Ministry of
Health and Long-Term Care

PHERO

Public Health and
Epidemiology Report Ontario

Volume 12, Number 9 October 27, 2001

IN THIS ISSUE

Erratum

The September issue of PHERO should have read Volume 12, Number 8, not Number 7.

A replacement page for the September issue has been included for your convenience.

The Public Health and Epidemiology Report Ontario is published monthly, by the:

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The contribution of scientific articles by the staff of local Boards of Health is invited. Address all inquiries and submissions to the Editor.

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ISSN 1181-960X

BULLETINS and NOTICES

ONTARIO'S ROAD SAFETY RECORD NOW BEST IN CANADA

The Ministry of Transportation (MTO) has released the Ontario Road Safety Annual Reports (ORSAR) for 1998 and 1999. ORSAR is a compilation of Ontario motor vehicle collision data.

Using 1999 ORSAR statistics and the latest data from other jurisdictions, MTO determined that Ontario now ranks first in Canada and second in North America (Massachusetts is first) based on the number of fatalities per 10,000 licensed drivers.

Both 1998 and 1999 ORSARs contain good news for Ontario: the 1998 report indicates Ontario continues to improve on the road user safety front with the lowest fatalities since 1950; according to the report, 1999 marks the 11th consecutive year Ontario has recorded a decrease in its fatality rate per 10,000 licensed drivers. The number of fatalities per 10,000 licensed drivers is a commonly used measure of road user safety in North America and in many other countries, which allows us to compare our performance against other jurisdictions.

All provinces and territories provide annual data to Transport Canada, which compiles the Canadian Motor Vehicle Traffic Collision Statistics. Information about U.S. states is obtained

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from the Insurance Institute for Highway Safety (IIHS) in Arlington, Virginia.

1998 ORSAR Highlights

- a 17 per cent decrease in the number of fatalities in collisions involving large trucks in 1998 over 1997
- a decrease in fatal collisions involving drinking drivers of more than 14 per cent in 1998 over 1997
- a five per cent decrease in the number of fatalities in all collisions between 1997 and 1998 (899 in 1997 and 854 in 1998)

1999 ORSAR Highlights

- a further decrease of 4.5 per cent in the number of fatal collisions involving drinking drivers
- a decrease in the fatality rate per 10,000 licensed drivers from 1.11 in 1998 to 1.10 in 1999
- no increase in the number of fatalities in collisions involving large trucks, despite an increase of more than six per cent in the number of large trucks registered in Ontario.

For more information visit www.mto.gov.on.ca/english (Note that ORSAR reports are now available online.)

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SOURCE & CONTACT

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YOU AND YOUR PRETEEN

Parent Information Sheets on Growth and Development

In the past, preteens have said that parents "don't have a clue" about what they are experiencing during their growth and development. Public Health Nurses from the City of Ottawa felt that parents did, but wanted to speak with both parents and children to confirm their impressions.

During the spring of 2000, discussion groups with parents and preteens were held across the city of Ottawa. Sessions focused on a variety of issues relating to the physical, social, emotional, and cognitive development of children between the ages of 10 to 14. Parents were also asked what it was like to be a parent of these children. Based on the information collected during these groups, the You and Your Preteen series of information sheets were developed. Following the pilot phase, minor changes were made and they are now ready for distribution. The cost for a unilingual set of 5 information sheets (English or French) is $6.50 and a bilingual (English and French) set is $10.00. To receive a set or for more information, please contact Public Health Nurse Dawn Grakist (724-4122 extension 26216; e-mail Dawn.Grakist@city.ottawa.on.ca) or Monique Traversy-Wong (724-4122 extension 26238; e-mail Monique.Traversy-Wong@city.ottawa.on.ca).

- You and Your Preteen: Puberty/Hygiene
- You and Your Preteen: Feelings;
- You and Your Preteen: Thinking;
- You and Your Preteen: Relationships;
- You and Your Preteen: Resources;

- Vous et votre préado: La puberté/L'hygiène
- Vous et votre préado: Émotion
- Vous et votre préado: La pensée
- Vous et votre préado: Les relations
- Vous et votre préado : Ressources

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EMERGENCY RESPONSE TO RACCOON RABIES INTRODUCTION IN ONTARIO

REPRINTED FROM THE JOURNAL OF WILDLIFE DISEASES VOL. 37, NO. 2, APRIL 2001. THE WILDLIFE DISEASE ASSOCIATION HOLDS THE COPYRIGHT.

ABSTRACT

During 15 July to 4 October, 1999, rabies control programs were implemented with the objective being to contain the first three confirmed cases of raccoon rabies in Canada. The strategy, called point infection control (PIC) involved the use of three tactics: population reduction (PR), trap-vaccinate-release (TVR) and oral rabies vaccination with baits (ORV), to control the spread of raccoon rabies. A total of 1,202 raccoons (*Procyon lotor*) and 337 skunks (*Mephitis mephitis*) were captured and euthanized using 24,719 trap-nights in the three PR zones around the location of the three rabies cases, near Brockville, Ontario. That represented an 83% to 91% reduction in the raccoon populations in an approximate 225 km^2 area around the three rabies cases. Raccoon density in the PR zones declined from 5.1-7.1/km^2 to 0.6-1.1/km^2 following control. All tested specimens were negative for rabies by the fluorescent antibody test (FAT). In addition, 1,759 raccoons and 377 skunks were intramuscularly (IM) vaccinated against rabies and released using 27,956 trap-nights in an approximate 485 km^2 TVR zone implemented outside of the PR zones. A total of 856 cats from both PR and TVR areas were also captured, vaccinated and released. Cost for the three PIC operations was $363,000.00 Cdn or about $500.00 Cdn/$km^2$. To further contain the outbreak, about 81,300 baits containing Raboral® V-RG oral rabies vaccine were aerially distributed on September 8 and 27, 1999, to create an 8-15 km wide buffer zone (1200 km^2 area) of vaccinated raccoons immediately beyond the PR and TVR zones. This was the first time that V-RG was used in Canada to orally vaccinate free ranging raccoons against rabies. Baiting costs were $241,000.00 Cdn or about $200.00 Cdn/$km^2$ including post baiting assessment costs. As of 31 August, 2000, thirty-five additional cases (38 in total) of raccoon rabies have occurred in the control and vaccination zones. This number is far below the level of rabies prevalence in U.S. jurisdictions where raccoon rabies was epizootic. In the future, PIC methodologies will continue to be used in Ontario to contain isolated cases of raccoon rabies.

Key words: *Mephitis mephitis*, *Procyon lotor*, rabies, oral vaccination, raccoon rabies, rabies control program, striped skunk.

INTRODUCTION

During the early 1990's, raccoons (*Procyon lotor*) found to be infected with a specific reported variant of rabies virus (referred to as raccoon rabies) were very close to the Ontario, Canada, border in the vicinity of Niagara Falls, New York, USA. As a result, staff from the Ontario Ministry of Natural Resources (OMNR) and its provincial and federal partners designed and implemented a contingency plan to prevent the disease from becoming enzootic in Ontario (Rosatte et al., 1997). Part of that proactive plan included creating buffer zones of vaccinated raccoons along the New York/Ontario International border using a method called trap-vaccinate-release (TVR) (Rosatte et al., 1992a; Rosatte et al., 1997). Despite those efforts, three cases of raccoon rabies in eastern Ontario (north of the vaccination zones) were confirmed by Canadian Food Inspection Agency (CFIA) staff during July-September 1999. These were the first confirmed cases of the raccoon variant of rabies in Canada (Wandeler and Salsberg, 1999).

The first case of raccoon rabies (14 July, 1999) occurred in a juvenile raccoon found dead in a dog kennel (with 3 dogs that were later euthanized) on a rural residential property (near Domville, Ontario) about 5 km NW of Prescott, Ontario (44^0 45'N, 75^0 35' W). OMNR, Rabies Research Unit staff immediately implemented a PIC program to contain the case. Before that operation was complete, the second case was confirmed by the CFIA on 26 July, 1999. The animal in question was an adult female raccoon that had attacked a dog on a rural residential property about 15 km north of Brockville near the village of Jellyby, Ontario (44^0 45'N, 75^0 50' W) (15 km west of the location of the first case) (Fig.1).

The OMNR subsequently moved another team of trappers into the zone on 27 July, 1999, to implement a second PIC program. On 17 September, 1999, the third case of raccoon rabies (an adult female raccoon) was confirmed in Ontario. This case was located 15 km

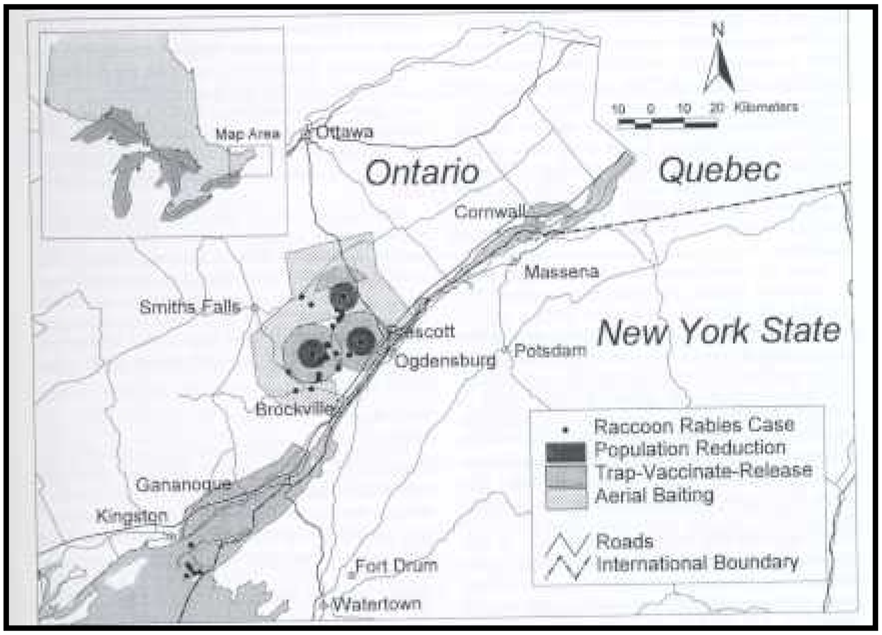

FIGURE 1. Location of the 38 cases of raccoon rabies including the population reduction (PR), trap-vaccinate-release (TVR) and aerial baiting zones in Ontario, Canada, 14 July 1999 to 31 August 2000. Raboral ® Vaccina-Rabies Glycoprotein (V-RG) baits were used in the aerial baiting zones.

north of the first case. This animal had been wandering aimlessly in a small residential community in rural eastern Ontario and was euthanized by a resident (5 km S.W. of the village of Oxford Station - 44^0 55'N, 75^0 35' W) (Fig.1). OMNR staff implemented another PIC operation on 20 September, 1999. As a precautionary measure about 81,300 rabies vaccine baits [Raboral® Vaccinia-Rabies Glycoprotein (V-RG)]; Merial, (Athens, Georgia, USA) were aerially dropped (on 8 and 27 September, 1999) outside of the TVR zones to further augment the control of the three cases of raccoon rabies.

