CPRC CANADIAN POLICE RESEARCH CENTRE

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TR-13-97
Radar Health and Safety Study
Executive Summary of TR-14-97

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TECHNICAL REPORT
March, 1997

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NOTE: Further information about this report can be obtained by calling the CPRC information number (613) 998-6343

EXECUTIVE SUMMARY

The Police Radar Health Study, a joint initiative of the Canadian Police Research Centre with the Canadian Association of Chiefs of Police, the Canadian Police Association, and the Solicitor General of Canada commenced in March 1993. Initial funding was put in place in March 1994. The study, all 54,000 surveys, were mailed out in July 1996 to active and retired police officers of the five largest police departments in Canada, (Metro Toronto, Montreal, the Ontario Provincial Police, the Sûréte du Québec and the Royal Canadian Mounted Police). The study was supported by the local police associations/brotherhood.

The study showed that, for the most types of cancers, there was no higher risk among police officers than among the general population. In fact, the incidence of testicular cancer, the concern that prompted the study is 20 percent lower among police officers.

The study did reveal that melanoma, the more serious kind of skin cancer, is apparently about eight times higher among police officers than the general public. The result is of great concern to the researchers. This high incidence of melanoma may be the result of a poorly-worded survey question which, when asking the types of cancer suffered by the respondent, listed melanoma as the only type of skin cancer and offered no other choices. Researchers are going back out to the RCMP active and pensioned police officers to ask the question more clearly (the RCMP part of the survey had the same standard incidence ratio as the other police departments). The researchers believe this should determine for the whole population, whether this concern of higher melanoma incidence is actual fact or a result of a poorly-worded question.

There was also an indication of a slight increase in the incidence of urinary tract cancers, but the researchers think that result is probably a statistical aberration. It has been suggested that police offers may wish to discuss with their doctors the taking of a urine sample at their yearly physical examination.

It has been recommended that police officers, whether on duty of off duty should follow the following steps to protect themselves from melanoma due to sun exposure:

1. Wear long sleeves, long pants, a peaked cap and sunglasses when in the sun.
2. Apply sunblock with a high UV protection factor (SPF15 or greater) at least 30 minutes before going out in the sun, and re-apply repeatedly during sun exposure.
3. Check your skin regularly for any moles or other marks which appear to be changing, getting darker, growing or becoming ragged around the edges.
4. Report any moles or marks which concern you to your doctor; melanoma is usually treatable if caught early.
5. At your regular check-up make sure that your doctor checks your skin thoroughly.

SOMMAIRE

L'étude sur le lien entre la santé des policiers et le fait d'avoir effectué du radar routier, une initiative du Centre canadien de recherches policières, de l'Association canadienne des chefs de police, de l'Association canadienne des policiers et du Solliciteur général du Canada, a débuté en mars 1993. Le financement initial commençait en mars 1994. En juillet 1996, on a posté 54 000 sondages à des policiers actifs et à la retraite des cinq plus grands services de police au Canada (communautés urbaines de Toronto et de Montréal, Police provinciale de l'Ontario, Sûreté du Québec et Gendarmerie royale du Canada). Les associations locales de police ont donné leur appui à l'étude.

Les résultats montrent que pour la majorité des cancers, les policiers ne présentent pas plus de risques que la population en général. En effet, l'incidence du cancer des testicules, à l'origine de l'étude, est de 20 % inférieure chez les policiers.

L'étude a bel et bien révélé que le mélanome, le cancer de la peau le plus grave, semble être huit fois plus élevé chez les policiers que la population en général, ce qui inquiète grandement les chercheurs. Un tel résultat peut être dû à la mauvaise formulation des questions, du moins pour ce qui est des types de cancer dont souffrait le répondant, parce qu'on y donnait comme seul choix de réponse le mélanome. Les chercheurs sont à reposer clairement la question aux policiers actifs et à la retraite de la GRC (l'incidence chez les sujets de la GRC était la même que celle chez d'autres services de police). Ils estiment que cela devrait permettre de savoir pour l'ensemble des policiers si l'incidence élevée du mélanome est réelle ou si elle résulte d'une question mal posée.

