# Predictors of palliative care program enrollment in Nova Scotia, Canada: Our findings using CART and hierarchical modeling

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# Context

Past research: Covariates with low palliative care program (PCP) enrollment for cancer decedents

- older age, time from diagnosis to death, distance to PCP
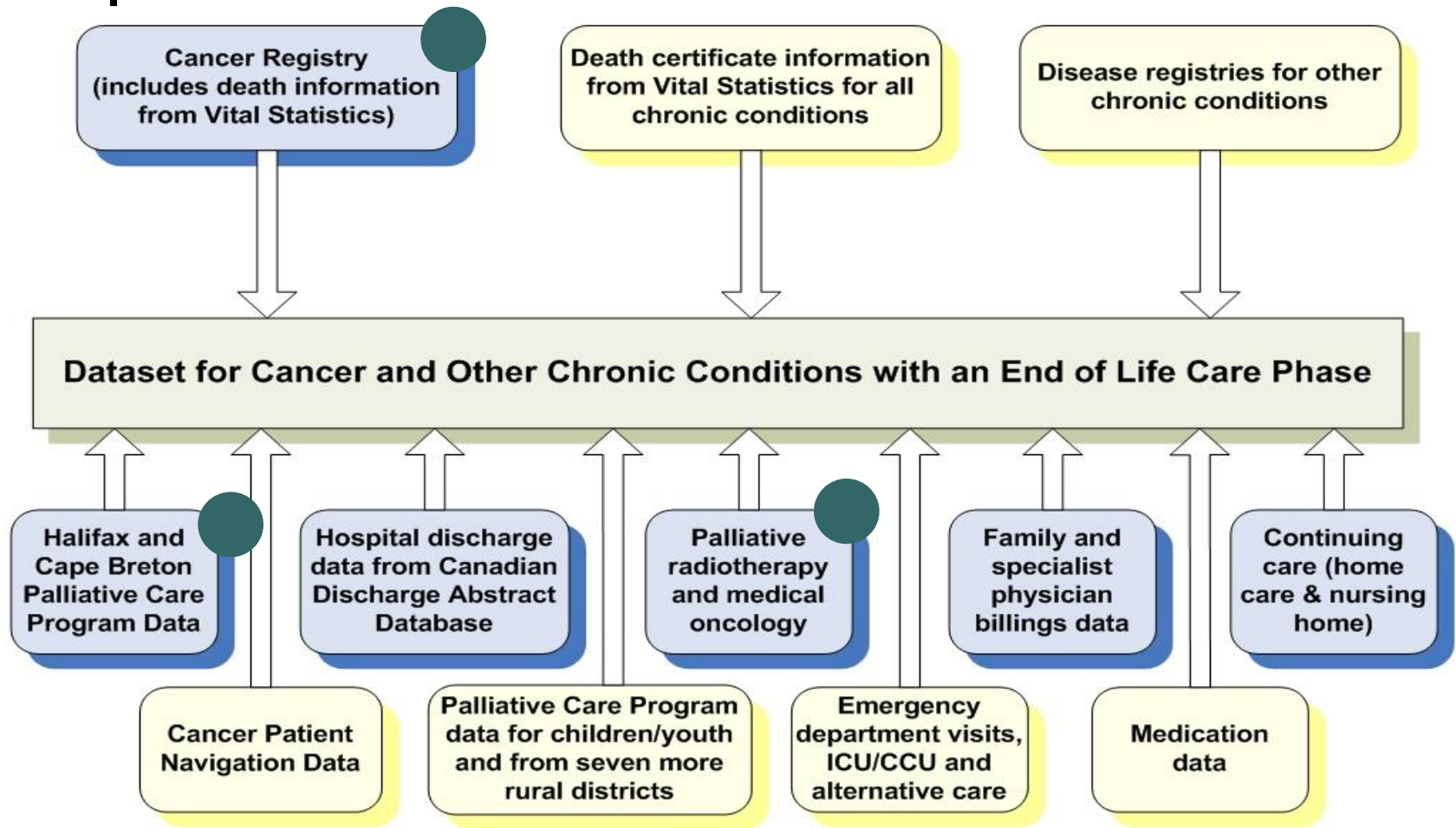
  (Johnston G et al (1998) **CMAJ** 158:1691-8; Burge et al (2002) **Pall Med** 16:255-6)

Recent analyses:

- Classification and Regression Tree (CART) and Hierarchical Modeling with more variables, e.g., nursing home; second PCP; update data to 2003

