The Influence of Providing Primary Care to an Uninsured Population in Clark County, Washington, Is Associated with Reduced Utilization of Emergency Department and Inpatient Services

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A Thesis

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CERTIFICATE OF APPROVAL

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Abbreviations and Glossary:

Affordable Care Act (ACA) – Patient Protection and Affordable Care Act (P.L. 11-148) and the Health Care and Education Reconciliation Act (P.L. 11-152) that expanded Medicaid coverage, increased eligibility period for dependents, and eliminated pre-existing condition clauses for health insurance plans.

Cardiovascular Disease (CVD) – diseases that involve the heart of blood vessels, including (but not limited to): ischemic heart disease, hypertensive heart disease, aortic aneurysms, cardiomyopathy, atrial fibrillation, congenital heart disease, endocarditis, and peripheral artery disease.

Children's Health Insurance Plan (CHIP) – free or low cost health coverage for children ages 0 – 18; benefit level based on parent's income level (FPL)

Chronic Condition Indicator (CCI) – HCUP software tool used to categorize ICD-9-CM diagnosis codes as *chronic* or *not chronic*, according to *condition type*.

Chronic Obstructive Pulmonary Disease (COPD) – progressive lung disease, emphysema and chronic bronchitis, including that is highly associated with smoking.

Direct Primary Care (DPC) – intervention; program extending primary care to the uninsured for a monthly 'membership' fee

Emergency Department (ED)

Federal Poverty Level (FPL) – a measure of income level issued by the Department of Health and Human Services to determine eligibility for selected programs and benefits such as Medicaid and the Children's Health Insurance Program.

Healthcare Cost and Utilization Project (HCUP) – health care databases and related software tools developed through a Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ)

Horizon Performance Manager (HPM) – hospital billing record system

Inpatient (IP)

Institutional Review Board (IRB) – committee formed to evaluate, approve and monitor biomedical and behavioral research involving human subjects

Medical Record Number (MRN) – unique, system specific, patient identifier

Outpatient/Ancillary (OP/Ancillary) – Outpatient and Ancillary services

Patient Centered Primary Care Home (PCPCH) – primary care approach that is patient centered, comprehensive, team-based, coordinated and focused on improved patient outcomes

Relative Rate (RR) – number of events per person time (10 patient years) for a the population

Relative Rate Ratio – ratio of rates between two populations

Abstract:

Context: Between January 2005 and December 2007 the unemployment rate in Clark County Washington was 6.4 ± 0.8%.[1] Between January 2009 and December 2011, following the Great Recession, 13.4 ± 1.3% of residents were unemployed and over 56,000 Clark County residents (13.4 ± 0.8%) were without health insurance. [2] To address the needs of the newly unemployed, PeaceHealth Medical Center created a pilot program to provide primary care to the region's uninsured. The goal was to improve the overall health of the population and reduce their dependence on emergency and urgent care. The program was called "Direct Primary Care" (DPC).

Objective: This study tests whether providing primary care to the uninsured using the DPC model is associated with reduced utilization of Emergency Department (ED) and Inpatient (IP) services, and to identify patient characteristics associated with these effects. Reduced rates of ED and IP services are used as a proxy to indicate improved health of the community and better management of chronic conditions.

Methodology / Study Population: This longitudinal study involves 433 standard and 221 scholarship members with no previous history of insurance, enrolled in PeaceHealth's DPC program for at least 3 months during the study period. Predictor variables collected from patient billing records include number and type of chronic conditions and select socioeconomic factors. Hospital and clinic encounters were collected from January 1, 2010 (to generate baseline health service rates prior to DPC enrollment) through December 31, 2013 or upon membership cancellation (to generate utilization rates while enrolled in DPC). A multivariate mixed effects negative binomial regression model was used to characterize the association between patient characteristics and chronic conditions with encounter rates, comparing the pre-intervention period to the enrollment period and with each patient serving as his/her own control. The model was tested for possible effect modification by membership type.