Selon les résultats du sondage, il semble y avoir une légère augmentation du cancer des voies urinaires, mais les chercheurs estiment qu'il s'agit probablement d'une erreur de statistiques. On suggère aux policiers de demander à leur médecin de prélever un échantillon d'urine lors de leur examen physique annuel.

On recommande aux policiers, qu'ils soient de service ou non, de prendre les mesures suivantes pour se protéger du mélanome dû à l'exposition au soleil :

1. Porter des manches longues, des pantalons longs, une casquette et des lunettes de soleil.
2. Appliquer un écran solaire ayant un facteur de protection contre les rayons ultra-violets (SPF15 ou plus) au moins 30 minutes avant de sortir au soleil et en remettre à plusieurs reprises.
3. Examiner sa peau régulièrement pour y déceler des grains de beauté ou d'autres marques qui semblent changer, se foncer, grossir ou qui sont poilus sur les bords.
4. Signaler au médecin toute marque ou grain de beauté irrégulier; le mélanome est généralement traitable s'il est diagnostiqué tôt.
5. S'assurer que le médecin examine bien la peau lors de l'examen médical régulier.

INTRODUCTION

Recently an increased awareness and concern has developed regarding the use of and exposure to common sources of man-made non-ionizing radiation (NIR). Exposure to low levels of NIR is part of everyday life. Some of these sources include radio frequencies such as AM or FM radiowaves, microwaves and electric heaters. Other sources of NIR are found in the workplace. Employment in the communications, security, medical, military, power and transportation fields to name a few may provide additional exposure to NIR.

Scientific research on the exposure to NIR has produced a plethora of opinions on the potential adverse effects from exposure to this type of radiation. In particular, law enforcement journals have reported anecdotal cases of cancer that have occurred in a small number of police officers who have operated radar units for the purpose of traffic control.

NIR has lower frequencies (from 0 Hertz (Hz) to 3000 Gigahertz (GHz)) and longer wavelengths (from 3×10^{8} to 3×10^{-10} meters) than ionizing radiation. It is these two types of radiation that form the electromagnetic radiation spectrum. Other than our ability to see light (visible) and feel heat (infrared), we are unable to detect most other forms of NIR.

Electromagnetic radiation is grouped in ascending order by wave frequency with the lowest being power lines and the highest ultraviolet light. Radar (**RA**dio **D**etecting **A**nd **R**anging) works by transmitting electromagnetic waves that are pulsed from the antenna and when these waves encounter a solid object they are reflected back and received by the unit. The pulsing of the signal means that the transmitted waves have greater amplitude than those received back. Radar units use microwaves (1 to 300 GHz) and belong to the radio waves part of the electromagnetic frequency spectrum. They are referred to as long wave, low frequency, low energy microwave and radio frequency emissions.

Since the mid 1950's police departments across Canada have used radar units for traffic control. The units are manufactured by a small number of manufacturers in Canada and the United States (U.S.). The original models were operated from outside the police car with the radar unit mounted on a tripod by the side of the road. As technology changed these radar units were replaced by units that could be operated in the police car. In general there are two types of radar units, those that are mounted in or on the vehicle and those that are hand held (radar guns). Prior to 1983, radar units regardless of type were x-band and emitted 10.525 GHz. In 1983 k-band units (24.150 GHz), which emit a higher frequency wave, came into use. Testing in Canada and the U.S. has shown that under normal operating conditions police officers in their vehicle are exposed to levels between 0.02 and 0.05 mW/cm^2 which is well below the safety limit of 5.0 mW/cm^2. Investigations into hotspots, which may produce elevated levels, also indicate levels within

safety limits with measured exposure levels less than 1.0 mW/cm^2. More recently the newest technologies that are becoming available are photo-radar and laser radar.

Recommendations from governments on exposure levels historically have been set by consensus and are not enforceable. These limits have been proposed for frequencies ranging from 10 kHz to 300 GHz. The American standard is established with a safety factor of 10 below where harmful biological effects may be measured. In 1982 American National Standards Institute (ANSI) limited the exposure of workers exposed to radiofrequency and microwave emissions (1.5 to 100 GHz) to a power density of 5 mW/cm^2 over a six minute time period for the radio frequency protection guide. ANSI revised their standard in 1988 and raised it to 10 mW/cm^2 for frequencies above 3 GHz. Many countries, including Canada, have based their recommendations on the original ANSI standards. Studies use a measure of the effects of radar exposure on a body of tissue called the specific absorption rate (SAR) in watts per kilogram of body mass (w/kg). Guidelines that have been established limit the whole body exposure to 0.4 w/kg.