Since the PIC operations were completed, 35 additional cases of raccoon rabies have been confirmed in Ontario (to 31 August, 2000). Twenty-nine of those were within the PIC zones and 6 occurred on Wolfe Island, where a TVR program had been implemented during July 1999 (Fig.1). This paper reports on the actions taken in response to the first cases of raccoon rabies in Canada.

METHODS

General

Upon receiving notification that Ontario had its first case of raccoon rabies, the "Point Infection Control Strategy" document (Rosatte, 1999) was reviewed by OMNR Rabies Research Unit staff and appropriate agencies/staff were notified to assist with the implementation of the plan. Within 24 hrs of notification of the first case, OMNR Rabies

Research Unit staff had moved a team of 15 trappers and eight support staff into the area to initiate a PIC Program. PIC involves the use of population reduction (PR), TVR and oral rabies vaccination (ORV) methodologies. Using PR, raccoons and skunks (*Mephitis mephitis*) are live-trapped and euthanized by injection while TVR includes live-trapping raccoons and skunks, vaccinating against rabies by injection and releasing the animal at the point of capture. ORV involves the distribution of baits containing liquid rabies vaccine. Raccoons are vaccinated when they orally contact liquid rabies vaccine while chewing the vaccine bait. Trapping effort in both PR and TVR areas was designed to be very intense so that the majority of raccoons and skunks would be removed from the PR area and the majority of raccoons and skunks in the TVR areas would be vaccinated against rabies .

Trapping commenced on Thursday, 15 July, 1999. The target zone for the PIC operation included a 300 km^2 area defined by a 10 km radial area around the location of the first rabies case (Fig.1). The area was divided into 30 trapping cells or pre-defined areas to be trapped. The PIC plan included live-trapping and euthanizing all raccoons and skunks captured within a 5 km radius of the case location (Fig.1). This was called the PR zone. That zone was about 75 km^2 in area and was divided into eight trapping cells each one being about 10 km^2 in area. Trappers gained verbal permission directly from landowners before setting traps on private property. Each of eight trappers assigned to those cells set about 100 live-traps (#106, #108 Tomahawk, Tomahawk Live-Trap Co., Tomahawk, Wisconsin, USA) for 7 consecutive nights in each trapping cell. Sardines were used as bait. All captured raccoons and skunks from the PR zone were brought to a field lab located in a vacant OMNR building north of the control zone at Limerick Forest. Raccoons and skunks were immobilized with an intramuscular (IM) injection of 1-2 ml (100 mg/ml) of ketamine hydrochloride (Ketaset-Rogar/STB Inc., London, Ontario, Canada). About 10 cc of blood was collected from all raccoons and skunks via cardiac puncture using 10 ml Vacutainer serum separation tubes and 22 gauge needles (Becton Dickinson, Oakville, Ontario, Canada). Blood was centrifuged, sera collected and stored in 2 ml provials (Sarstedt Inc., St. Leonard, Quebec, Canada), frozen (-21^{0}C) and later transported to CFIA, Nepean, for detection of rabies neutralizing antibody using an ELISA test. All raccoons and skunks were then euthanized with an intracardiac injection of 1-2 ml of T-61 euthanasia solution (Hoechst Canada, Inc., Regina, Saskatchewan, Canada) following anesthesia. Brain samples were collected (via syringe) from all euthanized raccoons and skunks, frozen and transported to CFIA diagnostic laboratory in Nepean, where they were examined using a fluorescent antibody test (FAT) as described by Webster and Casey (1988). Carcasses were transported and incinerated at the Agricultural College (Kemptville, Ontario).

While the PR program was being implemented, a TVR program was initiated at the same time, in the area immediately adjacent to the PR zone (Fig.1). All raccoons and skunks captured 5-10 km (225 km^2 - 22 trapping cells) from the case location were vaccinated with Imrab® 3 inactivated rabies vaccine (Merial Inc.) via IM injection, fitted with ear tags (numbered size 1 and 2)(National Band and Tag Co., Newport, Kentucky, USA) for identification and released at the point of capture. Seven trappers were assigned to those cells and utilized the same trapping effort (i.e. 100 traps/trapper/night) as during the PR operation. During the next 7 nights the 15 trappers from both PR and TVR zones trapped the remaining cells in the TVR area.

All cats trapped within both PR and TVR zones were vaccinated (Imrab 3) and released. Trappers who were designated as inspectors during the operation, were approved by CFIA to vaccinate cats pursuant to section 48 of the Health of Animals Act.

After the OMNR trappers completed trapping the PR zone (after the initial 7 nights of trapping) 12 trappers from the Ontario Fur Managers Federation were hired to trap raccoons and skunks within the PR zone for an additional 7 nights to capture and euthanize any raccoons or skunks that the OMNR team missed. All animals were processed as described above.

During the second PIC operation, all raccoons and skunks captured within 5 km of the case location were euthanized. In addition, all raccoons and skunks captured between 5 and 10 km from the case location were vaccinated (Imrab 3) and released. The second PIC zone (Fig.1) was divided into 22 trapping cells (7 in the PR zone and 15 in the TVR area). There were fewer trapping cells in the second PIC zone (compared to the first zone) as part of the 10 km radial area was trapped during the first PIC operation. Trapping cells in the second zone were also slightly larger than those in the first zone because of the orientation of roads. Eleven trappers were used for the PR and TVR operations over 14 nights. Six trappers were used to re-trap the PR zone for an additional 7 nights.

Since the third case of raccoon rabies (Fig.1) occurred within the area that received Raboral® V-RG baits on September 8/99, a full PR program but only a partial TVR program was implemented (i.e. TVR was not implemented in the portion of the 10 km radial zone around the case location that received ORV baits). A full PR program was warranted as sufficient time had not passed to allow raccoons to develop full immunity following contact with vaccine in the baits (Hanlon et al., 1998). The third PIC zone was divided into 12 trapping cells (7 for the PR zone and 5 for the TVR area). As with the first two operations, all raccoons and skunks within a 5 km radius of the location of the third case of raccoon rabies were euthanized following capture. For the PR operation (75 km^2 area), 7 trappers were utilized over a 7 night period. The area was then re-trapped for 7 nights with 7 different trappers. The 60 km^2 TVR area was trapped for 7 nights using 5 trappers. All raccoons, skunks and cats were vaccinated in the TVR area as during the first two PIC operations. Cats were also vaccinated and released in the PR zone.

As 11 cases of raccoon rabies occurred during December 1999 and January 2000 within areas where either a PR or TVR program had been completed during 1999, additional full PIC operations were not initiated in response to the additional cases. However, a public awareness campaign was increased through door-to-door notification of residents in the vicinity of the 11 cases. Surveillance was also increased through requesting residents to report any abnormal acting raccoons, and two Ontario Fur Manager Federation trappers were hired to trap and euthanize raccoons in the immediate vicinity around the 11 case locations during January 2000.

Mean raccoon population density and standard error (SE) estimates were calculated by input of capture/recapture data from the TVR programs into a software version of the modified Petersen model as used in Krebs (1989). A catch/unit effort removal model (Leslie plot with linear regression) was used to estimate mean raccoon density and SE with data from the PR programs (Krebs, 1989). Percent vaccinated estimates were determined by dividing the number of different raccoons vaccinated in a given area by the estimated raccoon population size and multiplying that by 100. Percent removal estimates were calculated by dividing the number of raccoons euthanized by the estimated population size and multiplying that by 100.

The habitat where the PIC programs were implemented, centered in the villages of Jellyby, Domville, and Oxford Station, Ontario, was a combination of agricultural pastureland/cropland, blocks of deciduous and coniferous forest, interspersed with wetland areas. Human population density was very low as the majority of the area was farmland and forest with a few small villages.

V-RG Baiting

During August 1999 a formal application was forwarded to the CFIA, Veterinary Biologics and Biotechnology Section (Nepean, Ontario), to approve use of Raboral © V-RG (Merial Inc., Athens, Georgia, USA) oral rabies vaccine in baits in Ontario to assist with the control of raccoon rabies. Approval was granted by the CFIA in early September 1999. This was the first time that Raboral® V-RG had been approved for field use in Canada. On 8 September, 1999, about 50,000 baits containing Raboral® V-RG were distributed aerially (using 2 OMNR de Havilland Twin Otter aircraft) in an 8-10 km wide zone around the outer perimeter of the first two PIC operations (Fig. 1). About 23,000 of the baits were Merial Fishmeal Polymer (FP) baits containing Raboral® V-RG. The remaining 27,000 baits were Ontario Slim baits (manufactured by Artemis Technologies Inc., Guelph, Ontario). These also contained liquid V-RG vaccine (the bulk vaccine was purchased from Merial Inc.). Target bait density was 70 baits/km^2 with flight line spacing of about 1 km.

Following notification of the third case of raccoon rabies, about 31,300 Raboral® V-RG FP baits were deployed aerially (on 27 September, 1999) in a 450 km^2 area north of the location of the third case of raccoon rabies (Fig. 1). Bait density and flight line spacing were the same as on 8 September, 1999.

RESULTS

PIC Operation # 1 - Domville area

Twenty-seven different trappers utilized 24,973 trap-nights to capture 2,258 animals during the first PIC program from 16 - 30 July, 1999 (Table 1).

The total included the 487 raccoons and 93 skunks from the PR zone (75 km^2 area) that were euthanized and submitted to the CFIA for rabies testing. All were negative for rabies by FAT. About 89% (423/487) of the raccoons from the PR zone were captured during the first seven nights of trapping (14 nights in total) (Fig. 2). Estimated raccoon density in the PR zone prior to control was 7.1 ± 0.4/km^2 ($\bar{x}$ ± SE). Post control raccoon density was 0.6 ± 0.3/km^2. About 91% of the raccoons in the PR zone were euthanized.

A total of 767 different raccoons, 199 different skunks and 281 cats (including those in the PR zone) were trapped, vaccinated (intramuscularly with Imrab 3) and released in the TVR zone (225 km^2 area) (Table 1). A total of 105 non-target animals were captured and released including 35 rabbits (Leporidae), 19 woodchucks (*Marmota monax*), 9 muskrats (*Ondatra zibethicus*), 6 gray squirrels (*Sciurus carolinensis*), 11 porcupines (*Erethizon dorsatum*), 8 fishers (*Martes pennanti*), 6 turtles (*Emydinae*), 2 rats (*Rattus* sp.), 2 mice (Sigmodontinae), 1 fox (*Vulpes vulpes*), 1 frog (Ranidae), 1 mink (*Mustela vison*) and 4 birds.

The estimated raccoon density in the 225 km^2 TVR zone was about 4.5 ± 0.4/km^2. About 77% (767/1003) of the estimated raccoon population in the TVR zone was vaccinated using a trapping effort of 66 trap-nights/km^2 (Fig. 3).

PIC operation # 2 - Jellyby area

Seventeen different trappers utilized 18,946 trap-nights to capture 1,966 animals during the second PIC program

Table 1
Trapping effort for the first point infection control program at Domville, Ontario, July 16-30/99.