Results: This study shows enrollment in DPC reduces members' utilization of ED and IP services, presumably by managing their chronic conditions. Standard members are associated with a 46 % (95% CI: 13 - 66%) reduction in ED encounters and a 48 % reduction (95% CI_{RR}:

0.25 – 1.06) in IP encounters. As expected, these reductions were accompanied by increased use of OP services with enrollment in DPC associated with and an 82 % [15 – 191%] *increase* in OP encounters. Scholarship members were associated with a 15 % (95% CI_{RR}: 0.52 – 1.41) reduction in ED encounters, 68 % (95% CI: 42 – 83%) reduction in IP encounters, and these were offset by a 3.3 fold (95% CI: 1.79 – 6.11 fold) *increase* in OP encounters after enrolling in DPC. The length of DPC membership influences the strength of these effects. In addition to improving the health of the community, such reductions are predicted to bring significant cost savings to the PeaceHealth hospital system.

Introduction:

The U.S. has the most expensive health care system in the world. And yet, according to a survey by the World Health Organization in 2007, Americans rank 31st for among nations for life expectancy, 36th on infant mortality, 28th on male healthy life expectancy and 29th on female healthy life expectancy.[3] Not much has changed since 2007: in a 2014 report by the Commonwealth Fund the U.S. ranks last among the world's eleven similar industrialized nations.[4] In addition to inefficiencies in the payment structure and problems in health care delivery, the U.S. is notorious for its lack of universal health insurance coverage and how this limits access to care.[5] The Affordable Care Act (ACA, 2010) expands access to care for many of the most vulnerable U.S. citizens and residents and looks to innovate, improve and enhance the health care delivery system.[6] Prior to the ACA, health care systems have been experimenting with innovative programs to improve the health of their communities. This thesis looks at one such program that extends access to primary care to the uninsured.

A review by the Kaiser Family Foundation found the rising cost of health care results from several key factors: 1) development and diffusion of new (and expensive) medical technologies, 2) aging of the U.S. population, 3) changes in disease prevalence, 4) unnecessary spending due to overtreatment, failure to coordinate care, administrative complexity, fraud and abuse and 5) increased prevalence of health insurance, which leads to increased utilization of higher cost technologies and tests.[7] The capitated DPC model focuses on coordinating care, reducing administrative complexity and costs, and fails to incentivize overtreatment.[8] In the absence of a

standard health insurance policy, both patient and health care professional are more judicious about over prescribing medical tests and treatments.

Simply gaining access to care is not sufficient to reduce costs and improve health outcomes. In 2008, Oregon extended Medicaid to 30,000 recipients, chosen at random, from a waiting list of 90,000 eligible subjects. Over the first 18 months of the program ED utilization rates among those newly entering the Medicaid system were 40% higher than for their uninsured counterparts. Most of these increased events could have been treated in a primary care setting.[9] This report showed access to care was not sufficient to reduce overall health care costs. By contrast, the 2013 Oregon Health Authority Performance Report showed Medicaid recipients treated under the Patient Centered Primary Care Home (PCPCH) approach reduced ED utilization rates by 17% over the 2011 baseline measure, concurrent with a 20% increased rate for primary care visits. The report shows reduced hospitalization rates for congestive heart failure (27%), chronic obstructive pulmonary disease (COPD; 32%) and adult asthma (18%).[10] These improvements were credited to system-wide changes in primary care practices under the PCPCH model, including increased patient involvement and improved management of chronic conditions. DPC clinical practices also reflect this new practice model.

As illustrated by the Oregon Medicaid experiment above, efficient utilization of health services and better patient outcomes for the uninsured requires re-education of both the practitioner (using alternative and coordinated approaches) and the patient (how to effectively use the health care system and how to self manage). The following are four common characteristics of the uninsured.

1. The uninsured receive fewer preventive services and recommended screenings than their insured counterparts. As a consequence, the uninsured are at increased risk for preventable hospitalizations or missed diagnosis of serious health conditions. [11] This contributes to significantly higher mortality rates and reduced quality of life years among the uninsured.[12] Among those with chronic conditions, the uninsured are less likely to receive follow-up care following a primary diagnosis or an acute event. This can lead to subsequent adverse outcomes or repeated hospital encounters.[13]

2. There is significant financial burden placed on those without health insurance. The uninsured pay 35% of their care out-of-pocket, compared with 17.4% of out-of-pocket expenses among those with private insurance and 3.6% of out-of-pocket expenses among those covered by Medicaid.[14] Without the benefit of negotiated prices, the uninsured are charged a higher price structure for their health care than those with insurance.[15] The average uninsured household has no net assets,[16] meaning the uninsured are almost twice as likely to have trouble paying their medical bills than those with health insurance coverage (47% of uninsured versus 23% of insured). Thus, the uninsured are more likely to neglect necessary health services due to cost.