Studies on exposure to radiofrequency and microwaves have identified two reactions: thermal and nonthermal. There appears to be consensus that the absorption of electromagnetic energy can cause thermal effects in living organisms. Thermal changes have consistently been identified at SARs at or above 1.0 W/kg. Unlike exposure to direct heat sources there is no cutaneous perception of the heating of the tissues. Two areas that may have a greater immediate impact on human exposure are the thermal effect on the testes and on the eyes. The testes have a normal temperature a few degrees below body temperature, approximately 33-35° Celsius. Increasing testicular temperature to that of the body may cause sterility, and the killing of mature sperm. The ability to warm tissue without deleterious effects has been turned into treatment such as diathermy and hyperthermia in the medical field. Nonthermal effects, those not explained by the warming of tissues, have not been universally accepted. Low level thermal and nonthermal effects are observed at SAR levels below 1.0 W/kg. The most significant findings linked to nonthermal effects of NIR exposure are those identified as neuroendocrinological and immunological in nature and are associated with the pulsed wave. The hypothesized relationship between exposure to NIR and the development of cancer has not had unanimous support.

Many studies reporting on the outcomes from exposures to NIR were carried out among various occupational groups with long-term exposure, notably radar workers. The research has included gonadic function, where differences in libido and alterations in spermatogenesis were found and hematological changes in the peripheral blood of workers exposed to chronic low-level microwaves. Other studies did not uncover a difference between the exposed workers and controls. In particular, a health surveillance of exposed workers, although far reaching, found only an unusually high incidence in functional disturbances such as neurotic syndrome, disturbances in the digestive tract and cardio-circulatory abnormalities; eye damage from microwave radiation in the military and as with

the other studies no differences were found; and exposure to radiofrequency levels less than 4 W/kg found no increased mortality or morbidity in humans.

Testicular cancer is the most common neoplasm in men aged 15 to 35 and affects approximately 3 in 100,000 men of all ages annually in the U.S. Although the incidence has doubled in the last 60 years, advances in diagnostic techniques, treatment and management have improved survival rates from 10% in the 1970s to 90% in the 1990s. In order to identify young men at increased risk, research has been geared to recognizing potential risk factors that should be identified and considered for early detection. Unfortunately, there is little concordance in the findings. There is strong agreement that cryptorchidism is a risk factor for testicular cancer. Medical risk factors that may be potentially associated with this disease are inguinal hernia, mumps and mumps orchitis, testicular atrophy, and in utero exposure to DES. Testicular trauma is also proposed to be associated with the diagnosis of cancer. This trauma could be inflicted by activities such as bicycling, motorcycling, horseback riding and operating a truck or tractor. Others speculate that it is not the injury to the reproductive organs that increases the risk, but that it functions as a stimulus to seek medical attention. Elevated testicular temperature has also been implicated as a risk factor. Indicators for this increased temperature have been the taking of hot baths and the wearing of jockey shorts versus boxers. Demographic variables were also examined and have brought forth an abundance of opinions. The main focus of these are residence (rural or urban), education, socioeconomic status and occupation.

Exposure to NIRs from radar units is almost exclusively restricted to people employed in policing. The specific objectives of this study were: to determine the prevalence of testicular cancer in Canadian police officers by surveying the members from the police forces across Canada; to determine prevalences of any other cancers such as leukemia, brain, melanoma of the eye or skin, thyroid and bone among police; and to describe the distribution of radar use by police in Canada.

METHODS

The study was cross-sectional in design with the main intent of determining the prevalence of testicular and other cancers among living members of the five largest police forces in Canada, namely: the Royal Canadian Mounted Police (RCMP), the Ontario Provincial Police (OPP), the Sureté du Québec (SQ), the Metropolitan Toronto Police (MTP) and the Montreal Urban Community (SPCUM).