Zone	Number of trappers	Number of trap-nights	Different raccoons	Recaptured raccoons	Different skunks	Recaptured skunks	Cats vaccinated
PR zone[a] (days 1-7)	8	6,188	423	0	83	0	98
TVR zone[a] (days 1-7)	7	4,627	255	77	86	37	68
PR zone (days 8-14)	12	4,000	64	0	10	0	0
TVR zone (days 8-14)	15	10,158	512	156	113	56	115
Total euthanized			487	0	93	0	0
Total vaccinated			767	233	199	93	281
Totals	27 (d)[a]	24,973	1,254	233	292	93	281

[a]d=different trappers; PR zone = population reduction zone; TVR Zone = trap vaccinate-release zone

from 28 July - 10 August, 1999 (Table 2). That included the 385 raccoons and 116 skunks from the PR zone (75 km^2 area) that were euthanized and submitted for rabies testing. All were negative for rabies by FAT. About 82% (315/385) of the raccoons from the PR zone were captured during the first 7 nights of trapping (14 nights in total) (Fig. 2). Estimated raccoon density in the PR zone prior to control was about 6.5 ± 0.6/km^2. Raccoon density as a result of the PR program declined to 1.1 ± 0.5/km^2. About 83% of the raccoon population in the PR zone was euthanized.

A total of 785 different raccoons, 223 different skunks and 290 cats (including those in the PR zone) were trapped, vaccinated (with Imrab) and released in the TVR zone (200 km^2 area) (Table 2). A total of 96 non-target animals were captured and released including 27 rabbits, 13 squirrels, 12 porcupines, 12 muskrats, 12 fishers, 8 woodchucks, 4 birds, 2 weasel (*Mustela sp.*), 1 turtle, 1 rat, 1 beaver (*Castor canadensis*), 1 coyote (*Canis latrans*), 1 dog (*Canis sp.*), and 1 mink.

The estimated raccoon density in the 200 km^2 TVR zone was about 7.2 ± 0.5/km^2 . About 55% (785/1440) of the estimated raccoon population in the TVR zone was vaccinated using a trapping effort of 46 trap-nights/km^2 (Fig. 3).

PIC Operation # 3 - Oxford Station area

Table 2
Trapping effort for the second point infection control program at Jellyby, Ontario, July 28-August 10, 1999.

Zone	Number of trappers	Number of trap-nights	Different raccoons	Recaptured raccoons	Different skunks	Recaptured skunks	Cats vaccinated
PR zone[a] (days 1-7)	7	4,734	315	0	102	0	88
TVR zone[a] (days 1-7)	4	2,647	189	53	32	23	62
PR zone (days 8-14)	6	4,000 estimated	70	0	14	0	0
TVR zone (days 8-14)	11	7,565	596	172	75	27	140
Total euthanized			385	0	116	0	0
Total vaccinated			785	225	107	50	290
Totals	17 (d)[a]	18,946	1,170	225	223	50	290

[a] d=different; PR zone = population reduction zone; TVR zone = trap-vaccinate-release zone

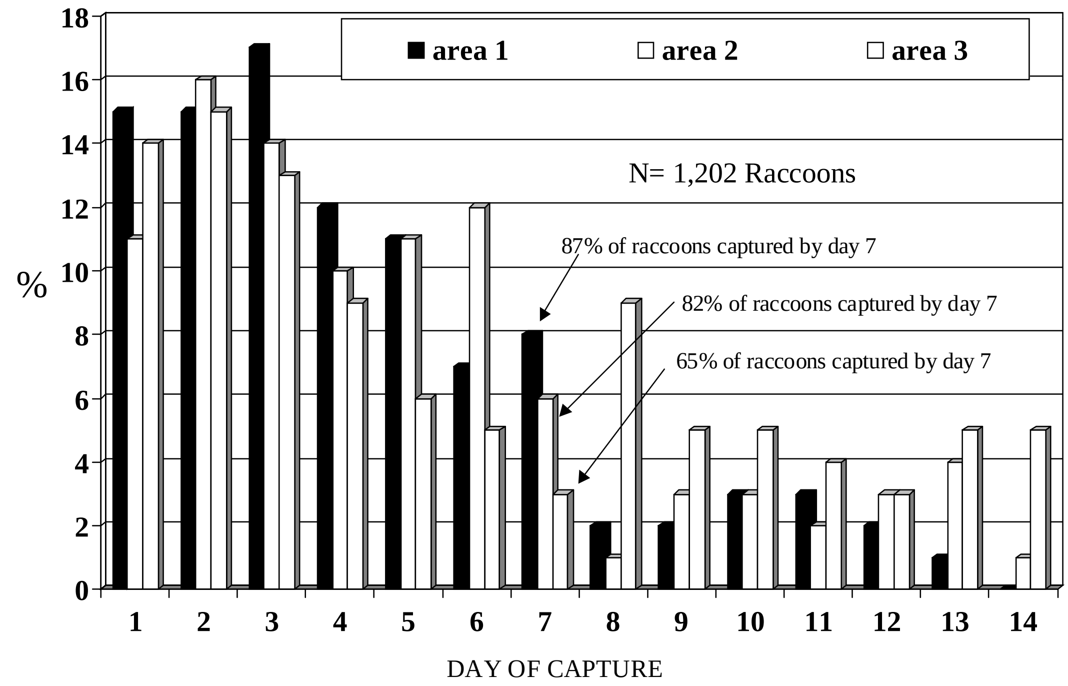

FIGURE 2. Number of raccoons captured per night in relation to total raccoon captures during 14 nights of trapping in the first three point infection control programs in Ontario, Canada, July-August 1999.

Nineteen different trappers utilized 8,756 trap-nights to capture 1,143 animals during the third PIC program from 20 September - 4 October, 1999 (Table 3). That included the 330 raccoons and 128 skunks from the PR zone (75 km^2 area) that were euthanized. About 65% (214/330) of the raccoons from the PR zone were captured during the first 7 nights of trapping (14 nights in total) (Fig. 2). Estimated raccoon density in the PR zone prior to control was about 5.1 ± 0.4/sqkm. Post PR program raccoon density was 0.72 ± 0.3/km^2). About 86% of the raccoons in the PR zone were euthanized.

A total of 207 different raccoons, 71 different skunks and

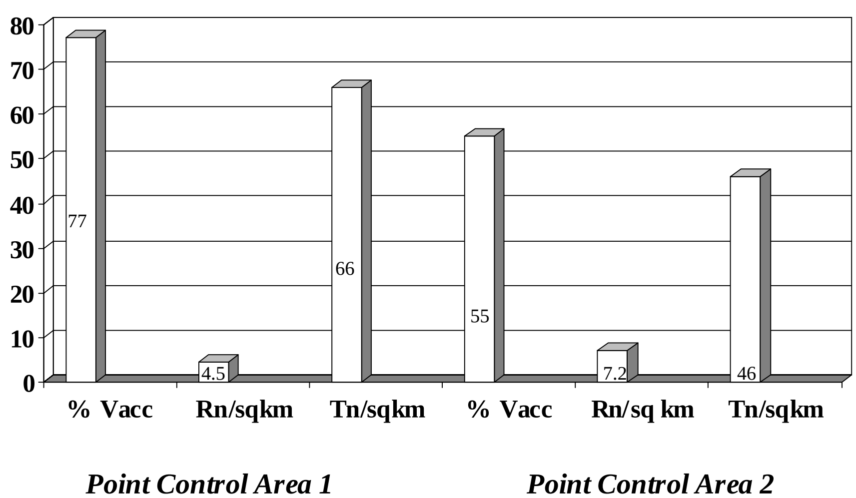

FIGURE 3. Comparison of the percentage of raccoons vaccinated, raccoon density and trapping efforts between the first two point infection control programs in Ontario, Canada during July-August 1999. % Vacc = percent vaccinated; Rn/sqkm = Raccoons per square kilometre: Tn/sqkm = Trap-nights/km^2

Table 3
Trapping effort for the third point infection control program near Oxford Station, Ontario, September 20-October 4, 1999.

Zone	Number of trappers	Number of trap-nights	Different raccoons	Recaptured raccoons	Different skunks	Recaptured skunks	Cats vaccinated
PR zone[a] (days 1-7)	7	4,039	214	11[a]	89	0	113
TVR zone[a] (days 1-7)	5	2,959	207	37	71	38	140
PR zone (days 8-14)	7	1,758	116	0	39	0	32
Total euthanized	-	-	330	0	128	0	0
Total vaccinated	-	-	207	37	71	38	285
Totals	19	8,756	537	48	199	38	285

[a] recaptures were ear-tagged animals that dispersed from the TVR zone; PR zone = population reduction zone; TVR Zone = trap-vaccinate-release zone

285 cats (including those in the PR zone) were trapped, vaccinated (with Imrab) and released in the TVR zone (60 km^2 area) (Table 3). A total of 36 non-target animals were captured and released including 13 rabbits, 6 squirrels, 5 porcupines, 7 fishers, 2 dogs, 1 bird, 1 beaver, and 1 mink. Raccoon density and percent vaccinated estimates for the TVR area were not calculated as the area (60 km^2) in question was deemed too small for confident estimates.

Trapping in the vicinity of raccoon rabies cases 4-14

Two trappers accumulated a total of 840 trap-nights during 5 to 12 January, 2000. Capture success included 13 raccoons (1 ear-tagged animal), 11 skunks (5 ear-tagged) and 30 cats. All tested animals were negative for rabies by FAT.

Media/Communications

The first case of raccoon rabies elicited intense media interest. Interviews were given to more than 75 different reporters during the 3 wk following the first case. A toll free rabies hotline telephone number was available to the public for raccoon rabies related inquiries. A total of 518 calls were documented during 26 July to 19 August,1999. Those calls were related to the media (22%), suspect rabid animals (27%), general rabies information (8%), nuisance animals (11%) and other issues (32%).

Costs for PIC operations

The total cost for the three PIC control programs was about $285,000.00 Cdn. However, traps and supplies had to be replenished which brought the total cost to about $363,000.00 Cdn. This is equivalent to a cost of about $500.00 Cdn/$km^2$. The distribution of costs is shown in Table 4. The cost to purchase vaccine, manufacture and distribute 81,300 V-RG baits was about $241,000.00 Cdn. including post baiting assessment costs, equivalent to a cost of about $200.00 Cdn/$km^2$.

DISCUSSION

Ontario has the unwanted distinction of being the first Province to confirm the raccoon variant of rabies in Canada. It is unknown how the disease made its way into the Province. In all likelihood, the first three cases probably represented a natural extension of an epizootic that was present in the Ogdensburg, St. Lawrence County area of New York State during 1998-99. In fact, 203 cases of rabies involving raccoons and skunks were reported in St. Lawrence County during the 18 mo period (1 January, 1998-30 June, 1999) immediately preceding the outbreak in Ontario (Trimarchi, 1998, 1999). The front of a raccoon rabies epizootic can progress 60 km or more during one year, lending further support to the theory of natural progression of the disease (Winkler and Jenkins, 1991). Only the St. Lawrence River separates Ogdensburg and the area of Ontario where raccoon rabies was found. The river is only about 1 km wide at that point and we have 6 documented instances of ear-tagged raccoons moving from Ontario to New York. However, one cannot discount the role that

Table 4
Costs (Cdn) to implement three point infection control programs in Ontario, Canada, during July-October, 1999.