3. Health care providers can choose to not provide care to the uninsured. Lack of access to primary care can drive ill individuals to seek care in EDs that are obligated to treat. After the patient is stabilized, follow-up care is often unavailable or neglected, resulting in subsequent health crises and returns to the ED.[17]

4. The uninsured are primarily adults. Most children living legally in the U.S. are covered under the Children's Health Insurance Plan (CHIP), Medicaid, or both.[18] The Affordable Care Act now allows young adults (up to age 26) to be covered under their parents' health insurance plans. Even with this provision a recent Gallup pool shows 23.0% of uninsured Americans are between 18 – 25 years of age, 26.6% are between 26 – 34 years, 16.3% are between 35-64 years, and only 2.2% are over 65 years of age.[19] 37.9% of the uninsured are Hispanic.[20] In 2014 Medicaid expanded eligibility requirements from 100% to 138% of FPL, extending access to health insurance to an estimated 10 million Americans. Unfortunately, an estimated 37 million Americans are still without health insurance. Medicaid has been expanded only in 27 states.*[1] In states without expanded coverage, residents face the "Coverage Gap" where adults without children are ineligible for Medicaid and are ineligible for subsidies on the Exchange. For this population the median income of families receiving Medicaid coverage is 44% of FPL.

*[1] Medicaid expansion approved in: Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Nevada, New Jersey, New Hampshire, New Mexico, New York, North Dakota, Ohio, Oregon, Rhode Island, Vermont, Washington, and West Virginia.

DPC delivers primary care to the uninsured using a single monthly 'membership' fee, in exchange for the current 'fee-for-service' business model. Patient "members" receive unlimited access to primary care focused on preventive, comprehensive, coordinated care at a fixed cost. PeaceHealth's DPC program covers all primary care visits, chronic disease management, basic labs, x-rays and childhood immunizations; family planning methods, prenatal visits and mental health services are not covered. Patients who need specialty care are referred to outside, low- or no-cost services. DPC creates a patient-centered practice, which bypasses insurance billing systems that can cost a practitioner significant time, money and personnel.[21]

Innovators of DPC suggest that doubling primary care spending (currently at 5% of all health care costs) will reduce downstream spending significantly more than the upstream cost of increasing primary care.[22] Unlike the failed managed care "gatekeeper" model of the 1980's, DPC strives to improve health outcomes at the primary care level, prior to the need for specialized care. Evidence for the success of this model is found in Table 1, taken from a non-peer reviewed study of health care utilization rates for Qliance DPC members contrasted with regional benchmark rates:

Table 1: Crude Health Services Utilization Data – Seattle Qliance Members Under Age 65 (2010) [23]

Type of Referral	Qliance # /1000, over a year**	Benchmark # /1000, over a year*	Rate Difference***	RR
ED Encounters	56	158	-102	0.35
Hospital Encounters	34	53	-19	0.64
Hospitalization (days)	105	184	-79	0.57
Specialist Encounters	670	2000	-1330	0.34
Advanced Radiology	300	800	-500	0.38
Surgeries	22	124	-102	0.18
Primary Care Encounters	3540	1847	1693	1.92

*Based on regional benchmarks from Ingenix and other sources
** Based on best available internal data, may not capture all non-primary care claims
Source: Qliance Medical Group non-Medicare patients, 2010 (n = 3,088)
*** Per 1000, over a year

In this study Qliance boasts 35% fewer hospitalizations, 65% fewer ED visits, 66% fewer specialist visits and 82% fewer surgeries than similar (benchmark) populations. [23]

