

# Prevalence and control of hypertension in an Ontario county

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A survey of a representative population sample was carried out to evaluate the prevalence and control of hypertension in Middlesex County, Ontario. Of the 3067 subjects selected 2735 completed the initial interview. If the diastolic blood pressure was greater than 89 mm Hg in three readings, up to two further visits were made. The prevalence rate of hypertension in the sample was estimated to be 115/1000. Only 5.1% of the hypertensive subjects were unaware of their condition, and 5.4% were aware but not receiving treatment. In 16.9% the hypertension was treated but uncontrolled, while in 72.6% it was treated and controlled. The prevalence rate was significantly higher in the older subjects ( $p < 0.0001$ ). Control was better in the women and the older subjects. The results indicate that physicians in Middlesex County are detecting and treating most patients with hypertension; screening programs are thus not needed. Control of hypertension could be further improved by determining why the condition in those receiving treatment is not being controlled.

Dans un échantillon représentatif de la population du comté de Middlesex (Ontario) on a relevé la prévalence de l'hypertension artérielle et jugé de son traitement. De 3067 sujets choisis, 2735 ont passé une première visite. Si la pression diastolique dépasse 89 mm Hg lors de trois prises, on fait une ou deux visites de contrôle. On estime que la prévalence de l'hypertension dans cet échantillon est de 115/1000. Parmi les sujets hypertendus, 5,1% ne savaient pas qu'ils l'étaient, 5,4% le savaient mais ne sont pas traités, 16,9% sont traités mais encore hypertendus et 72,6% sont traités et leur hypertension est jugulée. La prévalence est plus grande de façon significative chez les sujets plus âgés ( $p < 0,0001$ ). C'est chez ceux-ci et chez les femmes que l'hypertension est le mieux jugulée. Le tout indique que les médecins de ce comté reconnaissent et traitent la plupart de leurs malades hypertendus; il n'est donc pas besoin d'un programme de dépistage. Le traitement de l'hypertension serait encore plus efficace si on découvrait pourquoi elle n'est pas jugulée chez certains malades traités.

Cardiovascular disease is the leading cause of mortality and morbidity in adults in Canada.<sup>1</sup> A number of randomized controlled trials have shown that treating patients with sustained diastolic blood pressure elevation reduces the risk of cardiovascular disease and death.<sup>2-7</sup> However, there is concern that, despite the strong evidence for the efficacy of treating sustained diastolic hypertension, many people who would benefit from treatment are not actually being treated. For example, in a recent community survey in Connecticut in which blood pressure was measured at only one visit, 36% of people with diastolic blood pressure over 95 mm Hg were not aware that they had elevated blood pressure.<sup>8</sup> On the basis of this and similar studies, the National High Blood Pressure Control Program in the United States has been promoting implementation of screening programs to identify people who are unaware that they are hypertensive.

The studies on which this recommendation is based had two major methodologic problems. First and foremost, the definition of hypertension was based on one blood pressure reading. This is contrary to the clinical criteria for diagnosing hypertension,<sup>9</sup> which require sustained blood pressure elevation over several weeks. Consequently both the prevalence of hypertension and the proportion of people who are unaware that they are hypertensive would have been overestimated, since in a large proportion of people whose diastolic blood pressure was high in the first reading, the blood pressure would be normal in subsequent readings.<sup>10,11</sup> The second problem was identification of the study sample. Often convenience samples (volunteers) rather than random samples of the target population were studied. This introduced an unknown bias into the results.

A further problem in determining the effectiveness of hypertension treatment in Canada is that nearly all published studies were conducted in the United States. Given the major differences in the social and health care systems between Canada and the United States, extrapolating the American results to the Canadian population is unwise. The few published Canadian studies<sup>12,13</sup> have the same methodologic weaknesses (i.e., single readings and convenience samples) as most of the American studies.

We conducted a survey to evaluate the prevalence and control of hypertension in Middlesex County, Ontario. The study was designed in such a way as to overcome the two methodologic difficulties of single readings and convenience samples.

## Methods

The study was conducted from September 1981 to October 1982. The target population consisted of all noninstitutionalized people over the age of 18 who were regularly resident in Middlesex County. The county

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contains one large city (London), several smaller urban areas and a large rural area.