Salary costs-37 trappers, 8 support staff	$194,500.00
Vehicle lease/gas/mileage	$25,500.00
Accommodation/meals	$21,500.00
Contracts (security/maintenance etc)	$9,600.00
Equipment	$18,000.00
OMNR District support (field lab)	$6,000.00
Incinerator costs	$8,000.00
Replenish traps	$55,000.00
Replenish supplies	$25,000.00
Total costs	$363,100.00

proactive TVR programs on the Ontario side of the Niagara and St. Lawrence Rivers, initiated in 1994 and 1995 respectively, played in slowing the progression of the disease (Rosatte et al., 1997). Raccoon rabies was present in St. Lawrence County, New York, during 1998/99, and the TVR programs may have delayed the progression of the disease into eastern Ontario. As well, raccoon rabies has been in Niagara County, New York, since the mid 1990's and despite evidence that raccoons travel across the Niagara River (through re-capture of ear-tagged raccoons), the disease has yet to be confirmed in Niagara Falls (Ontario).

Despite the evidence for natural progression of the disease into Ontario, human assisted transport of raccoons cannot be discounted as being responsible for the first cases of raccoon rabies in the Province. In Massachusetts, the disease apparently jumped 100 km from Connecticut due to raccoons being transported by refuse trucks (Wilson et al., 1997). In Ontario, there have been 15 reported instances during 1996-98 where raccoons were transported via tractor trailers from the raccoon rabies enzootic area of the United States into the Greater Toronto area of Ontario. Although it is illegal to relocate raccoons by provincial legislation in Ontario under the Fish and Wildlife Conservation Act, many animal control agencies as well as the general public still relocate raccoons.

The key to the successful implementation of the PIC programs was the fact that a raccoon rabies contingency plan had been in place since 1993 (Rosatte et al., 1997). This allowed for the rapid deployment of staff as soon as the first case was confirmed as the raccoon variant of rabies. Intergovernmental communications worked exceptionally well so that all agencies were informed of the plan to contain the case the day that the plan was implemented. The communication links that were in place were so effective that trappers were at the site within 24 hrs of confirmation of the first case. This rapid response was critical to allow for the removal of any animals that may have been incubating the disease (as well as other clinical animals) and prevent the spread of raccoon rabies to the rest of Ontario.

Efficacy of the PIC strategy

If population reduction is to be an effective raccoon rabies control tactic, a significant portion of the vector population must be removed so that the potential for transmission from infected to susceptible individuals is minimal. An estimated 83% to 91% of the raccoons in the PR zones around the three raccoon rabies case locations were euthanized. As a result, raccoon density in the PR zones decreased significantly from 5.1-7.1/km^2 to 0.6-1.1/km^2. This minimal density is probably below that necessary for raccoon rabies to persist.

There is also a good chance that there were few clinically rabid raccoons in the containment area. This is due to the fact that there was a very intensive trapping campaign for 14 continuous nights. With 44 trappers (and many support staff) in the target area for that period of time, any abnormally behaving raccoons should have been encountered. All residents in the area were aware of the program and were on the look-out for rabid raccoons. Therefore, chances are good they would have noticed any additional rabid raccoons.

An estimated 77% of the raccoons in the TVR area around the first case of raccoon rabies were captured and vaccinated against rabies. However, only 55% of the raccoons were captured and vaccinated in the TVR area around the second rabies case. This difference was expected due to a greater trapping effort in area 1 (66 trap-nights/

km^2) as opposed to area 2 (46 trap-nights/km^2). Raccoon density was higher in area 2 (7.2 raccoons/ km^2) compared to area 1 (4.5 raccoons/ km^2). Higher raccoon density and lower trapping effort resulted in fewer raccoons being captured. The lower vaccination level may in part explain why 15 additional cases of raccoon rabies were confirmed in the TVR area of the second PIC operation during January to August 2000 (Fig.1). During 2000, trapping effort will be increased in any TVR operations to maximize the percentage of the raccoon population that are vaccinated against rabies.

Capture results from the first two PIC programs should not be compared to control of the third rabies case. This is due to the fact that the third case occurred within an area that had been baited with V-RG. As a result, a less intensive TVR program was completed (60 km^2 area compared to 225 and 200 km^2 areas in PIC operations 1 and 2, respectively). As the third case occurred in late September, the PIC program was not completed until early October. Cooler weather and less abundant food sources tend to slow raccoon movements making them more difficult to capture. For example, in PIC operation 3, only 65% of the total animals captured were taken by the seventh of fourteen nights of trapping (compared to more than 80% during the July control programs).

Justification for PR methodologies

The use of PR as a rabies control tactic is controversial. Some publications document apparent success at controlling rabies using PR while others were unsuccessful (MacInnes, 1988; Rosatte et al., 1986). However, most studies resulting in failure used PR in a rabies epizootic/enzootic situation. In Ontario, raccoon rabies was isolated to one specific area and control was implemented with the first reported case, before the disease reached a state where it was enzootic or well established.

We feel justified in using PR (along with TVR and ORV) to control isolated cases of raccoon rabies in Ontario. In Jeffersen/St.Lawrence counties, New York, ORV without PR or TVR was not successful at containing isolated cases of raccoon rabies during 1998/99. However, ORV has been successful in areas such as Massachusetts and New Jersey to stop advancing epizootics of the disease, as opposed to responding to a point source infection (Robbins et al., 1998; Roscoe et al., 1998).

Population reduction is the most effective means to remove animals that may be incubating rabies from the population (it is generally believed that vaccination will not work on animals in the later stages of incubation). As the morbidity period of raccoon rabies can be 2-8 days (Winkler and Jenkins, 1991) (at which time the animal may be infectious) there would have been ample opportunity for the three initial rabid raccoons to infect other animals in the area. This is evidenced by the fact that two additional cases of raccoon rabies occurred in the TVR zone around the second case during December 1999.

About 1,200 raccoons were euthanized to contain the first three reported cases of raccoon rabies. Had the disease not been contained, raccoon rabies could have spread rapidly across southern Ontario as the Province has about 1 million raccoons (Rosatte, 2000). In Connecticut, mortality rates as high as 60%-80% have been estimated for raccoons subjected to a raccoon rabies epizootic (Clavette, 1996). By euthanizing a few hundred raccoons in Ontario through the PIC programs and containing raccoon rabies to a small area, countless raccoons and other animals will have been spared certain death due to rabies. This is not to mention increased human exposures (2,000-4,000/yr) and rabies associated costs ($8-12 Million Cdn/yr).

Logic behind vaccination of skunks and feral and domestic cats

Raccoons account for the majority of animals diagnosed with rabies where the raccoon strain is established. In the USA, 50% of the total rabies cases were reported in raccoons during 1996 (3,595/7,881) (Krebs et al., 1997). In New York, raccoons accounted for 63% to 81% of the total rabies cases reported during 1991-1998 (Trimarchi, 1991-1998). However, skunks are also susceptible to the raccoon variant of rabies. This is evidenced by the fact that skunks accounted for 16% to 21% of the total New York rabies cases during 1995-1998 (Trimarchi 1995-1998). Therefore, as there are significant populations of skunks (Rosatte, 1987; Rosatte et al., 1991, 1992b), in addition to raccoons in Ontario, we also euthanized and vaccinated skunks in the PR and TVR areas, respectively, to prevent the spread of rabies by skunks. It is also important to remove infected skunks from the population as V-RG is not very effective at immunizing skunks against rabies. That is, ORV using V-RG would not be effective at controlling raccoon rabies in skunks.

Feral and domestic cats were vaccinated against rabies and released in both the PR and TVR areas of the PIC zones. This was done as cats (as well as other mammalian species) have been reported as being infected with the raccoon variant of rabies virus and could contribute to the spread of the disease to wild and domestic animals as well as humans (Vaughn et al.,1963). Cats accounted for 2%-3% of the annual rabies diagnoses in New York State during 1991-1998 (Trimarchi, 1991-1998). More importantly, in one area of Virginia, cats were responsible for initiation of 28% of the human post exposure treatments during 1992-96--57% of those were due to stray cat contact (Hensley, 1998). The importance of cat vaccination was evidenced in New Hampshire during 1994, where 655 people were exposed to one rabid cat (Brown and Szakacs, 1997). Cat vaccination was an important aspect of the PIC program as Ontario has significant feral/owned free ranging cat populations. During 1994 - 98, proactive TVR programs in a 1400 km2 area of predominantly rural Ontario farm-land habitat yielded 9,058 cat captures (Rosatte et al., 1997).

Timing for PIC tactics

In Ontario, raccoon and skunk activity declines during the autumn as ambient temperatures fall and food becomes scarce. In fact, during periods of inclement weather both species seek shelter in dens usually from November to February/March in Ontario (Rosatte, 1987; Rosatte et al., 1991). As the success of PIC tactics such as PR and TVR depend on live-capturing a significant portion of both raccoon and skunk populations, it would not be feasible to use either tactic during the winter in Ontario. This was evidenced by the poor capture success in the vicinity of cases 4-14 during January 2000.

The most effective time to use PR and TVR will be when young of the year are old enough to respond to vaccination (about 3 months of age or older - Rosatte et al., 1990) and at a time when they are mobile enough for capture. In Ontario, that time is usually between mid June and early July (Rosatte, 2000; Rosatte et al., 1992b). However, if a case of raccoon rabies occurs prior to that time a decision will have to be made as to whether it will be appropriate to use PIC methodologies. Currently, the plan is to implement full PIC operations in response to a case(s) of raccoon rabies if it occurs during 1 May to 1 November of any given year. Should a case occur during the winter months, the plan is to hire Ontario Fur Manager Federation trappers to implement a partial PR program within the immediate vicinity of the case as was done during January 2000 for cases 4-14. A full PIC operation would be implemented around that case location the following spring.

How large must the PIC zone be to contain raccoon rabies?

One rabid raccoon in New Jersey was documented as moving 13 km (Roscoe et al., 1998). How often does this occur and how wide does a control zone have to be to control raccoon rabies? The 3 PIC operations included 5 km radial PR zones, 5 km radial TVR zones, and the distribution of vaccine baits in an area that varied between 8 km and 15 km in width on the perimeter of the TVR zones. The total width of the PIC zone around any of the cases was 18 km to 25 km. Is this width of barrier sufficient to control rabies? In southern Ontario, raccoon movements are quite extensive. During one study near Niagara Falls, raccoons moved in excess of 40 km with most movements occurring in August and September (Rosatte, 2000). However, 90% of the movements were less than 25 km during 1994 (Rosatte, 2000). The odds are that the 18km to 25 km zone should be sufficient to control the spread of raccoon rabies. There is evidence to support this statement in that a zone of vaccine-baits that was 13 km wide was sufficient to halt the spread of raccoon rabies in Massachusetts (Robbins et al., 1998). Alternatively, a 16 km wide zone using aerial distribution of vaccine-baits was not sufficient to stop the advance of raccoon rabies in Ohio (USA); to date, a 40 km wide buffer zone in Ohio has halted the disease (Smith, 1999). However, among area comparisons of success at rabies control should be done cautiously, unless topography, raccoon density, bait density, and vaccination tactics are similar among the areas.