Relevance and limitations for Direct Primary Care post-Affordable Care Act: DPC is a provider model, not health insurance, and its regulation at state and federal levels shows a lack of policy consensus and understanding of the program. For example, DPC membership fees are

not currently eligible for reimbursement using Health Savings Accounts.[24] DPC practices exist in at least 24 states and DPC legislation is now in effect in 9 states: West Virginia (pilot program, 2006 - 2009), Washington (2007), Oregon (2011), Utah (2012),[25] and more recently, Arizona, Louisiana, Michigan, Mississippi and Idaho.[26] California failed to pass DPC legislation despite its widespread practice within the state. Under Washington State law DPC agreements are limited to individuals and not groups such as employers. Even so, DPC services are marketed to employers and payment is accepted from an employer "on behalf of an employee who is a direct primary care patient." The ACA allows DPC inclusion on health insurance exchanges when paired with a wraparound insurance policy that covers events outside of primary care (i.e. a catastrophic, high deductible insurance plan). [27] Recently, Seattle's Qliance DPC took advantage of this provision, paired with Cigna Insurance (high-deducible plan) and was offered on the 2015 Washington State Insurance Exchange.[28]

The DPC program at Fisher's Landing in Vancouver, Washington is the first of its kind in Southwest Washington and was created to provide primary care to those who had lost their health insurance during the economic recession. As access to health care is predicted to improve overall health and reduce the need for ED and IP services, extending primary care to Clark County's uninsured should achieve a primary objective of PeaceHealth's Community Health Needs Assessment (improving the health of the community) and reduce its charity care expenses.

Since its establishment in December 2011, PeaceHealth's DPC program has served over 1,165 patient members. A preliminary study showed that membership in DPC was associated with a 50% reduction in the crude rate of ED encounters over the baseline period (internship, unpublished data). Because of this preliminary analysis, PeaceHealth's Board of Directors agreed to continue and expand the program and to assess its relevance following Medicaid Expansion and implementation of the Health Insurance Mandate (January 1, 2014). The current study provides an in depth analysis of the Fisher's Landing DPC program from its inception through implementation of Medicaid Expansion (December 31, 2013) and tests whether exposure to primary care reduces the rate of ED and IP encounters and increases the rate of OP encounters for DPC members, compared to the period prior to enrollment. Future studies will address the impact of the Affordable Care Act on this innovative program.

Research Question and Specific Aims:

Primary care providers treat and manage a patient's health conditions, and this is predicted to reduce their reliance on ED and IP services. Access to primary care is typically limited to those with private or public health insurance. As a consequence, it is not uncommon for the uninsured to rely on EDs to treat their acute or chronic health conditions. DPC, a membership-based approach to low-cost primary care, was introduced into the Fisher's Landing Medical Clinic to fill this need for the uninsured. In this study we hypothesize that enrollment in Direct Primary Care is associated with reduced rates of ED and IP encounters, and that these decreases are offset by increased rates of OP encounters.

> Specific Aim 1: Collect, clean and code hospital and clinic billing records for past and current DPC members from January 1, 2010 (baseline measure, pre-DPC) through December 31, 2013 (study end point). Determine the descriptive statistics characterizing the DPC population.
>
> Specific Aim 2: Using a longitudinal approach, test if enrollment in DPC is associated with reduced ED and IP encounter rates, and if these decreased rates are offset by increased OP/Ancillary encounter rates for the uninsured, as compared with their baseline rates (pre-DPC). Test for potential effect modification between important variables and enrollment in DPC.

Methods:

Overview:

This longitudinal study was restricted to 654 patients with no previous history of health insurance, ever enrolled in PeaceHealth's Direct Primary Care program between December 1, 2010 and December 31, 2013. January 1, 2014 marks the implementation of Medicaid expansion and the Health Insurance Mandate, programs predicted to fundamentally change the demographic of DPC members and thus marks the end of the current study. Table 2 presents patient characteristics and potential confounders collected for this analysis, which includes age, gender, employment history, marital status, distance from the primary care clinic, and number

and type of chronic conditions. Using Longitudinal General Estimating Equations, hospital and clinic billing records were used to examine whether the number of ED, IP and OP encounters, per patient per year, changed after uninsured patients enrolled in DPC.