The target population of interest for this survey are the alive (active and pensioned) police officers. The study population includes all alive police officers, approximately 36,000 active and 17,200 pensioned police officers, in the five largest police forces in Canada. These forces, the RCMP, OPP, SQ, MTP and SPCUM account for 61% of all active police officers in Canada and cover the spectrum of law enforcement duties performed. Through

the efforts of the Canadian Police Association (CPA) and the Canadian Police Research Centre (CPRC), each police force provided a mailing list of all active and pensioned members of their force and a set of personalized mailing labels used to mail the questionnaire directly to all these members.

The questionnaire for this study was developed and pre-tested in a pilot study. It consisted of three sections: work experience; health including cancer diagnosis(es) and risk factors; and demographics. The purpose of the work experience section was to collect all pertinent data necessary to assess the level and type of exposure to radar. Time period information was collected that allowed for reconstruction of the timeline of a participant's police career and periods of duty during which radar was used. In addition, information was collected on the amount of training received prior to radar assignment, the type of radar unit used most often (mounted versus hand held), and where the radar unit was kept when active but not pointed at a vehicle, which provided an indication of risky behaviour that might be associated with the use and placement of radar units.

The health section was designed to collect information on cancer diagnosis, specifically testicular cancer. Information on the type of cancer diagnosed, date of diagnosis whether it had spread, and if so to which site and the corresponding date of diagnosis was collected for those indicating a cancer diagnosis. In addition, information was collected on putative risk factors for testicular cancer such as undescended testis, bicycling, horseback riding and severe trauma. The last section included the demographic questions, specifically date of birth, gender, marital status, progeny and rank.

Since it is impossible to accurately measure occupational exposure to NIR in a retrospective fashion, estimates of the exposure to NIR from the use of radar units was performed by using an algorithm of general exposure developed from information collected in a pilot study. The variables used in the algorithm include the number of years, hours per day and days per week assigned to highway patrol (as this is where radar unit use occurs). Levels of exposure were classified as low (below the 25th percentile of exposure), moderately low (between the 25th and less than the 50th percentile), moderate (between the 50th and less than the 75th percentile), moderately high (between the 75th and less than the 90th percentile) and high (at or above the 90th percentile). This is the same approach to classification used in electromagnetic exposure studies once exposure levels were measured among electric workers.

The primary outcome of interest is whether the police officer has been told that s/he has been diagnosed with cancer, specifically testicular neoplasms in the male officers. Secondary outcomes for this study are cancers that may also be associated with exposure to various frequencies of the electromagnetic spectrum. These cancers include leukemia, brain, melanoma of the eye or skin, thyroid and bone.

The epidemiological measures that were considered for this cross-sectional study for prevalence comparisons are prevalence ratios and prevalence differences (comparing persons in a given exposure level with persons in the reference category of lowest or no exposure). Internal comparisons (exposure levels) were considered.

RESULTS

Data from 25,777 questionnaires were received and entered into the study database. Taking into consideration the inventory of forms at the end of the study, a total 50,119 questionnaires were distributed. Assuming this number equals the number of forms mailed to the various association members, an overall response rate of 51.4% was obtained. Details of the return rates are given in Table 1. The rate varied by police force from a low of 38.9% for the MTP to 59.0% for the RCMP. Returned questionnaires that were not entered indicated that some were sent to deceased members (spouse and children receiving pension benefits) and some members received more then one questionnaire (either the member belonged to more than one of the forces at different times or the mailing inadvertently included two questionnaires).

Table 1: Questionnaire Return Rates

Police Force	Number Distributed	Number Entered	Response Rate	Number Returned N/A	Number Returned Refused
MTP	7,129	2779	38.9%	24	6
OPP	6,625	3,772	56.9%	23	1
RCMP	21,540	12,714	59.0%	212	47
SPCUM	8,025	3,328	41.5%	22	5
SQ	6,800	3,187	46.9%	2	5
ALL	50,119	25,777	51.4%	283	64

The average age was 47 years, 92% were male, 85% were married (including common law) and 78% had children. Of the respondents, 93% were non-commissioned officers, 66% were currently working in a police force and the average number of working years in the police forces was 20 years.