Expected level of raccoon rabies prevalence

We speculated that in all likelihood, the first two raccoon rabies cases that occurred in Ontario during July,1999, were not isolated and others were either incubating rabies or had yet to be found in areas outside of the PIC zones. As the average incubation period (based on laboratory experiments) for raccoon rabies is about 40 days (range 7-107 days) (Winkler and Jenkins, 1991; Winkler et al., 1985; Burridge et al., 1986), it was expected that additional cases of raccoon rabies would appear along the St. Lawrence River, probably in September, 1999. Our speculations were fulfilled when the third case was confirmed on 17 September,1999, just 15 km north of the first case. The 11 cases that occurred during December 1999-January 2000 in the vicinity of the second index case probably represented infections associated with the first three cases. The 6 cases on Wolfe Island may have been a result of a rabies infected raccoon(s) dispersing from the mainland of New York State as the St. Lawrence River is only about 1 km wide at that point with regular ferry crossing service (Fig. 1).

A total of 872 raccoons and 209 skunks were removed from the PR zones surrounding the locations of the first two raccoon rabies cases. All of those were negative for rabies (by FAT) upon testing at the CFIA Rabies lab in Nepean. That was expected as we were dealing with the first reported cases of raccoon rabies in Ontario and one would not expect any of the PR animals to be positive for rabies. That is because if the average incubation period for raccoon rabies is about 40 days, other raccoons infected by the initial cases would not have yet developed clinical rabies (Winkler and Jenkins, 1991). As the first 3 cases of raccoon rabies in Ontario may have represented the initial stages of an epizootic, few rabies positive animals would have been expected to follow (unless a rabies control program was not implemented).

Cost effectiveness of raccoon rabies control

The cost of the three PIC programs was about \$363,000.00 Cdn. The cost to deploy 81,300 V-RG baits (including post baiting evaluation costs) was about \$241,000.00 Cdn. Those costs are justified as by containing the spread of raccoon rabies, annual savings to Ontario are estimated at \$8-12 million Cdn. Savings were estimated using the fact that rabies associated costs in New Jersey doubled when raccoon rabies entered the state (Uhaa et al., 1992). Rabies associated costs in Ontario before raccoon rabies was reported were estimated at about \$6 million annually (excluding pet vaccination costs). Preventing the disease from becoming epizootic/enzootic in Ontario will result in fewer human rabies post exposure treatments (2,000-4,000 treatments/yr). This estimate is conservative considering that in Massachusetts, human rabies post exposure treatments went from 1.7/100,000 people in 1991 before the disease entered the state to 45/100,000 people in 1995 when raccoon rabies was epizootic (Kreindel et al., 1998). Controlling raccoon rabies in Ontario will also result in 1,500-2,000 fewer rabies cases/yr. This is based on the prevalence of the disease in neighboring states such as New York (Trimarchi, 1991-1998).

Although the PR and TVR Cdn. programs were more expensive than the aerial distribution of V-RG baits (\$500.00Cdn./km^2 versus \$200.00Cdn./km^2), we will continue to use PIC methodologies utilizing all three tactics. The reason for this is that PR removes animals from the population which are incubating rabies. Vaccination will be unsuccessful for animals that are already infected with rabies. If those incubators of rabies are not removed, rabies could spread beyond the PIC zone. In addition, when using TVR, development of an immune response following intramuscular vaccination is high as the vaccine is injected directly into the animal (Rosatte et al., 1990). With ORV, raccoon contact with the liquid vaccine in the bait is not guaranteed, therefore making for a lower probability of development of an immune response compared to IM vaccination. The efficacy of Imrab 3 (used in TVR operations) at stimulating a humoral immune response in raccoons when delivered via intramuscular injection has been documented at about 95% (Rosatte et al., 1990). Currently, a higher proportion of a free-ranging raccoon population can be immunized using TVR methodologies than by ORV with baits (Rosatte, 2000; Rosatte et al., 1992a; Roscoe et al., 1998). However, it must be remembered that TVR is only logistically feasible in areas of about 1500 km^2 or smaller due to labor, time and equipment requirements to trap areas of that size.

Use of ORV and future plans for raccoon rabies control in Ontario

The most feasible approach to immunize raccoons over large areas is through aerial deployment of baits containing oral rabies vaccine (MacInnes, 1988; Uhaa et al., 1992; Rosatte et al., 1993; Rosatte et al., 1998; Roscoe et al., 1998). While TVR may be more effective over small areas, that tactic is too labor intensive for large-scale operations. In fact, a 700 km^2 area in Niagara Falls, Ontario, that took 4.5 mo to TVR using seven trappers, could have been aerially baited in a few hours. The only vaccine currently available for the oral immunization of raccoons in the wild is Raboral® V-RG (Rupprecht et al., 1986). The immediate plan in response to the first three reported raccoon rabies cases in Ontario, Canada, was to deploy about 81,300 baits containing

V-RG in an 8-15 km wide buffer zone immediately outside of the TVR zones during September 1999 (Fig. 1). Bulk V-RG was acquired during 1999/2000 to manufacture about

900,000 baits for future deployment in 2000 to contain any additional cases of raccoon rabies.

The key to preventing raccoon rabies from becoming enzootic throughout Ontario will be a rapid response to contain isolated cases of the disease as soon as they are confirmed. The tactic of choice will be PIC methodologies including PR, TVR and ORV with baits. If multiple cases occur over a large geographic area, a program involving the aerial distribution of vaccine baits will be implemented as PR and TVR would not be feasible in that situation.

Has raccoon rabies in Ontario actually been controlled?

When raccoon rabies enters an area, the rate of spread is usually quite rapid (40-60km/yr) (Jenkins and Winkler, 1987; Winkler and Jenkins, 1991) and epizootic/enzootic conditions are soon achieved with resultant dramatic increases in total cases of rabies (Table 5) (Brown and Szakacs, 1997; Krebs et al., 1997; Wilson et al., 1997; Robbins et al., 1998).

In Connecticut, the first case of raccoon rabies appeared in March 1991. By December, 1991, 122 cases had been documented in that state (Wilson et al., 1997). The situation was ever more dramatic in New York. During 1989 there were 54 total rabies cases reported in that state. Raccoon rabies entered New York in 1990 and by 1991, there were 1,030 cases confirmed (Trimarchi, 1991). In every U.S. state where the disease has appeared (over a 1 million km2 area), epizootic conditions were followed by enzootic raccoon rabies except in areas such as Ohio, where active control programs were implemented following the epizootic (Smith, 1999). Given the above facts, enzootic raccoon rabies in Ontario should by now have been achieved had the control program been unsuccessful. To date (31 August, 2000), 14 months following the first confirmed case, we have just 38 reported cases of raccoon rabies in the Province of Ontario. Future plans include implementing PIC programs in response to additional cases of raccoon rabies, proactive TVR programs along the Ontario/ New York border and distribution of rabies vaccine baits in eastern Ontario to prevent the spread of raccoon rabies throughout Ontario.

ACKNOWLEDGEMENTS

The OMNR rabies program was supported by the Rabies Advisory Committee, Dr. J. Carlson, Chairman. The program was a success due to the dedication and unselfishness of the trappers and support staff who left friends and families at a moment's notice - without them there would not have been PIC programs. They included R. Warren, D. Grieve, R. Chambers, L. Bruce, D. Harris, T. Buchanan, T. Davies, D. Antonio, L. Howes, B. Johnston, J. Price, D. Raycroft, R. Redner, J. Ritchie, B. Slack, D. Annable, C. Bak, S. Baker, L. Bishop, G. Bron, J. Fawcett, G. Fischer, G. Hutchcroft, P. Hutton, J. Hutton, R. Jollymore, R. McNish, P. Quinn, D. Reynolds, D. Robertson, S. Sayeau, C. Sayeau, K. Seabrook, L. Stead, N. Tennyson, B. Thorpe, T. Wert, R. Dillabough, T. Dunn, B. Moir, G. Pankow, D. Robertson, M. Barnett, R. Page, D. Robinson, G. Johnson and D. Coleman. B. Stevenson operated the rabies hotline. E. Salsberg, C. LeBer, B. McNab, C. Gardner, R. Rogers and many others played a major role in coordinating provincial, federal and municipal activities upon notification of the raccoon rabies cases. G. Holder and G. Munro, OMNR, were key in acquiring emergency funding for the program. Special thanks to D. Hayes, CFIA, Brockville, who kindly kept us updated on the rabies diagnostic situation. F. Muldoon and the staff of the diagnostic unit of the CFIA Center of Expertise for Rabies, Nepean, performed rabies diagnostic tests on submitted specimens. Kemptville District MNR staff assisted with many operational details. Special thanks to D. Alkerton who coordinated the Ontario Fur Managers Federation trappers. Figure 1 was designed by B. Pond. P. Bachmann, L. Brown, C. Nunan, R. Grace and K. MacDonald assisted with the logistics and legalities of the V-RG baiting program. R.

Table 5
Prevalence of reported rabies cases following confirmation of raccoon rabies in selected U.S. States[1].

Year	1990	1991	1992	1993	1994	1995	1996	1997
New York	242*	1,030	1,720	2,747	1,585	1,162	1,081	1,266
Vermont					143*	179	135	113
Maine					10*	101	131	227
Connecticut		122*	831	762	748	353	274	544
Rhode Island					153*	324	39	42
New Hampshire			10*	143	221	152	55	49
Massachusetts			42*	698	734	401	115	282

[1]Data from MMWR (Morbidity Mortality Weekly Reports)
* first year that raccoon rabies was confirmed in the state

Tinline and D. Ball, Queens University designed the flight lines for the baiting operation. Special thanks to N. Ayers and the pilots, navigators and support staff who flew the baiting missions. A. Beresford, Artemis Technologies, Guelph, Ontario, M. Escobar, Merial Inc., Athens Georgia, and L. Bigler, Cornell University, Ithaca, New York played vital roles in the acquisition of V-RG baits. P. Silva and G. Gifford, CFIA, Nepean assisted with the approval process to use V-RG in Canada. Many others too numerous to mention played a vital role in the success of the operation.

❑

SOURCE

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DISEASE CONTROL SERVICE COMMENT

Since the first case of raccoon rabies was identified in Ontario on July 14, 1999, there were a total of seven cases identified in 1999, 40 cases in 2000, and 31 cases in 2001 as of November 1.

