower face*	*Total*	*Rate %*
1988	240,663	76,142	182,537	173,410	672,752	1.214
1989	272,161	86,122	206,462	196,139	760,884	1.177
1990	256,152	84,040	201,473	191,399	733,064	1.135
1991	243,975	77,189	185,048	175,796	682,008	1.092
1992	239,910	75,904	181,966	172,868	670,648	1.018
1993	222,462	70,384	168,732	160,296	621,874	1.000
TOTAL	1,475,323	469,781	1,126,218	1,069,908	4,141,230	

Annual Savings with Visor–Hypothetical Regulation (1993 dollars)

Year	Type of Injury					
	Eyes	*Teeth*	*Other upper face*	*Other lower face*	*Total*	*Rate %*
1988	214,191	0	162,469	0	376,660	1.214
1989	242,264	0	183,751	0	426,015	1.177
1990	227,975	0	179,312	0	407,287	1.135
1991	217,138	0	164,693	0	381,831	1.092
1992	213,520	0	161,950	0	375,470	1.018
1993	197,992	0	150,172	0	348,164	1.000
TOTAL	1,313,080	0	1,002,347	0	2,315,427	

TABLE 2. Estimated Gross Savings from Facial Protection Regulation for Adult Recreational Ice Hockey Players in Quebec after Six Years of Enforcement (1988-1993) for Two Types of Protectors

COST OF PREVENTION The following analysis of the 'cost of prevention' includes: 1) the cost related to the development of the regulation; 2) the cost related to the enforcement of the regulation and; 3) the cost related to the purchase of FFP by individuals.

Cost of development. The cost of developing the regulation was estimated at $200,000 in 1987 (see Table 3). This includes the salaries of QSSB personnel who worked on the project, plus the cost of outside expertise, publicity and administration.

TABLE 3. Cost to Develop the Regulation (1987 dollars)

Salaries		130,000
Lawyer	30,000	
Professionals	70,000	
Assistants	20,000	
Management	10,000	
Publicity		25,000
Outside expertise		35,000
Administrative fees		10,000
TOTAL		200,000

Because the regulation should have an impact over a number of years, this cost must be discounted over a certain period. Considering that all players might eventually have worn a full-face protector, even without a regulation, and looking at the pattern of voluntary compliancy rates of other protective equipment such as the helmet, it has been assumed that the cost incurred to develop the regulation should be discounted over at least 15 years.

The cost of development was discounted using the following formula:

$$AC_{rd} = \frac{TC_{rd} \times d}{1 - ([1 + d]^{-n})}$$

Where: AC_{rd} = Annual cost for regulation development;
TC_{rd} = Total cost for regulation development;
d = Discount rate;
n = Number of years for discounting.

Based on an annual discount rate of 5% over a period of 15 years, the annual cost entailed by the development of the regulation was estimated at $19,230. The regulation development cost attributed to the six-year period under study was then $115,380 in 1987 discounted dollars or $140,000 when updated in 1993 dollars.

Cost of enforcement. The total cost of enforcing the regulation over the six years between the 1988 and the 1993 seasons was $244,150 in 1993 dollars (see Table 4). This cost includes salaries and expenses (meals, transportation) for QSSB inspectors as well as administrative expenses. Publicity expenses for the regulation (posters in the arena) are also included. Formal province-wide inspections were done in the first three years following the adoption of the regulation. For the subsequent three years, the 'enforcement' was limited to information campaigns and a few inspection visits in the geographical regions showing the lowest compliancy rates.

Cost of Purchasing Face Protectors. The very first year following the enactment of the regulation, the percentage of adult recreational hockey players wearing a FFP rose from 25% to 81%. The compliancy rate has remained

TABLE 4. Yearly Cost to Enforce the Regulation

Year	*Cost to Enforce Regulation*	
	1987 $	*1993 $*
1988	50,000	60,700
1989	50,000	58,850
1990	50,000	56,750
1991	30,000	32,490
1992	20,000	20,360
1993	15,000	15,000
Total	215,000	244,150

almost constant at around 80% since then. There are 90,000 adult hockey players in Quebec who take part in leagues subject to the regulation. If we assume that all players who conformed to the regulation after 1987 had to buy the new piece of equipment, we find that 50,400 participants had to spend an average of $30 each because of the new regulation imposing the FFP. By discounting those individual costs over six years, the average expected lifetime of a FFP, it was estimated that the total cost assumed by individuals to conform to the regulation over the six-year period under study was $1,512,000. Assuming that they all bought their face protector in 1988 (which most of them did), this amounts to $1,835,000 in 1993 dollars.