A three-stage stratified probability sample was selected. Initially the county was divided into six strata on the basis of geographic boundaries. London accounted for four strata, the fifth stratum contained all the other urban areas, and the sixth stratum contained the rural areas. In the first stage of sampling, independent samples of enumeration areas were selected within each stratum from the 1976 census record of all the enumeration areas in the county. A total of 60 areas were selected, the number selected from each stratum being proportional to the square root of the 1976 stratum population. The probability that an enumeration area would be selected was chosen to be proportional to the 1976 population.

In the second stage of sampling, a random sample of households was selected from each enumeration area selected in the first stage. An interviewer first toured the area and produced a list of all the households in the area by means of a standard protocol adopted from the Canada Health Survey.<sup>14</sup> From the list 25 households were selected at random, without replacement.

In the third stage we interviewed all of the eligible adults within the selected households.

This method of sampling ensured that all people in a stratum had the same probability of being selected for the sample. In total, 1500 households were selected, with 3067 people being eligible for interview.

The interview was conducted in the home of the respondent at a time convenient to him or her. The interviewer administered a questionnaire, which took 10 to 15 minutes, then performed three blood pressure measurements using an updated version of the Hawksley random zero sphygmomanometer<sup>15</sup> designed to ran-

domly vary the zero level from 0 to 20 mm Hg; hence the user cannot know the true blood pressure until after the measurement is complete. This procedure has been shown to reduce the risk of end-digit preference and expectation bias in blood pressure measurement.<sup>16</sup> Fifth-phase diastolic pressure was used. When fifth-phase pressure was not detected, fourth-phase pressure was recorded, and a special notation was made. All blood pressure measurements were to be taken on the right arm, with the subject sitting quietly and not smoking. One of three different-sized cuffs was selected, depending on arm circumference.

The interviewers were trained in blood pressure measurement and were evaluated by means of the Rose technique.<sup>17</sup> All the measurements were within 2 mm Hg of the "true" mean systolic and fifth-phase diastolic blood pressure.

Subjects whose minimum diastolic blood pressure exceeded 89 mm Hg at the initial interview were paid a second visit about 1 week later, and the series of blood pressure measurements was repeated. If their minimum diastolic blood pressure was above 89 mm Hg at the second visit, a third visit was carried out about 1 week later. At both return visits information about possible new medical interventions was obtained.

Subjects were considered to be hypertensive if they either had a minimum diastolic blood pressure of over 89 mm Hg at the third visit or stated that they were receiving treatment for hypertension, regardless of their blood pressure level. Their treatment could consist of either drug or nondrug therapy (i.e., low-salt diet, or weight or stress reduction), and hypertension was considered to be controlled by treatment if the minimum diastolic blood pressure was 89 mm Hg or lower.

The identified hypertensive subjects were classified

**Table I—Sociodemographic characteristics of 3067 people in Middlesex County selected for survey of hypertension\***

| Characteristic                                    | Data source         |                        |                  |
|---|---------------------|------------------------|------------------|
|   | Sample, no. (and %) | Estimate for county, % | 1981 census, % † |
| <b>Sex</b>  |                     |                        |                  |
| Male  | 1431 (46.7)         | 46.2                   | 48.5             |
| Female  | 1632 (53.3)         | 53.8                   | 51.5             |
| <b>Race</b>                                       |                     |                        |                  |
| White   | 2962 (97.5)         | 97.5                   | NA               |
| Black   | 19 (0.6)            | 0.8                    | NA               |
| Other   | 57 (1.9)            | 1.7                    | NA               |
| <b>Mean age, yr (and standard deviation [SD])</b> | 42.0 (17.2)         | 41.8 (40.6)            | 42.7‡            |
| <b>Marital status</b>                             |                     |                        |                  |
| Married   | 1900 (69.5)         | 68.4                   | 68.9‡            |
| Not married                                       | 835 (31.5)          | 31.6                   | 31.1‡            |
| <b>Education</b>                                  |                     |                        |                  |
| Some high school                                  | 2357 (86.5)         | 86.9                   | 86.0‡            |
| Completed grade 13                                | 708 (26.0)          | 26.3                   | NA               |
| Completed university                              | 336 (23.3)          | 23.0                   | 11.0‡            |

\*In this table and the others the numbers do not always add up to the potential totals because of missing information or overlap of categories.

†NA = not available.