A total of 1,141 primary invasive cancers were reported by 1,073 members (4.2% of the respondents). Of these, 1,014 were male, 57 were female and in two cases gender

was not indicated. A summary of the distribution of these cancers by gender and site is given in Table 2. In particular, the most common cancer reported by both genders is melanoma. (This must be interpreted with caution as it may include non-invasive cancer (skin cancer)). The prevalence of cancer for selected sites for males in the police forces surveyed is summarized in Table 3. Bone tissue and skin (13.4 per 1000) and genital organs (12.7 per 1000) had the highest prevalence rates.

Table 2: Distribution of Primary Invasive Cancer Sites: All Departments

Number of police officers with invasive cancer = Male 1014 (4.3%), Female 57(2.9%), Overall 1073 (4.2%)

	Male		Female		Overall	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Blood & Lymph Tissues	**95**	**8.6**	**7**	**19.4**	**102**	**8.9**
Blood	35	3.2	1	2.8	36	3.2
Lymphoma & Non-Hodgkin's	30	2.7	3	8.3	33	2.9
Hodgkin's Disease	27	2.1	2	5.6	25	2.2
Other	7	0.6	1	2.8	8	0.7
Bone Tissue & Skin	**320**	**29.0**	**12**	**33.3**	**333**	**29.2**
Bone (unspecified)	12	1.1	0	0.0	12	1.1
Sarcoma	8	0.7	0	0.0	8	0.7
Melanoma	300	27.2	12	33.3	313	27.4
Brain	**13**	**1.2**	**0**	**0.0**	**13**	**1.1**
Eye	**6**	**0.5**	**0**	**0.0**	**6**	**0.5**
Digestive Organs	**129**	**11.7**	**0**	**0.0**	**130**	**11.4**
Colo-rectal	110	10.0	0	0.0	111	9.7
Stomach	9	8.2	0	0.0	9	0.8
Other	10	0.9	0	0.0	10	0.9
Genital Organs	**203**	**27.5**	**4**	**11.1**	**308**	**27.0**
Prostate	235	21.3	--	--	236	20.7
Testicular	67	6.1	--	--	67	5.9
Male other	1	0.1	--	--	1	0.1
Female other	--	--	4	11.1	4	0.4
Head & Neck	**40**	**3.6**	**0**	**0.0**	**40**	**3.5**
Salivary Gland	12	1.1	0	0.0	12	1.1
Other	28	2.5	0	0.0	28	2.5
Respiratory	**43**	**3.9**	**0**	**0.0**	**43**	**3.8**
Lung	39	3.5	0	0.0	39	3.4
Larynx	4	0.4	0	0.0	4	0.4

Urinary Tract	**93**	**8.4**	**2**	**5.6**	**95**	**8.3**
Bladder	66	6.0	0	0.0	66	5.8
Kidney	26	2.4	0	0.0	26	2.3
Other urinary	1	0.1	2	5.6	3	0.3
Breast	**1**	**0.1**	**7**	**19.4**	**8**	**0.7**
Endocrine Glands	26	2.4	3	8.3	**29**	**2.5**
Thyroid	23	2.1	3	8.3	26	2.3
Other	3	0.3	0	0.0	3	0.3
Other & Unspecified	**33**	**3.0**	**1**	**2.8**	**34**	**3.0**
Total	1102	100.0	36	100.0	1141	100.0

Table 3: Prevalence of Cancer (Male) for Selected Sites

	Prevalence per 1000
Blood & Lymph Tissues	**4.0**
Digestive Organs	**5.4**
Bone Tissue & Skin	**13.4**
Genital Organs	**12.7**
Head & Neck	**1.7**
Respiratory	**1.8**
Urinary Tract	**3.9**
Endocrine	**1.1**
Testicular	**2.8**
Melanoma	**12.6**

Approximately 67% of the respondents indicated that radar was part of their job. A wide variation in performing radar duties across the police forces was found with 25% of the SPCUM and 92% of the OPP indicating radar use. The average number of years performing radar duties was 8.2 with an average of 3.1 days per week and 4.8 hours per day. Usually both hand held and mounted radar units were used (60%), with only 10% and 30% using only hand held and mounted respectively.

