

# Estimating dynamics of direct medical costs among individuals with HIV/AIDS

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## Background

- A recent systematic review of published studies reporting on primary data for the direct medical costs of treating HIV-infected individuals revealed only nine studies that provided adequate data to make a meaningful statement about costs. Many of these studies were based on pre- and early-HAART era patient populations.
- Our objective is to characterize direct non-HAART medical costs by CD4-defined stage of disease progression and over time for HIV-infected individuals in British Columbia, Canada throughout the HAART era.

## Methods

- This study was based on a provincial-level linkage of a set of seven health administrative databases and disease registries in BC.
- The primary dependent variables considered in these analyses were direct non-HAART medical costs, and its components: costs of hospitalization, physician billing, and non-HAART drug dispensations.
- Two-part, or hurdle models were estimated to account for excess zeroes in each of the dependent variables. In the first stage, generalized linear models were specified with binomial distributions and logit link functions. In the second stage (non-zero cost observations), models were estimated with gamma distribution and log link function.
- We used the product rule to determine the total marginal effects of CD4 strata on the set of defined dependent variables. Total costs (TC) are modeled as the product of 2 factors (TC = P x L), where P is the probability of having nonzero costs and L is the level of the nonzero costs that occur.
- Therefore:  $TC'(CD4) = [P'(A) \times L] + [P \times L'(A)]$ , where L and P are evaluated at their predicted mean adjusted for all covariates. We interpret  $TC'(CD4)$  as the marginal effect on direct non-HAART costs of a change in CD4 stratum.

## Results

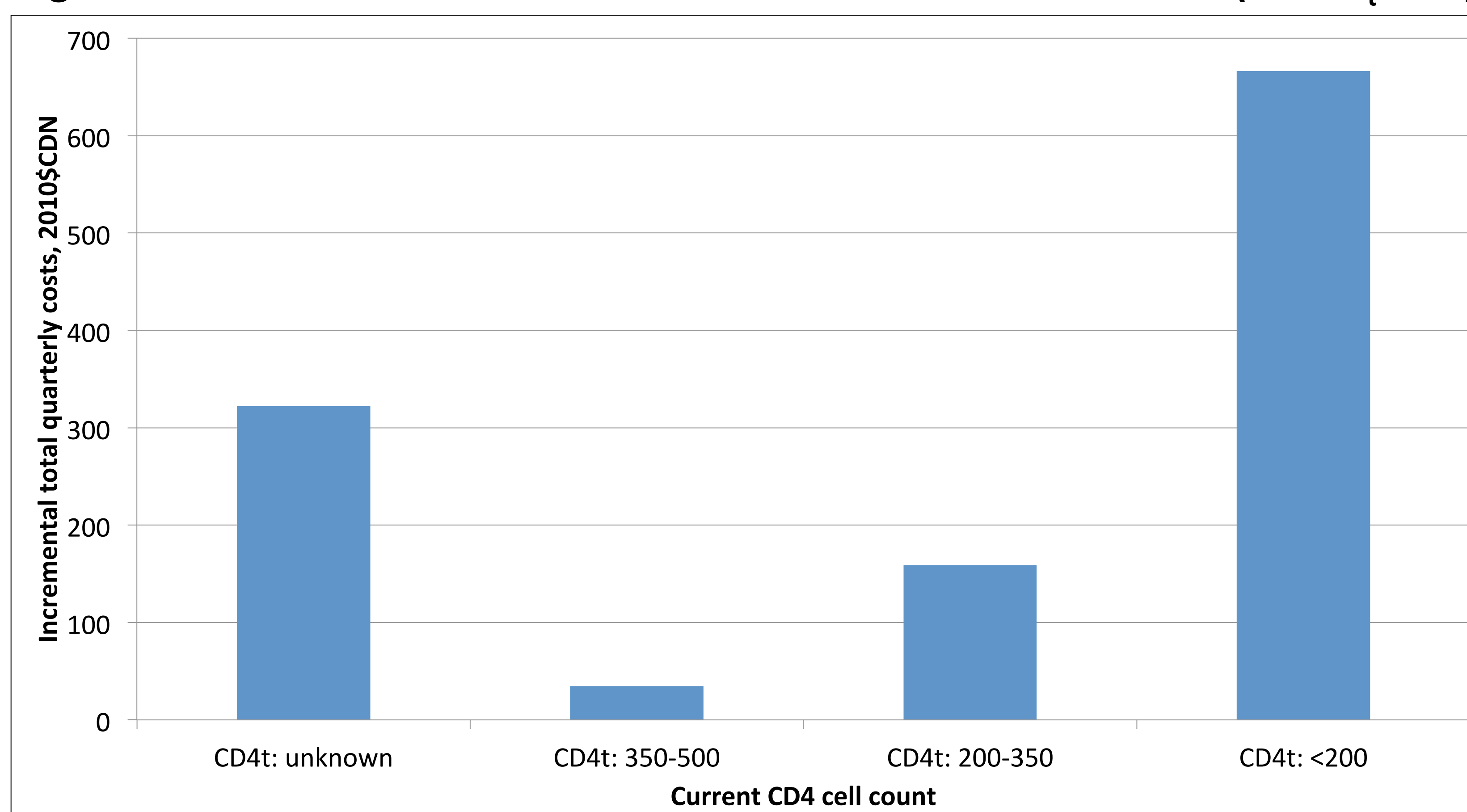
- Current CD4<500 was associated with modestly lower probability of non-zero cost, but progressively higher costs in non-zero observations for lower CD4 strata, and in observations in which CD4 data was not available (Table 1).
- Compared to person-quarters in which CD4 was >500, costs were \$35 (95%CI: \$34, \$35) greater for CD4:350-500; \$159 (\$159, \$159) greater for CD4 200-350 and \$667 (\$666, \$667) greater when CD4<200. Finally, those with no measured CD4 had costs \$322 (\$322, \$323) greater than in periods with CD4>500 (Figure 1).
- Compared to person-quarters with CD4>500, those with no available CD4 data featured marginally lower non-HAART drug dispensation costs (-\$4), but substantially higher costs of hospitalization and physician billing; the increment in hospitalization and physician billing costs among those with no available CD4 data were lower than the CD4<200 stratum, but higher than the CD4: 200-350 stratum (Table 2).
- Hospitalization costs have decreased as a proportion of total costs among known prevalent cases, while the costs of HAART have increased (Figure 2).