# Current and Proposed Data



**DECEDENTS DATASET SERVICES**

**Cancer Registry** (includes death information from Vital Statistics)

**Death certificate information** from Vital Statistics for all chronic conditions

**Disease registries for other** chronic conditions

**Dataset for Cancer and Other Chronic Conditions with an End of Life Care Phase**

**Halifax and Cape Breton Palliative Care Program Data**

**Hospital discharge data from Canadian Discharge Abstract Database**

**Palliative radiotherapy and medical oncology**

**Family and specialist physician billings data**

**Continuing care (home care & nursing home)**

**Cancer Patient Navigation Data**

**Palliative Care Program data for children/youth and from seven more rural districts**

**Emergency department visits, ICU/CCU and alternative care**

**Medication data**

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Currently included in cancer data set

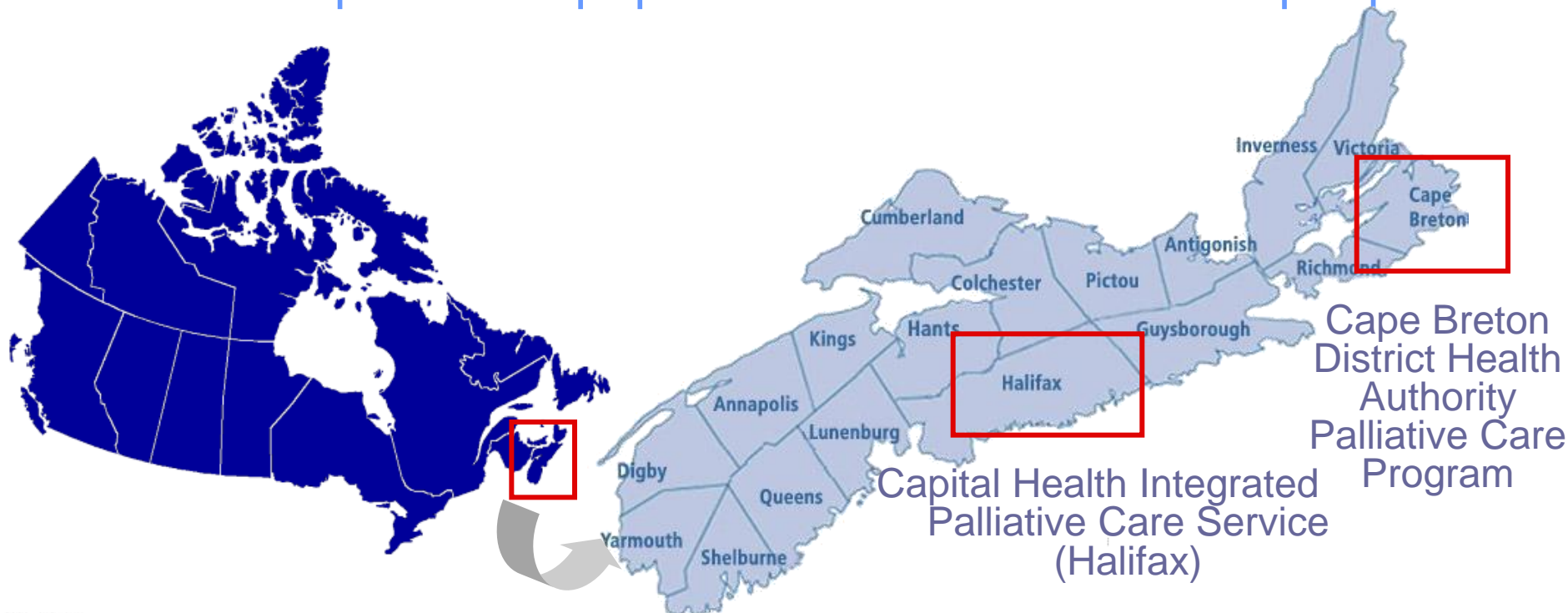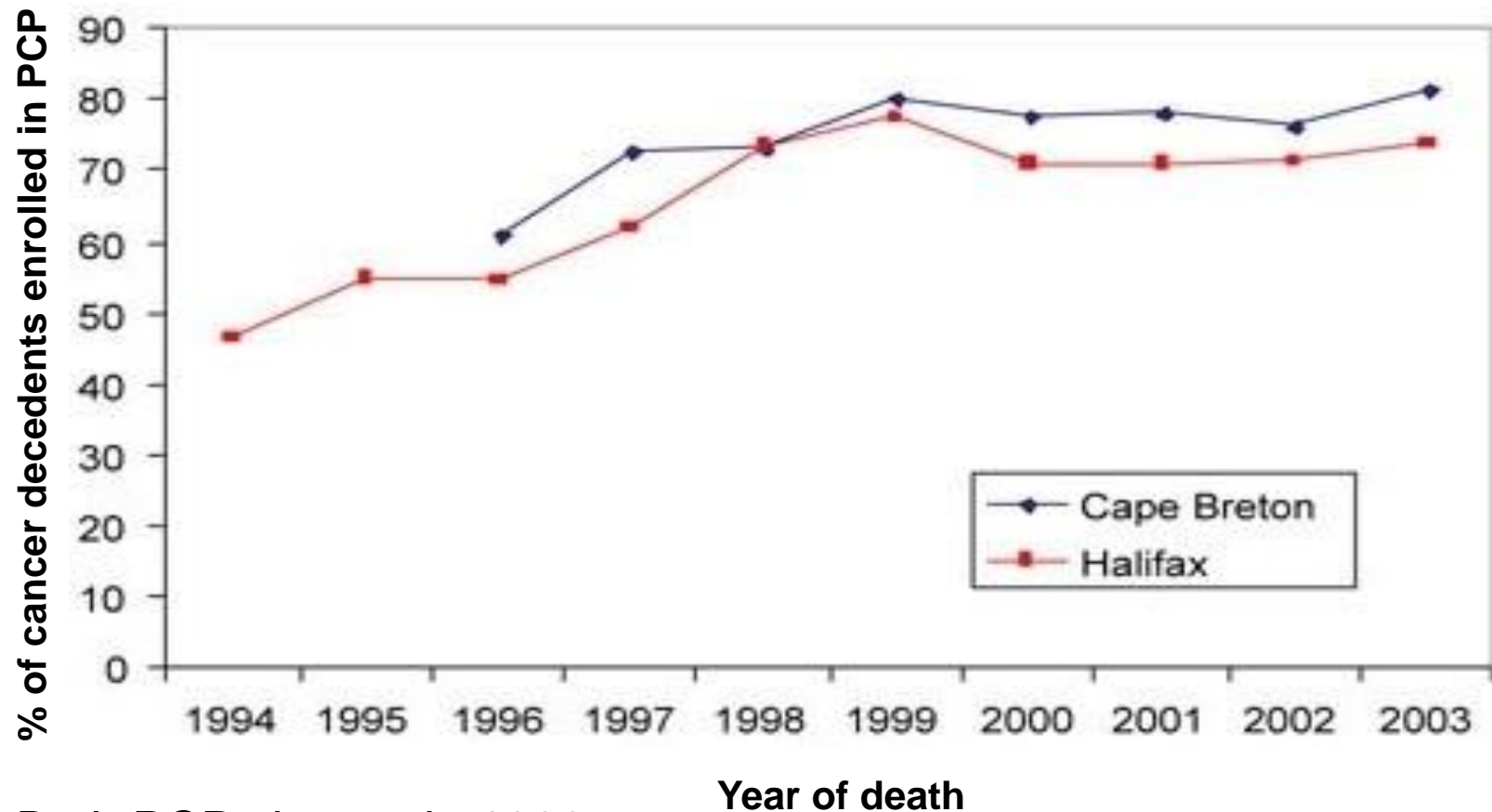Proposed for chronic disease data set