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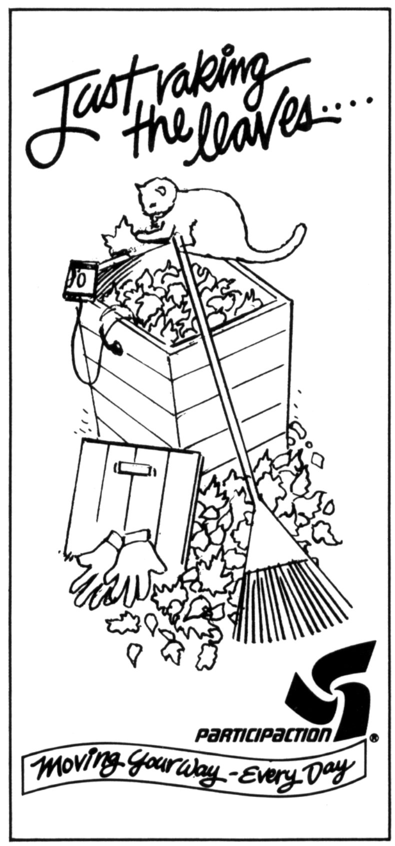

A PROPOSED MODEL FOR THE PREVENTION AND CONTROL OF CHRONIC DISEASES: ANALOGIES FROM COMMUNICABLE DISEASES

Introduction

The importance of systematic public health measures in preventing and controlling infectious diseases is well recognized. Public health experience and expertise in the area of communicable diseases is longstanding, occurring since the middle of the 19th century. Unlike communicable diseases, the prevention and control of chronic diseases is relatively recent. Public health has only started to focus upon the prevention of these diseases in the latter half of the 20th century.

The Epidemiologic Transition

In developed countries, the epidemiologic transition of the main causes of morbidity and mortality from infectious diseases to chronic diseases occurred early in the 20th century, as infectious disease mortality declined due to factors such as improved nutritional status, improved living, housing and sanitary conditions, and the use of vaccines and antibiotics (Evans et al., 1994; McKeown, 1976, 1979; Wallace et al., 1998; Wilkinson, 1996; Wilmoth, 2000). Infectious disease morbidity and mortality have declined, and life expectancy has increased in developed countries in part because public health infrastructure in communicable disease control and environmental controls became well-established and maintained.

In view of the fact that the leading causes of morbidity and mortality (cardiovascular diseases, cancer and injuries) are now non-communicable in nature, attention must now also be paid to the prevention and control of chronic diseases. In Canada today, cardiovascular diseases, cancer and injuries are not only the leading causes of death but are also the three most important causes of potential years of life lost (PYLL) to Canadians (Federal, Provincial & Territorial Advisory Committee on Population Health, 1999; Statistics Canada, 1999).

Need for the Proposed Model

There are several reasons why a model for the systematic prevention and control of chronic diseases is needed and why such a model could look to systematic communicable disease prevention and control for key principles. First, chronic diseases, now the leading causes of mortality and morbidity, require effective and systematic programming for prevention and control. Second, some of the long-standing and well-known structures and components of communicable disease prevention and control can be successfully applied with appropriate modification, to the development of effective, systematic chronic disease prevention and control (e.g. Haddon's Matrix for injury prevention; cluster investigation framework for clusters of rare non-communicable diseases).

Third, some local public health unit practitioners, managers and directors have identified the need for a systematic model that can improve the coherence and consistency of chronic disease prevention programming across public health units in Ontario. Unlike communicable disease programs which hlave achieved this consistency, with the exception of some programs like the heart health programs, chronic disease prevention programs within public health are still widely variable in their content and processes.

Fourth, public health has a unique capacity and role to play in chronic disease prevention and control which cannot be duplicated by other agencies. The mandates of these agencies and of public health, though overlapping, are fundamentally different.

Chronic disease prevention and control is complex. Unlike communicable disease control whose jurisdiction falls primarily and clearly within public health, chronic disease prevention is undertaken by many agencies. Thus, one area of complexity is the duplication rather than synergy of efforts amongst the prevention programs of multiple agencies. This has been cited as a common and important problem that needs to be addressed; thus, a co-ordinating role has been called for public health (Australia's National Public Health Partnership, 2000).

Unlike many agencies dedicated to the prevention of individual disease types (e.g. The Heart and Stroke Foundation of Canada and cardiovascular diseases; The Canadian Cancer Society and Cancer Care Ontario and cancer; the Asthma Society of Canada and asthma; etc.), public health's mandate is the prevention and control of a range of chronic diseases of significant population burden, and the promotion and optimization of overall population health. As such, public health is unlike the other agencies which invest in one specific disease. Which diseases take priority for public health change over time and with the population within a specific health unit. The public health role in chronic diseases is tied to the overall epidemiology of the different chronic diseases and to changing epidemiologic trends. Thus, public health has the unique role and need to prioritize amongst all chronic diseases and then to address those that have the greatest burden and most significant impacts for a given population at a given time.

Public health's mandate is broad rather than narrow, and encompasses a range of diseases rather than a specific disease. As such, a model for chronic disease prevention in public health, must be applicable to the range of chronic diseases, much in the way that communicable disease prevention and control strategies (such as surveillance, outbreak investigation, outbreak control, case and contact management) are based on broad principles that are applicable across the different types of infectious diseases.

Communicable Disease Prevention and Control: Principles Pertinent to Chronic Disease Prevention and Control

Disease States: Baseline versus Epidemic Disease

Communicable diseases within a population exist in one of two states: in a baseline or in an epidemic state. At baseline state, diseases occur naturally in a population and occur at expected rates for that population during a specific time of the year. The expected rate of a given disease at any given time is known as the baseline rate of that disease in a population. When the ***baseline rate*** of a disease is relatively high in a population, the disease is said to be endemic within that population. Epidemic disease occurs when the rate of a disease rises to a level above the baseline rate (Beaglehole et al., 1993)

In the control of communicable diseases, the goal, content and intensity of public health action are driven by the state in which a disease is occurring. In diseases occurring at non-epidemic low baseline rates, the goal of a prevention and control program is to keep disease rates low and steady, and to prevent the occurrence of epidemics. Measures to do this include surveillance, case and contact management, vaccination, standard protocols for infection control and environmental controls. During epidemics of diseases, the goal is to decrease the increased rates of disease and to bring them back to baseline levels. To achieve this, the scope and intensity of public health action are increased to include epidemiologic characterization by person/place/time, epidemic investigation to determine the source of an epidemic, and heightened general and specific infection control measures. Where applicable, policies, regulations and legislation are enacted to prevent future epidemics (Beaglehole et al., 1993).

Phases of Disease Prevention and Control: Control versus Elimination versus Eradication

There are three main phases of prevention and control in communicable diseases: control, elimination and eradication. "Control" refers to the measures that are undertaken to decrease the incidence of disease to low baseline rates, to prevent epidemics and to halt epidemics from spreading when they occur. "Elimination" is controlling a disease so well that the incidence becomes negligible or non-existent within a geographic area. "Eradication" is the worldwide elimination of a disease, so that there are no further cases of the disease (Beaglehole et al., 1993).

Components of Communicable Disease Prevention and Control Relevant to Chronic Disease Prevention and Control

Surveillance

Surveillance is the systematic collection, analysis and interpretation of data, and the dissemination of analysed data to those who need to know. Surveillance can have different objectives, including the determination of disease trends over time, the definition of baseline rates, the identification of epidemics, the evaluation of past or current programming, and the planning of programs and services (CCDR, 1991; Wallace et al., 1998). The following criteria are often used to determine if a communicable disease should be placed on surveillance: impact of the disease (including incidence, prevalence, morbidity, mortality, case fatality rates, socio-economic impact), changing trends of a disease over time, communicability, potential for outbreaks, vaccine preventability, the need for immediate public health response, World Health Organization (WHO) interest, Agriculture Canada interest, and public perception of risk (CCDR, 1991). The surveillance of communicable diseases utilizes legislated reporting of infectious disease cases as a main source of data (CCDR, 1991; Wallace et al., 1998).

Direction to Define Which Diseases are Reportable, What Data to Collect and Data Sources:

Federal ->Provincial ->Local and Provincial ->Local

What is deemed reportable is defined by regulation and legislation set both federally and provincially, depending upon the disease. Data sources (i.e. case reporting) are thus set at the federal and provincial levels.

Data collection and flow in Communicable Disease Surveillance:

Local -> Provincial -> Federal

Communicable disease cases are first reported to local public health departments. Local departments analyse and interpret this data, and disseminate this information to program planners, evaluators, policy-makers, politicians and the community to shape the infectious disease prevention and control policies and programming at the local level. Additionally, local public health departments report the data to the provincial level of public health and finally, provinces report their data to public health officials at the federal level.

Definition of Baseline Rates, and Epidemic Identification, Investigation and Control

In order to distinguish epidemic states from non-epidemic states, baseline rates of disease must be defined. It is the baseline rate of a disease, or its expected rate within a given population at a given time, that determines whether an epidemic exists.

When the rate of disease in a population is low and at baseline, standard communicable disease control measures ensure that disease rates stay at low baseline levels. Unless the disease has been targeted for elimination or eradication, there are no heightened public health interventions to try to further reduce the rate of disease.

In an epidemic, however, heightened measures of disease control are required and implemented for the purpose of decreasing the high rates of disease to baseline levels.

The Use of Legislation and Regulations

Aside from the legislation mandating the reporting of designated infectious disease cases to local public health departments, provincial legislation and regulations also exist that allow public health officials to act to safeguard the health of members of a community and that assist with the prevention of future epidemics. Included in such laws are powers designated to medical officers of health to place the health and safety of the general population above the rights of individuals and private businesses in special situations. Action can be taken against individuals and private business owners if there are reasonable and probable grounds that the actions of these individuals and businesses will lead to harm of the public's health.

A Proposed Model for Systematic Chronic Disease Prevention and Control in Public Health: A Model Based on Core Public Health Principles for Disease Prevention and Control

Based upon the key principles and components of disease prevention and control used in infectious diseases, the following model is proposed for the systematic prevention and control of chronic diseases.

Key elements in the proposed public health model then would include the following:

-***Surveillance:*** which diseases to be put under surveillance, what data are to be collected, and data sources would be defined (for consistency) by the federal and provincial levels of public health; data collection and analysis would then be done by the local public health unit and information would flow from the local public health level to the provincial level and then to the federal level.

-***Definition of acceptable baseline rates*** of chronic diseases

-***Definition of phases of disease control*** (control versus elimination versus eradication)

-***Pairing the public health goal*** and programming for a chronic disease to disease state and phase of disease control

-Identification of rates when they exceed acceptable baseline rates to ***identify epidemic states***

-***Characterization of epidemic states*** by person, place and time

-***Epidemic state investigation***

-***Epidemic state control*** involving heightened general and specific prevention and control measures

-The use of ***policy, regulations and legislation*** for the purposes of health protection and the prevention of future epidemic states

Surveillance

Proposed direction for which diseases on which to conduct surveillance, what core data to collect and what data sources to be used:

Federal ->Provincial ->Local and Provincial->Local

This paper proposes that public health at the federal and provincial levels provide direction as to which chronic diseases are designated for surveillance (based upon a scoring system of criteria met, akin to the system used in making a communicable disease reportable) (CCDR, 1991). The criteria for communicable disease surveillance can be modified and adapted to chronic diseases. For example, "vaccine preventability" can be changed to "preventability"**, and "potential for outbreaks" to "being in epidemic state or recently in epidemic state" (discussed in next section). The core set of chronic disease data to be collected and the data sources to be used by local health departments should also be defined at the federal and provincial levels, with input from local levels.