Using the percentiles of the distribution of total exposure years for the overall sample, levels of exposure were classified as low, moderately low, moderate, moderately high, and high. Using this classification system, Table 4 provides a summary of exposure by police force.

Table 4: Distribution of Respondents by the Exposure Algorithm

Police Force	Exposure Level					
	None	Low	Moderately Low	Moderate	Moderately High	High
MTP	41.3	22.8	17.2	10.6	4.9	3.2
OPP	9.0	16.5	19.5	24.2	18.2	12.6
RCMP	33.1	17.7	15.8	16.5	10.5	6.5
SPCUM	77.8	10.1	6.2	3.6	1/9	0.6
SQ	26.8	11.6	21.4	24.5	11.2	4.5
ALL	35.6	16.3	15.9	16.3	9.9	6.0

Using the placement of the unit when it was active but not pointed at a car, behaviours were classified as: most risky (next to body or front seat area of car); risky (mounted inside or kept inside car excluding the risky and least risky locations); least risky (on dash pointing forward or mounted on outside of windows); and not risky (kept on outside of car). Overall, 45% of the respondents indicated behaviours considered most risky, with 24%, 66% and 18% of behaviours considered risky, least risky and not risky respectively.

The distribution of primary invasive cancer by exposure level is provided in Table 5 by police force. In general, cancer occurred most often in members that were not exposed and no trend in cancer with increasing levels of exposure was found.

Table 5: Distribution of Primary Invasive Cancer by Exposure

Police Force	Exposure Level						
	None	Low	Moderately Low	Moderate	Moderately High	High	Overall
MTP	6.7	3.3	3.0	3.7	2.4	3.8	4.7
OPP	10.2	3.5	4.6	3.7	6.0	6.4	5.2
RCMP	8.5	3.0	2.8	1.7	2.3	2.8	4.5
SPCUM	3.7	1.2	3.1	1.8	1.7	0.0	3.3
SQ	5.5	2.5	0.8	1.7	0.6	0.7	2.4
ALL	6.7	2.9	2.8	2.3	3.0	3.7	4.2

In particular for testicular cancer, the distribution by exposure indicated no trend with levels of exposure: no exposure 0.33%; low 0.20%; moderately low 0.16%; moderate 0.15%; moderately high 0.29% and high 0.41%.

Proposed risk factors for testicular cancer include undescended testis, testicular trauma and activities such as bicycling and horseback riding. Overall, 4.7% of the respondents indicated that they were born with undescended testicle(s) and 11.4% indicated a severe injury or trauma to the testicles.

SUMMARY

With respect to the study objectives the following was found:

(1) Prevalence of testicular cancer was 2.8 per 1000.

(2) Prevalence of other cancers are given in Table 3. In particular, the most common cancer reported by both genders was melanoma with a prevalence of 12.6 per 1000. This must be interpreted with caution as it may include non-invasive cancer (i.e. skin cancer). This is currently under investigation in a follow-up study.

(3) Although a wide variation was found across the police forces, approximately 67% of the respondents indicated that radar was part of their job. The average number of years performing radar duties was 8.2 years. Usually both hand held and mounted radar units were used.

To help interpret these results two points should be noted. First, no trend in cancer with increasing levels of exposure to RADAR was found. Second, a companion study involving the RCMP highway patrol had been undertaken which indicated no increase incidence of cancer, except for melanoma (which is currently under investigation). For this initiative, a historical cohort design was used in which a group in the RCMP were identified at some point in the past and analysis of their subsequent morbidity experience during the observation period analyzed. The study design was conceptually longitudinal with a time interval extending from the past to the present. The specific results from this study are provided in Table 6.

Table 6: Standardized Incidence Ratios Among the Living Cohort of the RCMP Study

	SIR (O/E)	95% Confidence Interval	
		Lower	Upper
All Cancers	**0.97**	**0.82**	**1.15**
Melanoma	**6.31**	**4.68**	**8.33**
Male Genital Organs	**1.03**	**0.64**	**1.58**
Testicular	**0.84**	**0.31**	**1.85**
Urinary Organs			
Kidney	**1.65**	**0.79**	**3.03**