**Table 1: Marginal effects from two-stage analysis on direct non-HAART medical costs**

	Probability of non-zero costs				Costs in non-zero responses			
	dy/dx	95% CI	p	dy/dx	95% CI	p		
Calendar year	-0.007	-0.008 -0.006	<0.001	63.85	41.68 86.01	<0.001		
Calendar year <sup>2</sup>	0.000	0.000 0.000	<0.001	-3.17	-4.48 -1.86	<0.001		
Substance Use	0.025	0.022 0.029	<0.001	1166.24	1099.35 1233.13	<0.001		
Mortality within 3 months	0.046	0.043 0.049	<0.001	7516.69	6744.20 8289.17	<0.001		
On HAART <sub>t</sub>	0.190	0.177 0.202	<0.001	576.32	502.83 649.81	<0.001		
CD4 <sub>t</sub> : unmeasured	-0.003	-0.010 0.004	0.472	367.50	261.59 473.42	<0.001		
CD4 <sub>t</sub> : ≥500	Ref.			Ref.				
CD4 <sub>t</sub> : 350-500	-0.010	-0.018 -0.002	0.010	63.39	-4.91 131.69	0.069		
CD4 <sub>t</sub> : 200-350	-0.011	-0.019 -0.003	0.005	205.44	132.21 278.68	<0.001		
CD4 <sub>t</sub> : <200	-0.010	-0.019 -0.001	0.038	770.28	662.50 878.06	<0.001		

Ref: reference group; HR (95%CI): Adjusted Hazard Ratio (95% Confidence Interval); \*controlling for age, gender, medical comorbidity (Charlson Comorbidity Index score), baseline CD4, current AUC pVL.