Proposed direction of data collection and flow:

Local -> Provincial -> Federal

As with communicable disease data, it is proposed that data collection occur at the local level by health departments. This information can then be used for local programming and flowed to the provincial level which would then forward the information to the federal level.

Definition of Acceptable Baseline Rates of Chronic Diseases

It is proposed that acceptable baseline rates for the chronic diseases designated for surveillance, prevention and control be defined. Trends over time and amongst countries can be explored for the definition of such baseline rates.

If we look again at communicable diseases and baseline rates, the following principles can be delineated:

1) baseline rates are defined for a given population at a given time
2) where there are high endemic rates of disease (high in comparison to other populations or geographical areas), control measures strive to decrease the incidence rates of disease as well as to prevent epidemics; thus, the definition of a baseline rate below which heightened measures are unnecessary implies that it is a rate that has reached a low steady state and that this rate is comparable to populations/areas where rates are relatively low.

Analogous to the above for communicable diseases, ***acceptable baseline rates of chronic diseases*** at which public health need not strive to reduce rates further (unless the goal of elimination has been set) can be defined as age-standardized rates that:

1) are comparable to populations/areas with relatively low rates of the disease of interest, and
2) have reached a low steady level

Depending upon what data is available for surveillance as well as the importance of morbidity (e.g. disability) versus mortality from a disease, baseline states can be defined for mortality or incidence or both. Where data is important but currently unavailable (e.g. cardiovascular disease incidence), indicators and data collection systems should be developed.

An example of a chronic disease in Canada that might be close to baseline state for mortality is stroke. Stroke mortality has been decreasing over the last four to five decades in Canada and has reached a low steady rate stable over the last 10 years (Heart and Stroke Foundation of Canada, 1999). The rate of stroke mortality in Canada is also amongst the lowest in the world for both men and women (Heart and Stroke Foundation of Canada, 1999). This does not mean, however, that stroke incidence is at an acceptable baseline rate. Since there is currently a lack of good data on stroke incidence, surveillance for stroke incidence and the definition of the state of stroke incidence (epidemic versus baseline) will require the development of appropriate indicators.

Defining Phases of Disease Control and the Public Health Goals for Chronic Diseases

Phases of disease control include Control, Elimination and Eradication. In the Control Phase, acceptable baseline rates would necessitate no enhanced public health action to further decrease the rates of that outcome

**The criterion of "preventability" in chronic diseases can take into account the following: presence of known risk factors, evidence of effectiveness of public health interventions, and the proportion of mortality from the disease that is premature mortality (e.g. through the use of Potential Years of Life Lost, or PYLL, data).

(e.g. stroke mortality). Maintenance of public health measures, policies, regulations and legislation that brought the outcome to baseline rates would continue. The Elimination and Eradication Phases can be considered for outcomes at low baseline rates. These latter phases would likely entail highly resource intensive measures.

In the Control Phase, epidemic states would require public health measures aimed at decreasing rates of the disease outcome to low baseline levels. It is suspected that, with exceptions such as stroke mortality, many chronic disease outcomes in Canada today are in an epidemic state.

Identification of Epidemic States for Chronic Diseases

The definition of acceptably low baseline rates for chronic diseases would allow the identification of the chronic diseases that are in epidemic states. ***Epidemic states*** can be defined as states of chronic diseases where age-standardized rates are above defined acceptable baseline rates (i.e. above the rates of other populations/ areas with relatively low rates and/or are not a low steady level). The transition to and from epidemic states in chronic diseases is expected to take a much longer time period than in communicable diseases.

Analogies drawn from infectious disease prevention and control would suggest that the steps below are necessary for the control of chronic diseases found to be in epidemic states.

Characterization of Epidemic States by Person, Place and Time

As with epidemics of communicable diseases, chronic diseases in epidemic states can be characterized by person, place and time. Person characterizations would define the population groups that have mortality and/or incidence rates of a chronic disease that are above baseline. Place characterizations would define geographical regions within a jurisdiction that have rates of a chronic disease above low baseline rates. Time characterizations can be used to determine the trends of a chronic disease over time. If rates have not reached low steady baseline levels, it would be important to determine whether rates are at high steady levels, are decreasing or are increasing over time. All three types of epidemiologic characterizations can then be paired to appropriate disease control measures (see below).

Epidemic State Source Investigations

In communicable disease epidemics, epidemiologic investigation of the source of the epidemic plays a key role in its management. Where common or point sources are suspected based on epidemic characterization, laboratory testing and further in-depth epidemiologic study, usually via a cross-sectional, retrospective cohort or case-control study, are undertaken to confirm the source.

Chronic diseases in epidemic states will also require source investigation, if the specific etiologic factors of the disease in a population are to be identified for public health prevention and control. Known risk factors and their trends within a population should be studied as potential sources.

Epidemic State Control

"Chronic disease control", as defined in this paper, refers to the public health measures taken to decrease the incidence and/or mortality rate of a chronic disease found in epidemic state to defined low baseline levels, and to keep rates low once baseline levels are achieved. Bringing a chronic disease in epidemic state under control would require the prevention of further cases of the disease through heightened primary, secondary and/or tertiary prevention strategies using either a population or high-risk approach.

Rose has defined two approaches that can be used to prevent disease and promote health: population approaches and high-risk approaches (Rose, 1992; Rose, 1985). Population approaches have as their target the population at large. This approach seeks to shift the distribution of risk factors across the entire population to lower levels. It can be particularly effective when a large percentage of those affected by a disease fail to be identified as high risk. High-risk approaches, on the other hand, target intervention at individuals at high risk of developing the disease of interest. The latter is a reasonable approach when a particular risk is confined to an identifiable minority (Rose, 1992; Rose, 1985).

By implication, knowing when to employ a high risk approach versus a population approach requires the knowledge of the epidemiology of a chronic disease by at least person and place characterization. This is proposed as part of the current model.

Through the characterization of chronic diseases in epidemic states by person, place and time, an epidemiologic profile of the disease is created that can be used to better delineate appropriate prevention and control measures. Characterization by person allows the determination of whether specific sociodemographic groups have high rates of a disease and whether these risk groups, versus the whole population, can be and should be targeted.

Characterization by time is also important. Whether a chronic disease has steady high rates, decreasing rates or increasing rates should be used to help determine the approach taken in prevention and control. For example, where rates of disease are decreasing, it seems logical that disease cases would likely cluster more and more among the high risk. The epidemiologic characterization by person would help to confirm this. If in fact this is so, then a high risk targeted approach would likely be more useful than a population approach. Where rates of disease are increasing, it seems logical that disease cases are likely becoming more generalized in a community. Although disease cases might have started within specific subgroups (necessitating high risk approaches early on in the rise of rates), over time they could be spreading to more of the population (necessitating population approaches later as the rates rise). In a state of high steady rates, it seems likely that the disease and its risk factors are likely prevalent throughout the population. Thus, a population approach is likely appropriate. Again, epidemiologic characterization by person would help to either confirm whether the general population or specific subsets of the population have epidemic rates of a disease, and appropriate intervention approaches can then be used.

Which risk factors to target would be a question for the source investigation to answer.

Please see Figure 1 and Table 1 in the Appendix.

The Use of Public Policy, Regulations and Legislation

Many chronic diseases are multifactorial in etiology, necessitating the address of many risk factors. Additionally, in the last two decades, there has been accumulating scientific evidence that social and economic conditions also have an impact. Included in this list of health determinants are working conditions, social supports, socioeconomic status and the distribution of incomes (Evans et al., 1994; Wallace et al., 1998; Wilkinson, 1996). Effects of such conditions are both direct and indirect, impacting on diseases both independently of behavioural risk factors and additionally through their effects on behavioural risk factors (Evans et al., 1994; Wallace et al., 1998; Wilkinson, 1996).

Health protection for factors beyond individual control necessitates the use of policy, regulations and legislation. In communicable diseases, this is a well-recognized and well-accepted concept. Additionally, it is also common practice in communicable disease control to use policies, regulations and legislation to prevent future epidemics of infectious diseases. For example, there is both public expectation and acceptance that restaurants not meeting minimum sanitary and food handling standards would be forcibly closed by public health authorities.

Even though the Ottawa Charter for Health Promotion (1986) has called for five main strategies to promote health (reorienting health services, building personal skills, creating supportive environments, strengthening community action and ensuring healthy public policy), chronic disease prevention and control has primarily focused on behaviour change through education and the building of personal skills. Although health protection legislation is beginning to occur with environmental tobacco smoke, vast untapped areas of policy, regulation and legislation for health protection remain with chronic diseases. For example, health regulations in food processing and manufacturing focus on microbiological contamination and safety but largely ignore the regulation of ingredients used by food manufacturers that contribute to chronic diseases like cardiovascular diseases.

There has long been a recognition of the importance of living conditions in the control of infectious diseases (Evans et al., 1994; McKeown, 1975, 1976, 1979; Wallace et al., 1998; Wilkinson, 1996; Wilmoth, 2000), and housing and building standards usually include sanitation standards that must be met to prevent and control infectious diseases (e.g. rental housing standards ensure that running water for both drinking and sanitation must be available for all tenants). For chronic diseases, like cardiovascular diseases, there has been accumulating evidence that economic, social and working conditions are important (Evans et al., 1994; Wallace et al., 1998; Wilkinson, 1996). Economic and labour practices, policies, regulations and legislation, however, generally fail to take the risks of these chronic diseases into account. Even for healthy behaviours such as healthy eating and physical activity, more policies are needed to ensure access to affordable and nutritious foods, and opportunities for physical activity, for all and particularly for those most at risk for chronic diseases. These examples are important because they highlight processes and conditions (food manufacturing and processing, wage levels and taxation policies, municipal planning and workplace policies and regulations) over which members of the public have little individual control and "choice".

Communicable disease examples of health protection and epidemic prevention measures gained through public policy, regulations and legislation abound. Particularly in areas over which individual control is minimal, there is much room to expand the use of policy, and regulatory and legislative means for chronic disease prevention and control.

Conclusion

Public health practitioners have identified a need for a model for systematic chronic disease prevention and control. Communicable disease prevention and control principles are well-known, longstanding, consistent, systematic and effective, and with appropriate modification, can be used to help structure chronic disease programming in public health.

This model has been conceptualized to stimulate discussion among federal, provincial and local chronic disease prevention practitioners, managers and directors, epidemiologists and medical officers of health. The model, as presented in this paper, is far from complete and requires, through such discussion, further development and refinement. The authors invite feedback through our contact information below.