Table 2: List of variables and predictors for analysis

Variable Name	Type	Description	Source
newptID		unique identifier	
dpc	predictor	preDPC (baseline); DPC (intervention period)	
daysdpc	offset	length preDPC or DPC	
Outcome Variables			
ED	counts	number ED encounters, by DPC	McKesson[1]
IP	counts	number IP encounters, by DPC	McKesson[1]
OP	counts	number OP and ancillary encounters, by DPC	McKesson[1]
clinic	counts	number office visits/procedures, enrolled in DPC	HPM*
Variable of Interest and Potential Confounders			
Member type	binary	Standard member; scholarship member	DPC[2]
gender	binary	Male; female	DPC[2]
employment	categorical	Full time employed; under employed, child	McKesson[1]
marital Status	binary	Married/life partner; not married	McKesson[1]
age at study end	categorical	Ages 0 - 18; ages 19 - 34; ages 35 - 44; ages 45 - 51; ages 52 - 58; > age 59	DPC[2]
length DPC	categorical	3 - 6 mos; 6 - 9 mos; 9 - 12 mos; > 12 months	DPC[2]
distance from clinic	categorical	Vancouver; 10 - 25 miles; over 25 miles	HPM[3]
Chronic Conditions:			
chronic1	binary	Malignancy	HPM[3]
chronic2	binary	Controlled Diabetes	HPM[3]
chronic3	binary	Uncontrolled Diabetes	HPM[3]
chronic4	binary	Substance Abuse	HPM[3]
chronic5	binary	Mental Health Disorders	HPM[3]
chronic6	binary	Neurologic Disorders	HPM[3]
chronic7	binary	Controlled Hypertension	HPM[3]
chronic8	binary	CVD	HPM[3]
chronic9	binary	Stroke	HPM[3]
chronic10	binary	COPD/Asthma	HPM[3]
chronic11	binary	Genitourinary System	HPM[3]
chronic12	binary	Gynecologic Disorders	HPM[3]
chronic13	binary	Chronic Pain	HPM[3]
chronic14	binary	Obese	HPM[3]
chronic15	binary	Other	HPM[3]
Number CHR	continuous	number of chronic conditions	HPM[3]

[1]McKesson, Hospital database system
[2]DPC enrollment database
[3]Horizon Performance Manager, Clinic database system

Original Data:

Hospital and clinic billing records were collected on 1,163 patients ever enrolled in PeaceHealth's Vancouver Fisher's Landing DPC program. Subjects were stratified into two membership categories, *Standard* and *Scholarship*. *Standard Members* self-elected for DPC membership and paid a low monthly fee. Children could be enrolled independent of their parents. *Scholarship Members* were recruited upon discharge from an ED or IP encounter. These were subjects experiencing an acute medical condition requiring stabilization. Scholarship members were granted 4-months free DPC membership and were predicted to show reduced hospital encounter rates when given access to primary care.

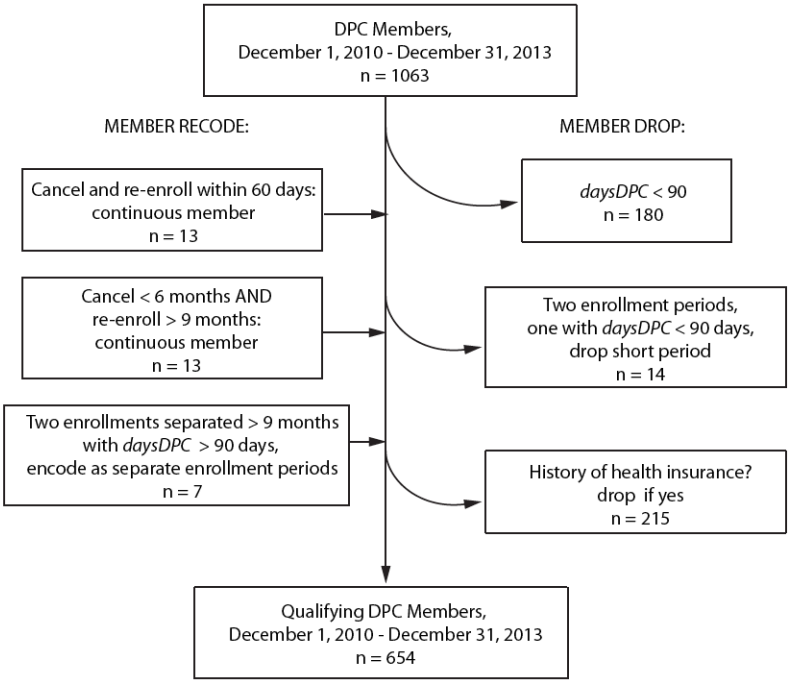
Selection Criteria:

All members enrolled less than 3 months were dropped (n = 180). 47 members who enrolled, canceled, and then re-enrolled were evaluated manually. Members who cancelled and re-enrolled within 90 days were recoded as continuous members (n = 13). Most of these were members who encountered payment glitches that were resolved within 30 days. Members who cancelled for less than 6 months and re-enrolled for more than 9 months (and with no encounters during the non-enrollment period) were treated as continuous members (n = 13). Members with one enrollment period less than 90 days and a second enrollment period greater than 90 days had the shorter period dropped (n = 14). In general, these were members who enrolled for a wellness appointment, cancelled, and re-enrolled for a subsequent wellness appointment. Membership rules were changed (January 2013) to eliminate this practice. Members with two-enrollment periods $\geq$ 90 days but who cancelled for more than 9 months were recoded as new enrollments (n = 7). Finally, inclusion was limited to those with no previous history of insurance (433 standard, 221 scholarship members). The exclusion/inclusion process is presented in Figure 1.

*Data collection***:**

The following data was collected: 1) enrollment information on DPC members ever enrolled between December 1, 2010 and December 31, 2013, 2) hospital billing records (McKessen system) from PeaceHealth Southwest Medical Center between January 1, 2010 and December 31, 2013, and 3) clinic billing records (HPM) from PeaceHealth Medical Group Family Medicine at Fisher's Landing and Battle Ground between January 1, 2010 and December 31, 2013.

Figure 1: Exclusion and Inclusion Criteria for Study Enrollment



DPC Enrollment File:

Registration information on DPC patients included *Groupcast ID*, membership type, DPC start and cancel date, date of birth, age, and gender. Prior to de-identification *GroupcastID* was used to match patients to clinic-billing records; personal identifiers including *GroupcastID* were used to match patients with hospital Medical Record Numbers (MRN).

Clinic Data Files:

Clinic billing records from the Fisher's Landing/Battle Ground Clinic HPM database were collected, by month, from January 1, 2010, through December 31, 2013. Two independent reports were generated and merged to assemble the variables listed in Table 1. *Groupcast ID* was used to extract DPC members from the clinic billing records.

Hospital Data Files:

Medical Record Numbers (MRNs) were extracted from the hospital database using *Patient Name*, *Date-of-birth* and when necessary, *Patient address,* for all DPC patients experiencing a hospital encounter. MRNs were entered into the McKesson Horizon Performance Manager

(HPM) to create a query file containing hospital billing data including encounter type, death code and the demographic variables listed in Table 1 for the period between January 1, 2010 and December 31, 2013.

Outcome Variables:

Hospital outcome variables include ED, IP (includes psychiatric and rehabilitation) and OP (includes imaging, ongoing series, oncology and same day surgery as well as the ancillary hospice and home health services). Outcomes are summed as counts (encounters) for the preDPC (baseline) and DPC periods and used to estimate encounter rates in person years using the offset variable, *daysDPC*.

Covariates/Potential Confounders:

Adjustments for the following covariates were performed: age, gender, employment status, marital status, distance from clinic, and number and type of chronic conditions. Covariates were limited to variables available from patient billing records. Decisions for these variables were made based on biologic mechanisms and previous findings for social determinants of health. Covariate levels were collapsed into logical groupings when cell numbers are small. For example, 'married' and 'life partner' were collapsed into a single group; 'divorced' 'separated' and 'widowed' were collapsed into the single variable, 'not married.' Marital status was not available or not given for 23% of members. Similarly, 'Employed Part-Time' 'Self-Employed' and 'not employed' were collapsed into the single variable, 'Under-Employed'. Employment status was not available or not given for 27% of members. Ages for scholarship members ranged from 20 to 66 years; ages for standard members ranged from 0 to 77 years. The variable, *age,* was grouped as 0 – 18 years of age (Standard members only), 19 – 34, 35 – 44, 45 – 51, 52 – 58, and over 59 years of age. Only 53% of members specified race; of those 90% identify as white. Due to this limited response race it omitted from the analysis. Any possible confounding effects from *Previous history of insurance* was avoided by limiting the study to members with no previous history of insurance.