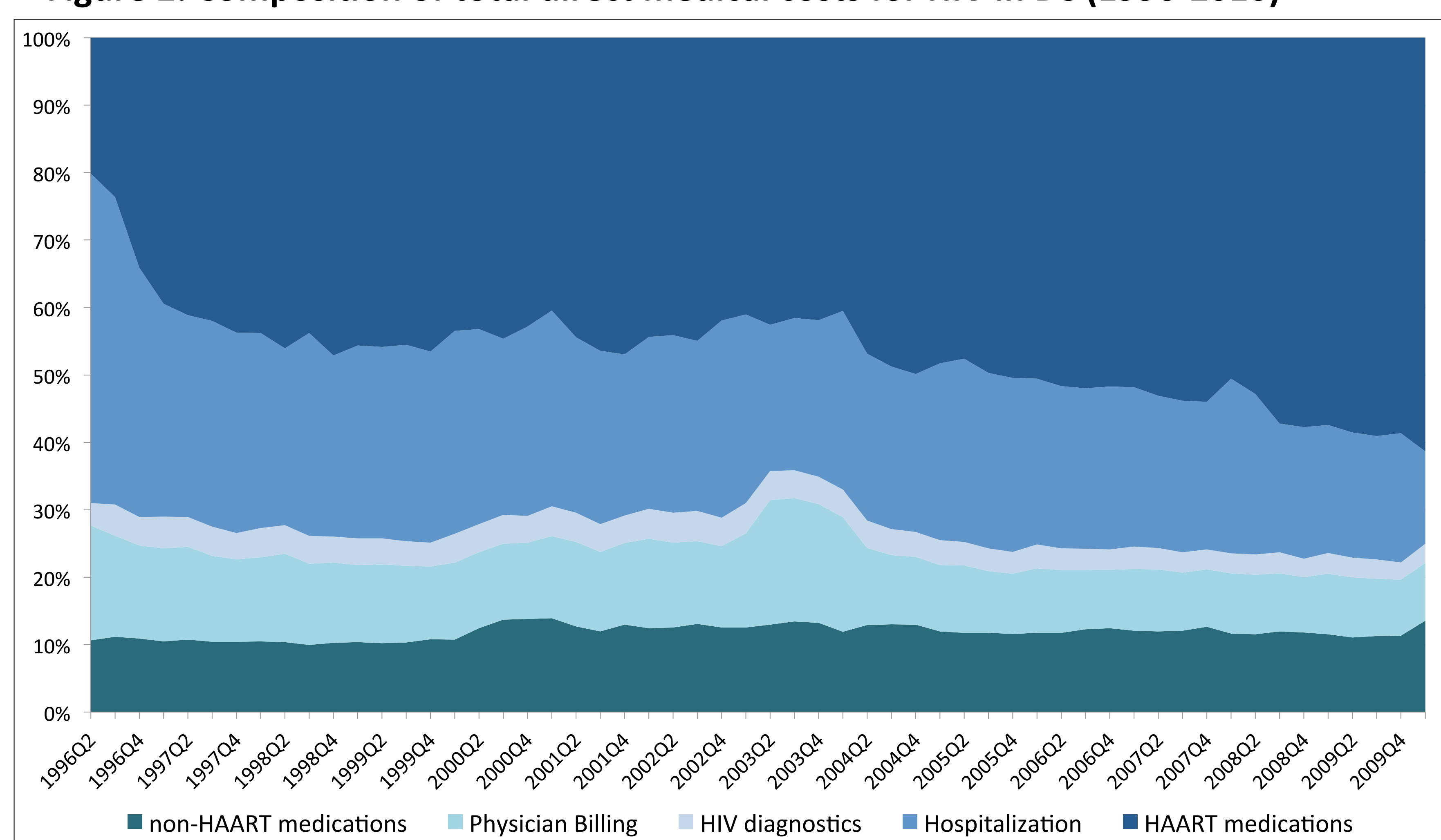
**Figure 1: Net effect of current CD4 count on direct non-HAART costs (vs. CD4<sub>t</sub>>500)**



**Table 2: Net effect of current CD4 on non-HAART cost components (vs. CD4<sub>t</sub>>500)**

	Mean	SE	95% CI	
<b>Hospitalizations</b>				
CD4 <sub>t</sub> : unmeasured	301.07	0.42	300.25	301.90
CD4 <sub>t</sub> : 350-500	37.94	0.06	37.82	38.05
CD4 <sub>t</sub> : 200-350	124.06	0.15	123.78	124.35
CD4 <sub>t</sub> : <200	501.84	0.67	500.53	503.14
<b>Physician billing</b>				
CD4 <sub>t</sub> : unmeasured	43.01	0.02	42.98	43.04
CD4 <sub>t</sub> : 350-500	5.17	0.01	5.16	5.19
CD4 <sub>t</sub> : 200-350	24.00	0.01	23.97	24.02
CD4 <sub>t</sub> : <200	74.26	0.03	74.20	74.33
<b>Non-HAART drug dispensation</b>				
CD4 <sub>t</sub> : unmeasured	-3.84	0.01	-3.85	-3.82
CD4 <sub>t</sub> : 350-500	9.55	0.00	9.54	9.56
CD4 <sub>t</sub> : 200-350	57.73	0.03	57.67	57.78
CD4 <sub>t</sub> : <200	159.15	0.08	159.01	159.30

**Figure 2: Composition of total direct medical costs for HIV in BC (1996-2010)**



## Discussion

- Primary care costs have previously been positively related to disease progression, as later disease stage necessitates closer physician monitoring and carries a higher probability of inpatient care due to the occurrence of opportunistic infections, adverse drug reactions and related medical complications.
- Our findings are consistent with these prior studies, and suggest those not accessing regular HIV care incur health care costs similar to those with relatively advanced-stage HIV – costs which are primarily driven by inpatient and outpatient care rather than medications.