‡Data for people aged 18 to 20 years were estimated.

into four groups on the basis of previous detection and treatment status. The "undetected" group comprised people with elevated blood pressure at the third visit who denied having been informed that their blood pressure had been elevated in the past. The "untreated" group comprised people with elevated blood pressure at the third visit who were aware of their condition but did not report receiving any treatment. The "uncontrolled" group comprised people who were receiving treatment but whose diastolic blood pressure was elevated at the initial interview. The "controlled" group comprised people receiving treatment whose diastolic blood pressure was not elevated at the initial interview.

To estimate the socioeconomic characteristics of the population of Middlesex County from our data we used a procedure that incorporated the sample selection procedure. These estimates were then compared with the 1981 census data for Middlesex County in order to document any significant selection biases.

Estimates of prevalence and control were calculated by means of formulas adopted from standard sampling theory. Approximate variances were obtained for ratio estimates by means of a Taylor series expansion.<sup>18</sup> Rates were compared by means of chi-square approximation and log-linear modelling when appropriate.<sup>19</sup>

## Results

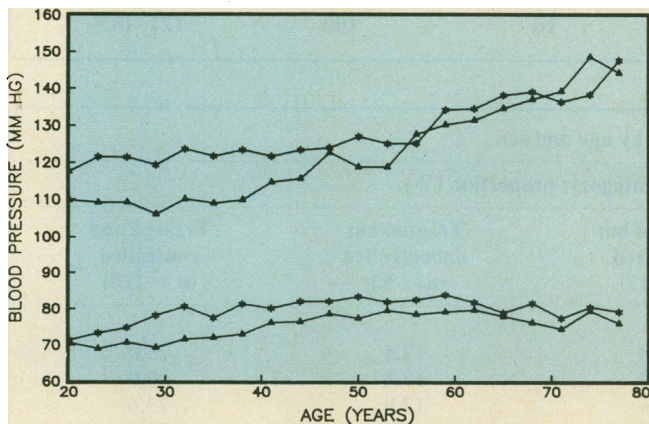
Of the 3067 people eligible for interview 2735 (89.2%) completed the initial interview. The sociodemo-

**Table II—Mean systolic and diastolic blood pressure in three readings at first visit in 2735 subjects**

| Reading | Mean blood pressure<br>(and SD) |               |
|---------|---------------------------------|---------------|
|         | Systolic                        | Diastolic     |
| First   | 124.1 (19.39)                   | 76.9 (11.25)  |
| Second  | 122.9 (18.94)                   | 76.7 (11.07)  |
| Third   | 122.2 (18.51)*                  | 76.5 (10.95)† |

\*Paired  $t = 11.62$ ;  $p < 0.0001$ .

†Paired  $t = 3.99$ ;  $p < 0.0001$ .



**Fig. 1—Mean systolic and diastolic blood pressure in third reading at first visit in 1260 men and 1459 women. \* = systolic (upper line) and diastolic (lower line) pressure, men; ▲ = systolic (upper line) and diastolic (lower line) pressure, women.**

graphic features of the sample are shown in Table I. They reflect the predominantly white-collar/farming community in Middlesex County. Fifty-three percent of the subjects were women. The age of the subjects ranged from 18 to 98 (mean 42) years. The adjusted county estimates showed a slightly higher proportion of women (54%), while the racial composition was unchanged. The adjusted mean age and the education status were also unchanged, while the proportion of the population who were married or in a common-law relationship was slightly lower (68%). The estimated population characteristics were very similar to those found in the 1981 census; thus, there was no indication of any significant bias in the sample.

The response rate for follow-up visits was 94.6%. Of the 14 people who refused follow-up 8 were hypertensive and were receiving treatment, as shown by data collected at the first visit. As the diagnostic and treatment status of these eight people was known, the effective follow-up response rate was therefore 252/258 (97.7%).

All but five subjects had their blood pressure measured while they were sitting. The right arm was used in nearly all the subjects (99.3%). Fifth-phase blood pressure was obtained in 2723 subjects (99.6%), with fourth-phase pressure being recorded in 12 subjects whose Korotkoff sounds extended to zero. All three cuffs were used in the survey: most subjects (84%) required the normal adult cuff, but 1% needed the thigh cuff, and 15% required the pediatric cuff. The thigh cuff proved very difficult to use because of its length, even though the arm circumference was large.