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SOURCE

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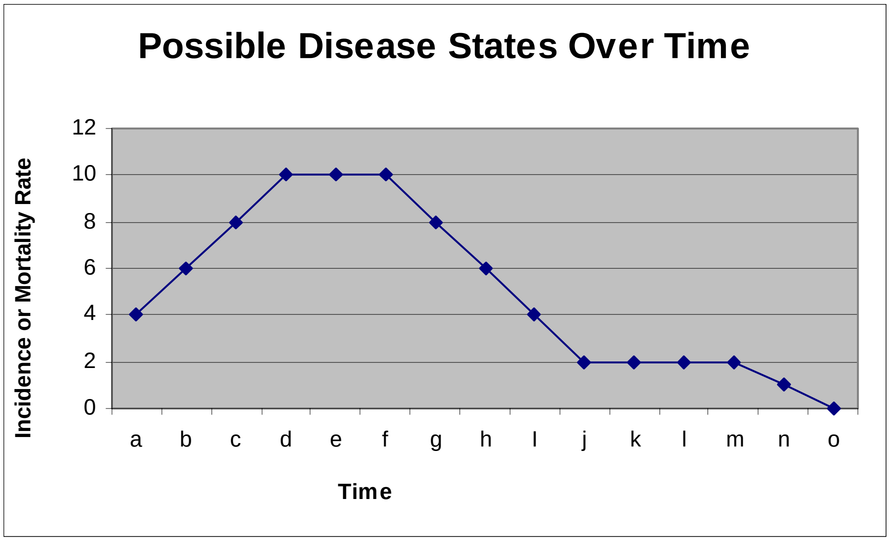
Appendix.

Figure1. A diagram illustrating possible chronic disease states over time and the phases of disease control



Time	Disease State	Phases of Disease Control
a to d	Epidemic State - increasing rate	Control
d to f	Epidemic State - high steady rate	Control
f to j	Epidemic State - decreasing rate	Control
j to m	Baseline State	Control
m to o	From Baseline Rate to Eliminated	Elimination

Table 1.
Disease States over Time, Expected Distribution of Disease and Risk Factors, Expected Prevention Approach and Goal of Prevention

State of Disease	Expected Distribution of Disease and Risk Factors*	Prevention Approach**	Phase of Disease Control	Goal of Prevention
Epidemic State - increasing rate	Specific subgroups (early) Large segments of population (late)	High risk (early) Population (late)	Control	Stabilize rates
Epidemic State - high steady rate	Whole population	Population	Control	Decrease rates
Epidemic State - decreasing rate	Large segments of population (early) Specific subgroups (late)	Population (early) High risk (late)	Control	Increase the rate of decrease
Baseline State		Continued surveillance and maintenance of public health measures, policies, regulations and legislation used to get epidemic state under control Heightened measures are required to achieve elimination	Control Elimination	Ensure rate stays at low baseline level Decrease rates to zero
Eliminated				No Cases of Disease

* To be confirmed by "Person" and “Place” Characterizations

Summary of Reportable Diseases in August, 2001

Health Units by Region	1996 Population	AIDS	Campylo.	Chicken-pox	Chlamydia	Enceph./ Meningitis	GAS	Gonorrhea
Algoma	123,953				10			
North Bay	93,841			28	12	3		
Northwestern	80,235		1		23			1
Porcupine	97,437		3	2	12			
Sudbury	201,154		5		32			
Thunder Bay	161,187		3		23			1
Timiskaming	38,847							
Total - Northern	**796,654**		**12**	**30**	**112**	**3**		**2**
Eastern Ontario	185,314		7		10			
Hastings-Prince Edward	143,790		2	1				
Kingston-Frontenac	175,568		10		20	1		1
Leeds-Grenville	156,129		4	3	3			1
Ottawa City	721,136		46		86	2		14
Renfrew	97,634	1	2		3	1		
Total- Eastern	**1,479,571**	**1**	**71**	**4**	**122**	**4**		**16**
Durham Region	458,616		23	7	47	1	2	7
Haliburton-Kawartha	165,039		5		1			
Muskoka-Parry Sound	78,675		3	1	3			
Peel Region	852,526		77	23	87	7	1	21
Peterborough	123,448		3		11	1		
Simcoe County	329,865		1	18	14	3		1
Toronto City - total	2,385,421	4	214	32	521	9	5	146
North	*589,653*		*46*	*6*	*83*	*2*	*1*	*22*
South	*653,734*	*3*	*75*	*7*	*237*	*5*		*66*
West	*475,252*		*70*	*5*	*131*	*1*	*2*	*44*
East	*666,782*	*1*	*23*	*14*	*70*	*1*	*2*	*14*
York Region	592,445	1	60	8	10	4	1	1
Total - Central East	**4,986,035**	**5**	**386**	**89**	**694**	**25**	**9**	**176**
Grey-Bruce	153,312		11		2			
Elgin-St. Thomas	79,159		5	2	2			
Huron	60,220		8	3	1	1		
Chatham-Kent	109,650		3		8			
Lambton	128,975		1					
Middlesex-London	389,616		12		47	2		2
Oxford	97,142		4		3	2		
Perth	72,106		10					
Windsor-Essex	350,329		23	7	48	1		8
Total - Southwest	**1,440,509**		**77**	**12**	**111**	**6**		**10**
Brant	114,564		6		14	1		
Haldimand-Norfolk Region	102,575		8	1	9			
Halton Region	339,875		18		21	4		
Hamilton-Wentworth	467,799	2	19		69	1		11
Niagara Region	403,504		27	81	43	1	1	6
Waterloo Region	405,435		15		56	3	1	4
Wellington-Dufferin-Guelph	217,052		21	2	9	1		
Total - Central West	**2,050,804**	**2**	**114**	**84**	**221**	**11**	**2**	**21**
August 2001	**10,753,573**	**8**	**660**	**219**	**1,260**	**49**	**11**	**225**
*** Total YTD 2001**	**-**	**54**	**3,055**	**8,218**	**10,455**	**325**	**242**	**1,924**
*** Total YTD 2000**	**-**	**76**	**3,401**	**21,984**	**9,684**	**227**	**311**	**1,891**

The Toronto City regions above are now defined as: North - former North York; South - former City of Toronto; West - former Etobicoke and City of York; East - former Scarborough and East York

* Adjusted for deletions and late reports.

Summary of Reportable Diseases in August, 2001

Health Units by Region	1996 Population	PPNG	Hepatitis A	Hepatitis B	Hepatitis C	Hib	Influenza	Measles	Meningo-coccal
Algoma	123,953				6				
North Bay	93,841								
Northwestern	80,235				3				
Porcupine	97,437								1
Sudbury	201,154		1		7				
Thunder Bay	161,187		1		9				
Timiskaming	38,847								
Total - Northern	**796,654**		**2**		**25**				**1**
Eastern Ontario	185,314				3				
Hastings-Prince Edward	143,790			1	2				1
Kingston-Frontenac	175,568				2				
Leeds-Grenville	156,129				3				
Ottawa City	721,136	1	2		34				
Renfrew	97,634				1				
Total- Eastern	**1,479,571**	**1**	**2**	**1**	**45**				**1**
Durham Region	458,616	1							1
Haliburton-Kawartha	165,039				7				
Muskoka-Parry Sound	78,675			1	3				
Peel Region	852,526	4	3		15				
Peterborough	123,448				1				
Simcoe County	329,865				1				1
Toronto City - total	2,385,421	7	3	6	170	1			1
North	*589,653*				*61*				
South	*653,734*	*6*	*1*	*5*	*52*				*1*
West	*475,252*	*1*	*1*		*26*	*1*			
East	*666,782*		*1*	*1*	*31*				
York Region	592,445		1		9				1
Total - Central East	**4,986,035**	**12**	**7**	**7**	**206**	**1**			**4**
Grey-Bruce	153,312				6				
Elgin-St. Thomas	79,159				2				
Huron	60,220				1				
Chatham-Kent	109,650				4				
Lambton	128,975				5				
Middlesex-London	389,616				17				
Oxford	97,142		1		1				
Perth	72,106				2				1
Windsor-Essex	350,329	1			14				
Total - Southwest	**1,440,509**	**1**	**1**		**52**				**1**
Brant	114,564				2				
Haldimand-Norfolk Region	102,575		1		3				
Halton Region	339,875		2		8				
Hamilton-Wentworth	467,799	1	3		25				1
Niagara Region	403,504				28				1
Waterloo Region	405,435				12				
Wellington-Dufferin-Guelph	217,052		1		2	1			
Total - Central West	**2,050,804**	**1**	**7**		**80**	**1**			**2**
August 2001	**10,753,573**	**15**	**19**	**8**	**408**	**2**			**9**
*** Total YTD 2001**	**-**	**138**	**116**	**107**	**3,301**	**7**	**754**	**6**	**87**
*** Total YTD 2000**	**-**	**120**	**81**	**106**	**3,973**	**5**	**1,521**	**8**	**59**

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* Adjusted for deletions and late reports.

Summary of Reportable Diseases in August, 2001

Health Units by Region	1996 Population	Mumps	Pertussis	Rubella	Salmon.	Shigellosis	Syphilis (Prim/Sec)	VTEC
Algoma	123,953							
North Bay	93,841				1			
Northwestern	80,235		3		1			
Porcupine	97,437				1			
Sudbury	201,154				3			
Thunder Bay	161,187				1	2		
Timiskaming	38,847				2			
Total - Northern	**796,654**		**3**		**9**	**2**		
Eastern Ontario	185,314				5			
Hastings-Prince Edward	143,790		3		5			
Kingston-Frontenac	175,568		2		2			
Leeds-Grenville	156,129				8			
Ottawa City	721,136	1			12	2		3
Renfrew	97,634				2			
Total- Eastern	**1,479,571**	**1**	**5**		**34**	**2**		**3**
Durham Region	458,616				5			
Haliburton-Kawartha	165,039				4	1		1
Muskoka-Parry Sound	78,675				2			
Peel Region	852,526				41	2		3
Peterborough	123,448		1		5			
Simcoe County	329,865							
Toronto City - total	2,385,421		8		84	12		12
North	*589,653*		*3*		*17*	*1*		*1*
South	*653,734*		*4*		*21*	*10*		*4*
West	*475,252*		*1*		*28*	*1*		*4*
East	*666,782*				*18*			*3*
York Region	592,445		3		17			4
Total - Central East	**4,986,035**		**12**		**158**	**15**		**20**
Grey-Bruce	153,312		1		7			4
Elgin-St. Thomas	79,159				4			
Huron	60,220				1			1
Chatham-Kent	109,650		1		3			
Lambton	128,975				2			
Middlesex-London	389,616		1		6			
Oxford	97,142							1
Perth	72,106		2		3			4
Windsor-Essex	350,329		1		7			
Total - Southwest	**1,440,509**		**6**		**33**			**10**
Brant	114,564				3			1
Haldimand-Norfolk Region	102,575				5			
Halton Region	339,875	1			10			
Hamilton-Wentworth	467,799				8			2
Niagara Region	403,504		3		11			
Waterloo Region	405,435	1			10			2
Wellington-Dufferin-Guelph	217,052				3	1		5
Total - Central West	**2,050,804**	**2**	**3**		**50**	**1**		**10**
August 2001	**10,753,573**	**3**	**29**		**284**	**20**		**43**
*** Total YTD 2001**	**-**	**6**	**280**	**15**	**1,689**	**162**	**7**	**215**
*** Total YTD 2000**	**-**	**27**	**413**	**7**	**1,631**	**198**	**14**	**487**

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