NET SAVINGS The net savings resulting from the FFP regulation over the six-year period between 1988 and 1993 were computed from the following formula:

$$S_n = S_g - (C_d + C_e) - C_p$$

Where: S_n = Net savings from the regulation;
S_g = Gross savings from the regulation;
C_d = Discounted cost to develop the regulation attributed to the 1988-1993 period;
C_e = Cost to enforce the regulation;
C_p = Cost to purchase the face protector.

The net savings resulting from the FFP regulation for the six-year period under study were thus estimated at $1,922,080. If the regulation had im-

TABLE 5. Estimated Net Savings from Facial Protection Regulation for Adult Recreational Ice Hockey Players in Quebec after Six Years of Enforcement (1988-1993) for Two Types of Protectors

Net Savings with FFP–Actual Regulation		
Gross Savings		
• Medical Treatment Avoided	$4,141,230	
		$4,141,230
Costs		
• Regulation Development	$140,000	
• Regulation Enforcement	$244,150	
• Personal Equipment Purchase	$1,835,000	
		$2,219,150
NET SAVINGS		$1,922,080
Net Savings with Visor – Hypothetical Regulation		
Gross Savings		
• Medical Treatment Avoided	$2,315,427	
		$2,315,427
Costs		
• Regulation Development	$140,000	
• Regulation Enforcement	$244,150	
• Personal Equipment Purchase	$1,835,000	
		$2,219,150
NET SAVINGS		$96,277

posed a visor instead of a FFP, the net savings would have been $96,277 (see Table 5). The savings/cost ratios for the actual FFP regulation and for the hypothetical visor regulation are 1.87:1 and 1.04:1, respectively.

SENSITIVITY ANALYSIS Assumptions had to be made about various parameters in the analyses. In order to give the reader a better idea as to how some of these assumptions might influence the conclusions, sensitivity analyses were performed using the category of 'other upper face injuries'. This particular example was chosen because the estimate of the gross savings in the medical treatment of these injuries accounts for more than a quarter of the total gross savings estimate in the base case scenario ($1.1M/$4.1M; see Table 2).

Table 6 presents the values used as the 'base case' to estimate the costs related to 'other face injuries' and a range of values for each parameter. Costs were recalculated using the extreme values of the range. Results are shown in the far right column. The largest range of estimates resulting from these calculations is roughly $440,000 to $630,000. Note that these are the estimates for the costs of 'other face injuries'. The corresponding estimates for the cost of 'other upper face injuries' would be $220,000 to $315,000, assuming, as was done in the base case, that half of the 'other face injuries' affect the upper face.

The next step in the original analysis was to estimate gross savings for 'other upper face injuries' using an estimate of the effectiveness of the FFP, an estimate of the compliancy rate in 1987 and an estimate of the costs of 'other upper face injuries'.

The base case used in the original analysis provided an estimate of $1,126,218, representing 27% of the total gross savings (see Table 2). Table 7 shows how different values for the 'effectiveness', the 'compliancy rate' and the 'cost' parameter influence that estimate. Using the range provided by the sensitivity analysis on the costs of upper face injuries (Table 6) and a range of 35% to 15% for the compliancy rate in 1987, the estimate of 'gross savings for other upper face injuries' varies from about $920,000 to $1,320,000. Thus, the estimate of $4,141,230 for 'total gross savings' only varies from $3,935,012 to $4,335,012, depending on the assumptions made to estimate the costs and gross savings for the influential category of 'other upper face injuries'. Although this sensitivity analysis suffers from its uni-

TABLE 6. Results of Sensitivity Analysis for the Cost of 'Other Facial Injuries'

Parameters	*Base Estimate*	*Range of Estimate*	*Cost Range (base = $537,000)*
N injuries	2900	2400-3400	$444,456-$629,646
Prof. fees	$99	$70-$130	$452,951-$626,951
Hosp. rate	1.5%	0%-3%	$455,706-$618,396
Hosp. days	5	1-10	$471,975-$618,396
Hosp. cost	$374	$200-$550	$499,206-$575,331
ER visit rate	95%	80%-100%	$510,423-$545,925
N ER visit	1.7	1-2.5	$467,625-$616,395
ER visit cost	$36	$20-$50	$462,115-$602,620