# Purpose

To contrast insights from **CART** and **hierarchical modeling**, compared to past multiple logistic regression findings, **to identify predictors of palliative care program enrollment**.

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# Study Population

Adults (18+ years) who died of cancer from 1998 to 2003
o  death certificates (ICD9-CM and ICD10-CM)

o  two largely urban districts: Halifax and Cape Breton, 54% of provincial population of almost a million people



Cape Breton District Health Authority Palliative Care Program

Capital Health Integrated Palliative Care Service (Halifax)

Maps from ww.globecanada.net and
http://www.gov.ns.ca/snsmr/freemaps/

# % of cancer decedents enrolled in PCP over time



Both PCPs began in 1988;
Databases began in 1998 for Halifax, and 1996 for Cape Breton

# Classification and Regression Tree (CART)

**CART Purposes**:

o   CIHR NELS ICE grant purpose is to address inequities in access to quality care at end of life

o   Identify low PCP enrollment subpopulations for deaths between 2000 and 2003
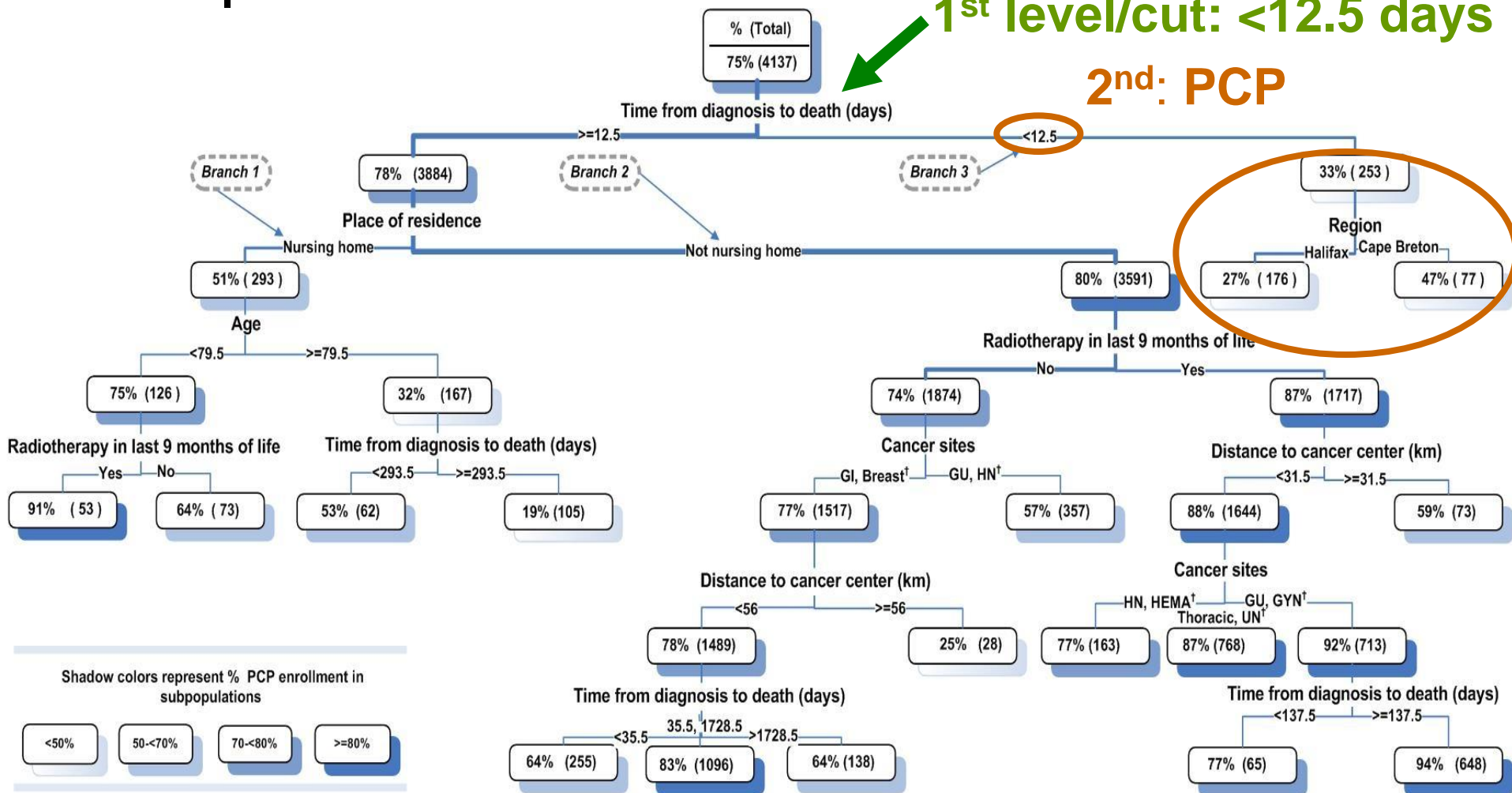
**Value of CART**:

*Segmenting population* into mutually exclusive subpopulations associated with a risk factor, in this study: *low % PCP enrollment*

# CART



**Of 4,137 decedents, 75% PCP enrolled:**

**1st level/cut: <12.5 days**

**2nd: PCP**

**For those diagnosed within 12 days of death, PCP enrolment varied by PCP**

Branch 3

Time from diagnosis to death (days) <12.5

% (Total)

33% (253)