The mean systolic blood pressure at the first visit fell significantly between the first and third reading, by 1.9 mm Hg (Table II). The mean diastolic blood pressure also fell significantly, by 0.4 mm Hg. Linear regression analysis with the third reading showed highly significant trends ( $p < 0.0001$ ) in systolic and diastolic blood pressure with age (Fig. 1): the mean increases per year of age for men were 0.38 and 0.16 mm Hg respectively, while the corresponding figures for women were 0.64 and 0.17 mm Hg.

Of the 2735 subjects 314 were found to be hypertensive (Table III), for an estimated prevalence rate of 115/1000, with a 95% confidence interval of 103/1000 to 127/1000. Eliminating the 28 subjects who had blood pressure readings under 90 mm Hg and whose only treatment consisted of nondrug therapy gave a prevalence rate of 105/1000, with a 95% confidence interval of 91/1000 to 118/1000 (Table IV).

The estimated population prevalence rates for our sample are presented in Table III. The rates of undetected and detected but untreated hypertension were low (6/1000 and 7/1000 respectively). Only 5.2% of the hypertensive subjects were unaware of their condition, and only 5.9% were aware but not receiving treatment. In another 72.4% the hypertension was controlled with treatment. Eliminating the 28 people with normal blood pressure whose only treatment consisted of nondrug therapy gave a slightly higher proportion of the population with undetected hypertension (5.8%), a higher proportion with detected but untreated hypertension (7.3%) and a slightly lower proportion with hypertension controlled with treatment (70.4%) (Table IV).

**Table III—Categories of hypertension in 314 subjects**

| Category                 | No. of subjects | Estimated prevalence per 1000 population (and standard error of the mean [SEM]) | Estimated proportion of population (%) |
|--------------------------|-----------------|---|--|
| Undetected               | 16              | 6 (1.5)   | 5.2                                    |
| Detected but untreated   | 17              | 7 (1.5)   | 5.9                                    |
| Treated but uncontrolled | 53              | 19 (2.5)  | 16.5                                   |
| Treated and controlled   | 228             | 83 (6.3)  | 72.4                                   |
| <b>Total</b>             | <b>314</b>      | <b>115 (6.6)</b>  | <b>100.0</b>                           |

**Table IV—Categories of hypertension in all subjects except the 28 whose condition was controlled with nondrug therapy**

| Category                 | No. of subjects | Estimated prevalence per 1000 (and SEM) | Estimated proportion of population (%) |
|--------------------------|-----------------|---|--|
| Undetected               | 16              | 6 (1.5)                                 | 5.8                                    |
| Detected but untreated   | 19              | 8 (1.6)                                 | 7.3                                    |
| Treated but uncontrolled | 49              | 17 (2.2)                                | 16.5                                   |
| Treated and controlled   | 202             | 74 (6.7)                                | 70.4                                   |
| <b>Total</b>             | <b>286</b>      | <b>105 (6.8)</b>                        | <b>100.0</b>                           |

**Table V—Prevalence rates of hypertension in 2735 subjects, by age and sex**

| Characteristic    | Hypertension category; rate per 1000 |                        |                          |                        | Total (and SEM) |
|-------------------|--------------------------------------|------------------------|--------------------------|------------------------|-----------------|
|                   | Undetected                           | Detected but untreated | Treated but uncontrolled | Treated and controlled |                 |
| <b>Age (yr)</b>   |                                      |                        |                          |                        |                 |
| ≤ 29 (n = 832)    | 1                                    | 0                      | 1                        | 7                      | 10 (3.4)        |
| 30–44 (n = 773)   | 5                                    | 8                      | 10                       | 35                     | 58 (8.4)        |
| 45–69 (n = 915)   | 11                                   | 8                      | 38                       | 159                    | 215 (13.6)      |
| ≥ 70 (n = 204)    | 10                                   | 20                     | 39                       | 240                    | 304 (4.9)       |
| <b>Sex</b>        |                                      |                        |                          |                        |                 |
| Male (n = 1266)   | 10                                   | 11                     | 23                       | 64                     | 107 (8.7)       |
| Female (n = 1469) | 3                                    | 2                      | 16                       | 100                    | 121 (8.5)       |