Parameters	*Base Estimate*	*Range of Estimate*	*Range of Gross Savings (base=$1,126M)*
Effectivenes of FFP	100%	90%-100%	$1,013,596-$1,126,218
Cost of injuries	$268,500	$220,000-$315,000	$916,000-$1,333,667
Compliancy rate (1987)	25%	35%-15%	$921,517-$1,316,539

TABLE 7. Results of Sensitivity Analysis for 'Gross Savings on Upper Face Injuries'

variate nature (parameters were manipulated only one at a time), it illustrates the relative strength of the conclusions derived from the base case scenario.

Discussion The decision taken by the Quebec government to impose full facial protection on all adult recreational hockey players in the province resulted in net savings of $1.9 million to society in health care costs from 1988 to 1993. This figure is certainly an underestimate of the total savings to society since it does not consider savings due to reduced rates of incapacitation or productivity losses. Also, although it includes the cost entailed by the purchase of a full-face protector by all participants who had to comply with the regulation, it does not consider the economic benefits of such purchases on the province's manufacturers and retailers of FFPs.

If the regulation had imposed a visor instead of a full-face protector, the net savings to society, assuming compliancy rates similar to the ones achieved with the FFP regulation (about 80%), would have been only $96,277 for the six-year period under study. Calculations done under a 'no regulation' scenario for the visor, with a voluntary use rate reaching 49% by 1993, yielded a reduction of $497,023 in direct medical costs. Based on those results, it seems that a regulation *imposing* the use of visors on adult recreational hockey players would not have been socio-economically profitable. On the other hand, the $1.9 million net savings from the regulation imposing a FFP easily surpass the $665,912 savings computed under the 'no regulation' scenario for voluntary use of FFPs.

Compliancy rate for FFP reached a high of 88% in 1989 but has been declining since then, to reach 76% in 1993. This situation stems from a definite relaxation on the part of the QSSB in enforcing its regulation, coupled with much confusion resulting from the new CSA standard on visors and from the exception granted to the Quebec Junior Major Hockey League.

Players from the QJMHL fall under the jurisdiction of the QSSB's regulation imposing FFP. However, the league's officials felt strongly that the regulation was unfair to its players since the other two junior major leagues of the country were not faced with the same obligation toward their players. The officials were not interested in the improved safety offered to their players. Instead, they were concerned that scouts from professional teams would not be able to evaluate the talent or the courage of their players correctly since they were not playing with the same level of protection as the other Canadian junior major leagues nor the professional leagues. In short, they argued that playing with a FFP instead of a visor, like other Canadian junior players, would hurt their chances of becoming a professional hockey player; that since the visor was now CSA-certified, it offered a sufficient level of

protection; and that, in the end, eye and face injuries had to be considerd as an inherent risk of highly competitive amateur hockey.

The government granted a three-year exemption starting with the 1991-92 season, providing the QJMHL take a series of steps to otherwise improve the safety of its players (e.g., stricter rules on fighting and other dangerous behaviors).

In a percentage which is impossible to evaluate, this exemption has probably contributed to the decline in the use rate observed among adult recreational players over the last three years. The debate leading to the exclusion of QJMHL players from the regulation was widely publicized and the QJMHL is represented in almost every major city of the province.

The special treatment given to junior hockey players, coupled with the availability in sporting goods stores of newly CSA-certified visors, certainly sent a counter-productive message to adult recreational hockey players.

The QSSB plans to launch a new information campaign in 1994-95 to remind adult recreational hockey players of the regulation in force in Quebec. Calculations should be done to estimate if the increase in compliancy rate hoped to be achieved with such an operation warrants the expenses it will entail. These calculations should consider the fact that the reluctant 25% of players will 'cost' more to convince than the 'early adopters' who have been at the root of the savings reported in this study.[49] On the other hand, it could be argued that these reluctant players might also be the ones most at risk, not unlike drivers resisting seat belt use.[50] A small increase in the compliancy rate of this 'delinquent' population might result in relatively larger savings in health care costs.

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