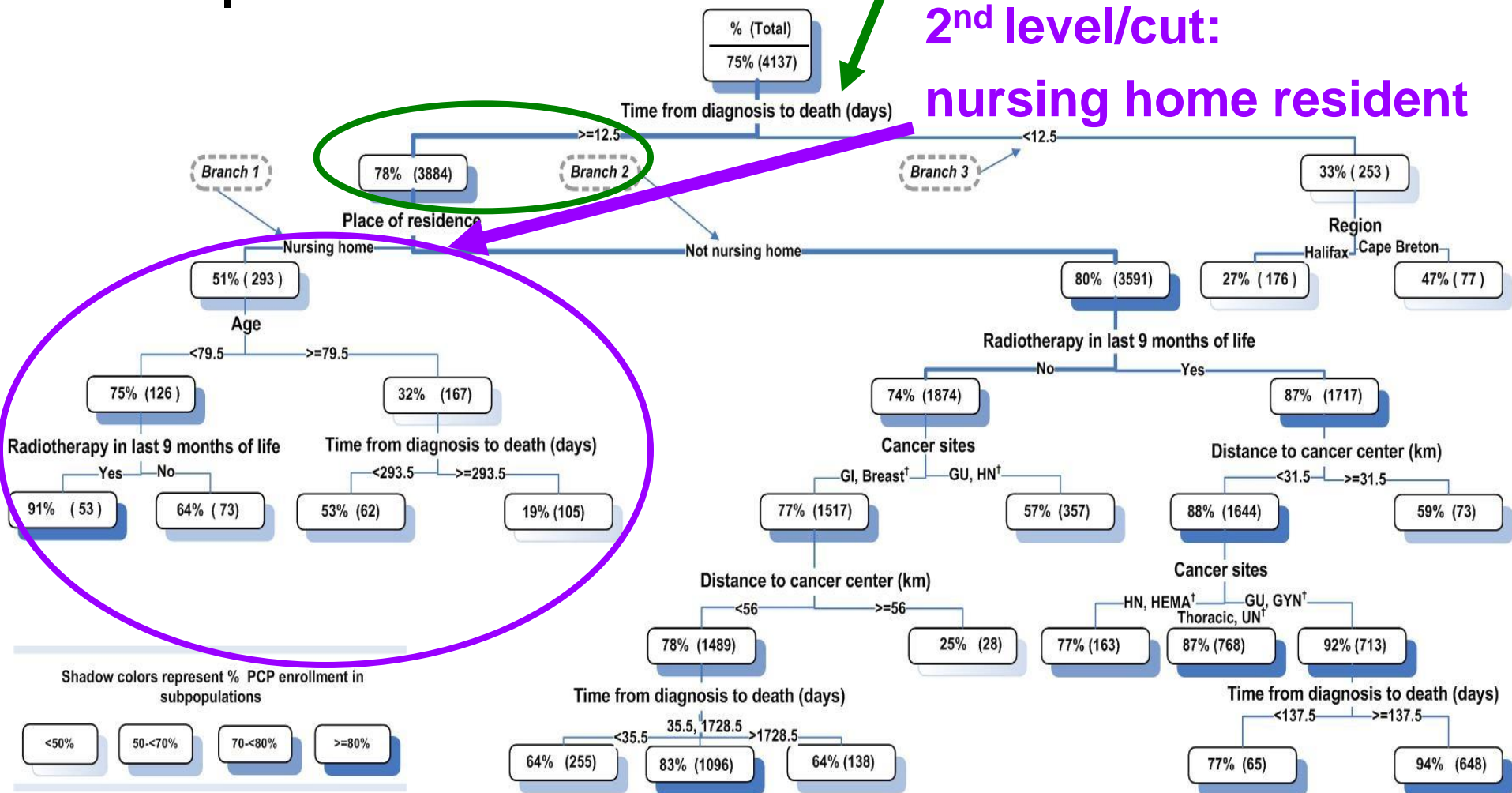Region

Halifax — Cape Breton

27% (176)    47% (77)
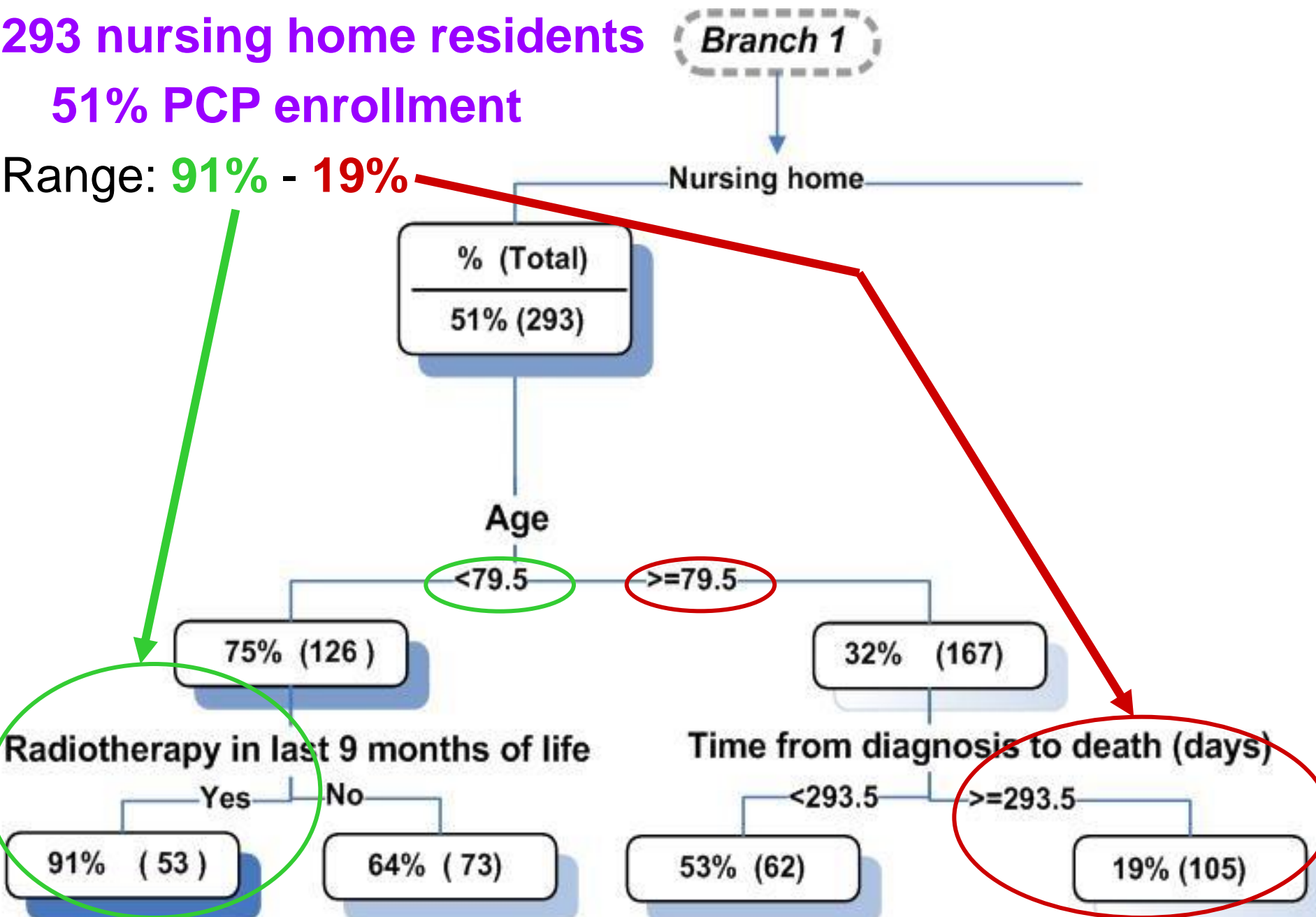
# CART



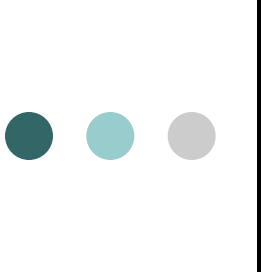1st level/cut: >12.5 days
78% PCP enrolled
2nd level/cut:
nursing home resident

**293 nursing home residents**

**51% PCP enrollment**

Range: **91%** - **19%**

Branch 1

Nursing home