**Table VI—Proportion of subjects in each hypertension category, by age and sex**

| Characteristic  | Category; proportion (%) |                                 |                                   |                                  |
|-----------------|--------------------------|---------------------------------|-----------------------------------|----------------------------------|
|                 | Undetected (n = 16)      | Detected but untreated (n = 17) | Treated but uncontrolled (n = 53) | Treated and controlled (n = 228) |
| <b>Age (yr)</b> |                          |                                 |                                   |                                  |
| ≤ 29            | 13.5                     | 0.0                             | 12.5                              | 75.0                             |
| 30–44           | 8.9                      | 13.3                            | 17.8                              | 60.0                             |
| 45–69           | 5.1                      | 3.6                             | 17.8                              | 73.6                             |
| ≥ 70            | 1.6                      | 6.5                             | 8.7                               | 79.0                             |
| <b>Sex</b>      |                          |                                 |                                   |                                  |
| Male            | 8.8                      | 10.3                            | 21.3                              | 59.6                             |
| Female          | 2.2                      | 1.7                             | 13.5                              | 82.6                             |

The prevalence of hypertension was strongly related to the age of the subjects, rising from 10/1000 for people under age 30 to 304/1000 for people over age 69 ( $\chi^2 = 275$  with 3 degrees of freedom [df],  $p < 0.0001$ ) (Table V). In contrast, the prevalence of hypertension was unrelated to sex ( $\chi^2 = 1.26$ , 1 df,  $p = 0.26$ ).

There was no significant difference in the proportion of hypertensive subjects with controlled hypertension among the age groups ( $\chi^2 = 4.80$ , 2 df,  $p = 0.09$ ) (Table VI). There was a nonsignificant drop in the proportion of subjects with undetected hypertension as age increased ( $\chi^2 = 3.54$ , 2 df,  $p = 0.17$ ). The first two age groups were combined for these analyses. The proportion of women with controlled hypertension (82.6%) was significantly higher than the corresponding proportion of men (59.6%) ( $\chi^2 = 20.5$ , 1 df,  $p < 0.0001$ ). The proportion of subjects with undetected hypertension was significantly lower among the women ( $\chi^2 = 6.89$ , 1 df,  $p = 0.01$ ), but in both groups this proportion was low (2.2% and 8.8% respectively).

There were no statistically significant differences between urban and rural areas in prevalence rates (124/1000 and 113/1000 respectively,  $\chi^2 = 0.51$ , 1 df,  $p = 0.47$ ) or in rate of control of hypertension (72% and 77% respectively,  $\chi^2 = 0.63$ , 1 df,  $p = 0.43$ ), but there were nonsignificant trends toward lower prevalence rates and more frequent control in rural areas.

Multivariate log-linear analysis confirmed the univariate results and did not show any interaction effects.

## Discussion

The major conclusion from this survey is that physicians in Middlesex County are doing better than expected in detecting and treating people with sustained diastolic hypertension. Unlike most investigators, we did not find many subjects with undetected hypertension. Furthermore, in most of the subjects receiving treatment, therapy reduced the diastolic blood pressure to under 90 mm Hg. These results suggest that screening is not needed in Middlesex County. However, hypertension control could be improved by providing better treatment for people who are not already receiving optimal treatment. Reasons for less-than-optimal treatment may include noncompliance with treatment, belief by the physician that treatment is not necessary or inadequate dosing.

Results of the Minnesota Heart Survey<sup>20</sup> indicated that detection and control of hypertension are now substantially better than 10 years ago. Two random samples of adults aged 25 to 59 years were studied, the first in 1973-74 and the second in 1980-81. Subjects were considered to be hypertensive if they had a diastolic blood pressure reading greater than 95 mm Hg at one visit or were receiving antihypertensive medication. The proportion of subjects who were unaware that they were hypertensive dropped substantially between the two periods, from 25.5% to 6.6%, and the proportion whose hypertension was controlled increased greatly, from 40.4% to 76.1%. These rates are similar to those found in our survey. Methodologic differences between the two surveys preclude a more formal comparison, but

it is encouraging to find such good control rates in other communities.