% (Total)

51% (293)

Age

<79.5    >=79.5

75% (126)

32% (167)

Radiotherapy in last 9 months of life

Time from diagnosis to death (days)

Yes    No

<293.5    >=293.5

91% (53)

64% (73)

53% (62)

19% (105)

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# Hierarchical Nonlinear Regression Model, 1998-2003
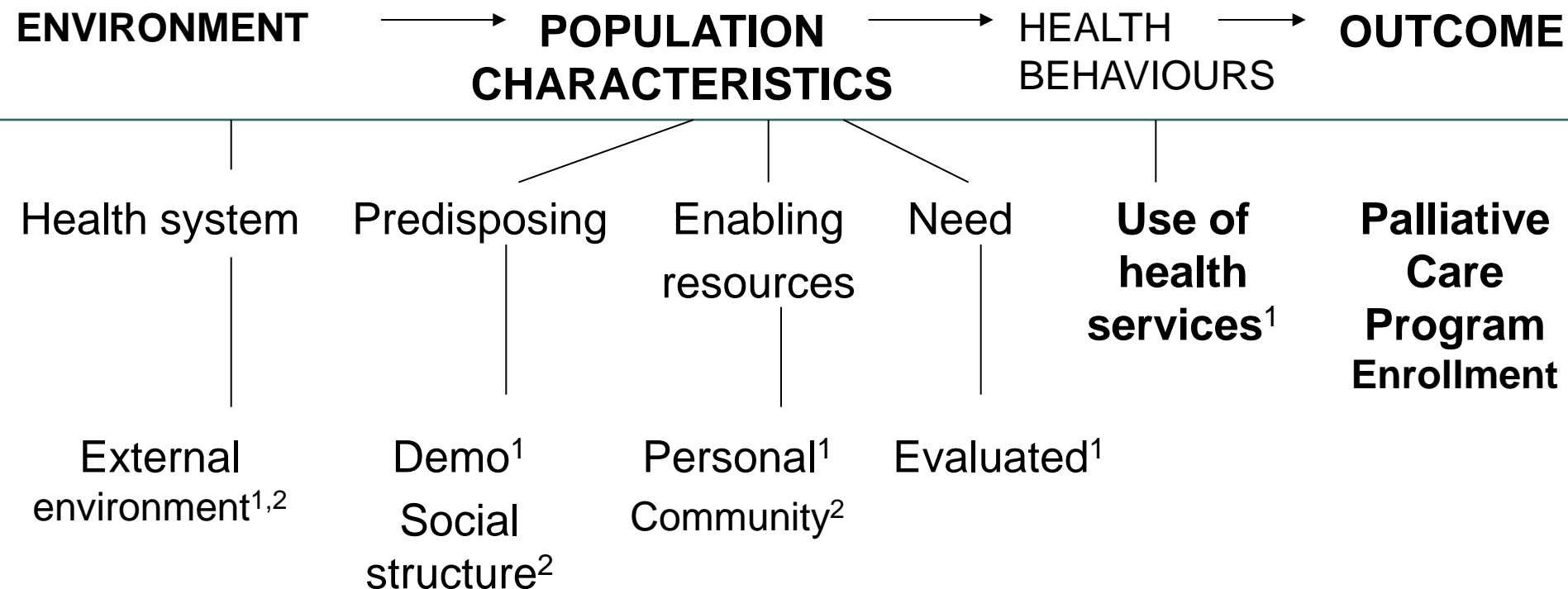
**Purposes**:

o CIHR grant to investigate aging effects at end of life

o Re-examine relationship between age and PCP enrolment

**Value of Model**:

o Multi-level data: individual and community

o Results presented across all study subjects

o Simultaneously adjusts for many variables

o Application of Andersen's conceptualization

# Andersen's model of health utilization - adapted

| ENVIRONMENT | → | POPULATION CHARACTERISTICS | → | HEALTH BEHAVIOURS | → | OUTCOME |
|---|---|---|---|---|---|---|

Health system | Predisposing | Enabling resources | Need | **Use of health services**[1] | **Palliative Care Program Enrollment**

External environment[1,2] | Demo[1] Social structure[2] | Personal[1] Community[2] | Evaluated[1]

[1]Individual level;  [2]Community level

# Hierarchical Modeling Selected Results

| Predictors of PCP Enrolment: Demographic, Enabling, Need | Odds ratio (OR); 95% Confidence Interval (CI) | |
| --- | --- | --- |
| | **Unadjusted** | **Adjusted*** |
| **Age** (versus <65 years)<br>65-74<br>75-84<br>**85+** | <br>0.6 (0.5, 0.7)<br>0.4 (0.4, 0.5)<br>**0.2 (0.2, 0.2)** | <br>0.8 (0.7, 0.9)<br>0.7 (0.6, 0.8)<br>**0.4 (0.3, 0.5)** |
| **Nursing home resident** (no)<br>yes | <br>**0.3 (0.3, 0.4)** | <br>**0.5 (0.4, 0.6)** |
| **Survival** (< 61 days)<br>**61-120 days**<br>121-183+ days | <br>**2.1 (1.7, 2.5)**<br>1.7 (1.6, 2.0) | <br>**1.8 (1.5, 2.3)**<br>1.5 (1.3, 1.8) |
| **Charlsen Co-morbidity index** | **1.2 (1.2, 1.2)** | **1.1 (1.1, 1.1)** |

# Hierarchical Modeling: More Results

| Predictors of PCP Enrolment: Service and System Factors | Odds ratio (OR); 95% Confidence Interval (CI) | |
| --- | --- | --- |
| | Unadjusted | Adjusted[*] |
| **Hospital days** last 6 months (0)<br>1-14<br>15-31<br>**32+** | <br>1.4 (1.2, 1.6)<br>1.8 (1.6, 2.1)<br>2.0 (1.7, 2.3) | <br>0.8 (0.7, 1.0)<br>1.3 (1.0, 1.6)<br>**1.7 (1.4, 2.3)** |
| **Radiotherapy** last 6m (no)<br>**yes** | <br>3.3 (2.9, 3.7) | <br>**2.7 (2.4, 3.1)** |
| **Distance to care (> 50 km)**<br>0-10 km<br>11-50 km | <br>7.9 (6.6, 9.5)<br>8.3 (6.9, 10.0) | <br>8.2 (6.0, 11.1)<br>8.2 (6.1, 11.0) |

# Conclusions

**Hierarchical modeling** improved the conceptualization incorporating many variables.

Results did not differ substantially from traditional multiple logistic regression.

**CART** produced relevant cut points and more clearly identified subpopulations of low PCP enrollment for intervention; better translates research into practice. Presenting/interpreting CART findings is challenging.

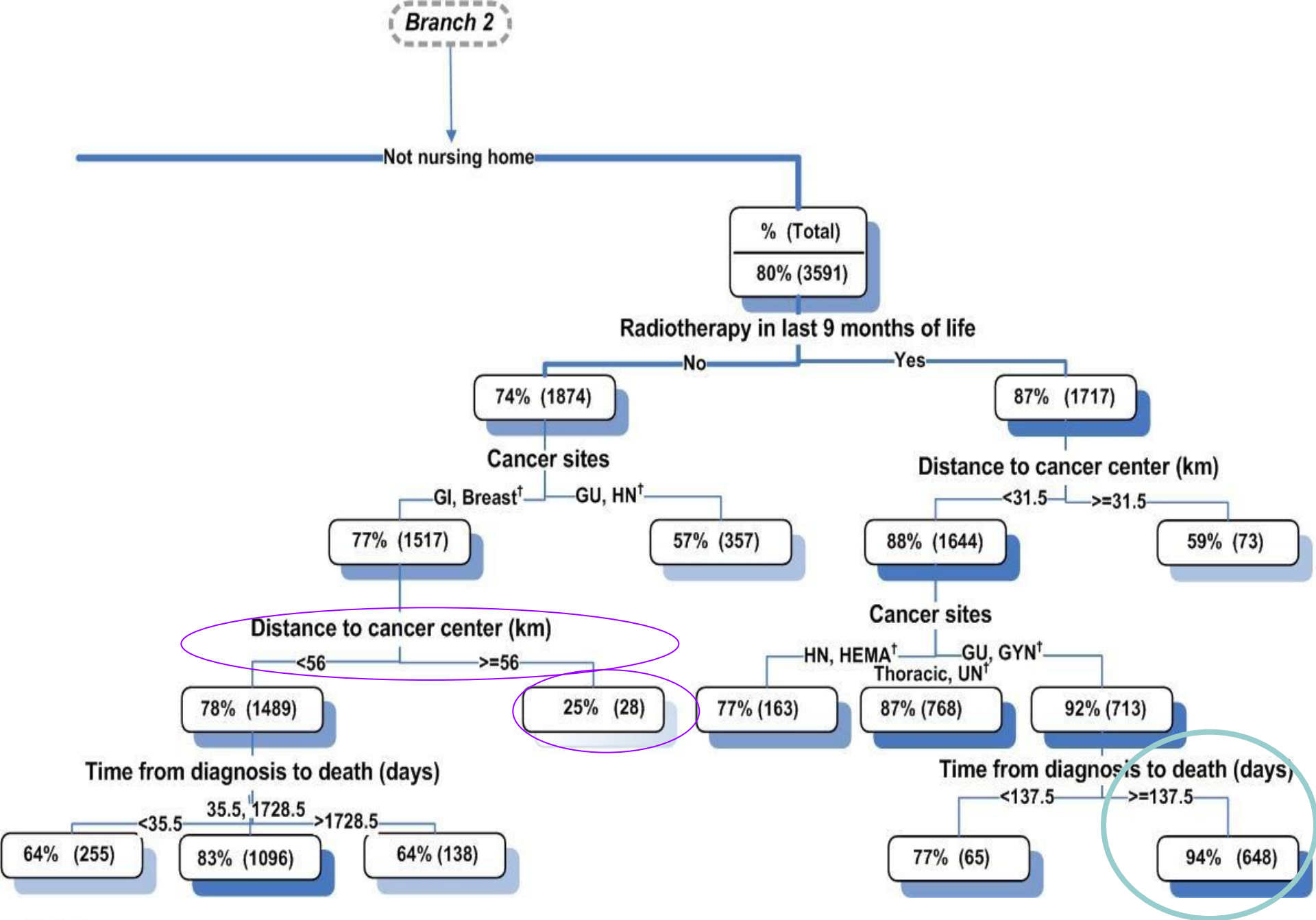# Acknowledgements

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# Hierarchical Modeling Additional Level 1 Results

| Predictors of PCP Enrolment | Odds ratio (OR); 95% Confidence Interval (CI) | |
|---|---|---|
| | **Unadjusted** | **Adjusted*** |
| Sex (vs Female) - Male | 0.8 (0.8, 0.9) | 0.8 (0.7, 0.9) |
| 1+ medical oncology consultation (vs no) Yes | 3.7 (3.2, 4.3) | 2.0 (1.7, 2.5) |

*Final multivariate models. Adjusted for all other factors in the final model. Estimates associated with the population average model with robust standard errors are reported here

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# Level 2: Hierarchical Model

| Neighbourhood factors | Odds Ratios (95% CI) | |
|---|---|---|
| Predictors of PCP Enrolment | Unadjusted | Adjusted[*] |
| Visible minorities excluding black (<10%) >= 10% visible minorities | 1.6 (1.3, 2.0) | 1.3 (1.0, 1.7) |
| Francophone community (< 10% French >= 10% French as mother tongue | 0.2 (0.1, 0.3) | 0.6 (0.3, 1.0) |
| High school graduates (<50%) >=50% graduated high school | 2.1 (1.6, 2.7) | - |
| Urban rural indicator (vs Urban) Rural | 0.5 (0.5, 0.6) | 0.8 (0.7, 1.0) |
| Income quintiles  (vs upper) Low Low-middle Middle Upper-middle | 0.8 (0.7, 1.0) 0.7 (0.6, 0.9) 0.8 (0.7, 0.9) 1.0 (0.8, 1.2) | 0.9 (0.7, 1.1) 0.7 (0.6, 0.9) 0.8 (0.6, 1.0) 1.1 (0.8, 1.3) |