A further factor in interpreting our results is the method we used to diagnose hypertension. In persons who were receiving antihypertensive treatment it was not possible to determine blood pressure measurements before treatment, nor was it possible to conduct a chart review. Therefore, it was not possible to verify the original diagnosis of hypertension. If physicians were treating people who did not require treatment, an artefactually high control rate would have been found. However, a survey of physicians in Middlesex County did not reveal any evidence to support this possibility.<sup>21</sup>

The criterion used to classify people as hypertensive was a sustained diastolic blood pressure of 90 mm Hg or higher. At the time we conducted our survey the recommended treatment criteria were sustained diastolic blood pressure over 105 mm Hg or target organ damage with sustained blood pressure between 90 and 104 mm Hg.<sup>22</sup> Hence, the diagnostic level we selected was more liberal than that recommended. We selected the level of 90 mm Hg for two reasons. First, many physicians are already using this level in their own practices.<sup>21</sup> Second, as we could not obtain blood pressure measurements before treatment, we would have been unable to determine whether people receiving treatment actually met the diagnostic criterion. When we examined our data using a level of 100 mm Hg, we found much lower rates of undetected hypertension (less than 1%) and somewhat better rates of hypertension control (80%).

The general characteristics of blood pressure levels in our sample conformed to established epidemiologic knowledge. There was a significant trend toward higher systolic and diastolic blood pressure in older people. The overall prevalence rate was lower than in many American studies but was similar to that reported in a white sample in Connecticut when allowance is made for the absence of follow-up visits in that study.<sup>8</sup> As in other studies,<sup>8</sup> control was better in women and in older people.

Our study provides a statistically valid description of hypertension control in Middlesex County. However, caution must be used in extrapolating our results to other areas of the country. Our sample was not a random sample of Canadians and differed in many important ways from populations in other regions: racial composition, diet, socioeconomic circumstances and access to health care. Hence, it is important that further surveys be conducted in other parts of Canada to determine whether the encouraging situation in Middlesex County is being replicated elsewhere.

We thank the interviewing team, whose diligence made the project a success, the people of Middlesex County, for their cooperation, and Dr. David L. Sackett, for valuable feedback and guidance.

The project was funded in part by grant DM513 from the Health Care Systems Research Committee, Ontario Ministry of Health. One of us (N.J.B.) held a Research Scientist Award from the Government of Ontario at the beginning of the project and a Research Scholar Award from the Department of National Health and Welfare at the conclusion of the project.

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## MEETINGS

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June 16-20, 1985

International Conference on Oceans Safety and Health  
Sydney, NS

Professor Lino Polegato, Director, Division of Engineering,  
University College of Cape Breton, PO Box 5300, Sydney,  
NS B1P 6L2; (902) 539-5300

June 16-21, 1985

XII Interamerican Congress of Cardiology  
Hotel Vancouver and Hyatt Regency Hotel  
The Secretariat, c/o Venue West Ltd., XII Interamerican  
Congress of Cardiology, 801-750 Jervis St., Vancouver, BC  
V6E 2A9; (604) 681-5226

June 18-21, 1985

3rd National Conference on Gerontological Nursing  
Hamilton Convention Centre  
Dorothy Pringle, VON for Canada, 76 St. Clair Ave. W,  
#400, Toronto, Ont. M4V 1N2

June 21-23, 1985

Pediatric Nutrition  
Montreal

Dr. R.K. Chandra, Janeway Child Health Centre, St. John's,  
Nfld. A1A 1R8

June 23-28, 1985

Sixth Annual Congress of the Canadian Society of Laboratory  
Technologists

Convention Centre, Winnipeg

Mr. Kurt H. Davis, Director, Information Services, Canadian  
Society of Laboratory Technologists, PO Box 830,  
Hamilton, Ont. L8N 3N8; (416) 528-8642

June 26-29, 1985

International Classification in Psychiatry: Unity and Diversity  
Queen Elizabeth Hotel, Montreal

Dr. A.N. Singh, Chairman, Organizing committee, Hamilton  
Psychiatric Hospital, PO Box 585, Hamilton, Ont. L8N  
3K7; (416) 388-2511

August

Aug. 25-30, 1985

Fourth World Conference on Lung Cancer  
Toronto

Fourth World Conference on Lung Cancer, Secretariat office,  
342 MacLaren St., Ottawa, Ont. K2P 0M6; (613) 234-4398

Aug. 2-7, 1987

International Association of Forensic Sciences  
Vancouver

International Association of Forensic Sciences, 801-750 Jervis  
St., Vancouver, BC V6E 2A9; (604) 681-5226