Potential Effect Modifier:

To better understand the association between the rate of hospital encounters and access to primary care, individual and group level interactions between relevant covariates and DPC were

tested. These included membership type, where we expected little-to-no change in encounter rates for *Standard* members who self-elect for DPC and significant changes in encounter rates for *Scholarship* members recruited to the DPC following a health crisis. We likewise tested length of DPC membership, categorized as 3 – 6 months, 6 – 9 months, 9 – 12 months, and over 12 months. We expected members with longer memberships to be associated with greater reductions in hospital encounter rates, a reflection of improved management of members' health issues over time. Chronic conditions and number of chronic conditions were also tested as potential effect modifiers.

Statistical analysis / Data Cleaning:

Statistical analysis was performed using the software package STATA13 (StataCorp, College Station, TX).

Preparing the Data Set:

> Specific Aim 1: Collect, clean and code hospital and clinic billing records for past and current DPC members from January 1, 2010 (baseline measure, pre-DPC) through December 31, 2013 (study end point). Determine the descriptive statistics characterizing the DPC population.

Three independent databases were created and merged. 1) newptID dataset: Using DPC enrollment files, a master file was created containing patient name, *Groupcast ID*, *MRN*, membership type, DPC start and cancel date, date of birth, age, gender and zip code. DPC start and cancel dates were used to define the enrollment period. The variable, *DaysDPC* (DPCcancel – DPCstart) was created to indicate the length of DPC membership through December 31, 2013. The variable, *dayspreDPC* (DPCstart – studystart) was created to indicate the pre-intervention period (preDPC) for each subject. These were combined to create the offset variable, *daysDPC*. Zip code was replaced by *distance from clinic* using the zip code calculator.[29] Date of birth was replace with *age at study end* (studyend – date of birth). Patients were then de-identified using a three-stage randomization process to create the variable *newptID,* matched

to *GroupcastID* and *MRN*. All personal identifiers were stripped except *newptID* and DPC start and cancel date prior to export into STATA.

2) Clinic datasets: HPM files were extracted from the clinic database, by month, imported into Excel and restricted to DPC patients using *GroupcastID* numbers. Excel files were appended, extraneous variables removed and two independent clinic reports were merged, duplicates removed, and checked for errors. Patient information was de-identified as *newptID* and the database imported into STATA. Files were inspected and re-coded as in Table1.

Creating Chronic Conditions: Up to three ICD-9 (International Statistical Classification of Diseases) codes were provided with each clinic billing record, which can vary between clinic visits. Each ICD9 code was classified as 'Chronic' or 'not Chronic' using the Chronic Condition Indicator (CCI) tool designed by the Healthcare Cost and Utilization Project (HCUP).[30] 'Not Chronic' codes were dropped. Chronic codes were further categorized by 'body type' using the CCI tool or as chronic conditions endemic to the DPC population, as advised by the PeaceHealth DPC Care Coordinator. Relevant chronic condition variables are listed in Table 1. A new dataset was created, duplicate chronic conditions removed and dataset reshaped for each chronic condition by *newptID*. Unique chronic conditions were summed by *newptID* to estimate the total number of chronic conditions (*numberCHR*), based on this classification system. Multiple clinic encounters enabled identification of up to ten chronic conditions for selected patients.

Separate datasets were created to remove duplicate marital status, employment status or insurance type. The most recent marital or employment status during the DPC enrollment period was used for the analysis. *Current Insurance Class* was recoded as 'DPC' 'Medicaid' 'Private' 'Injury/Auto' or 'None' and was used to select for those with no previous history of insurance ('None'). Demographic datasets were merged with chronic condition dataset by *newptID* to create the Clinic Demographic Dataset.

3) Hospital datasets: McKesson files were extracted from the hospital database, by *MRN*, and imported into Excel. Excel files were de-identified as *newptID*, extraneous variables removed, and the database imported into STATA. Files were re-coded as in Table1, tested for death code (n=1), and re-checked for errors. *Primary Payer Name* (insurance type) was recoded as 'Charity'

'Medicaid' 'Private' (including catastrophic plans) 'Injury/Auto' or 'None' and was used to identify those with no previous history of insurance ('Charity' and 'None'). Separate datasets were created to remove duplicate marital status, employment status or insurance type, as described above. Most recent marital and employment status was used for the analysis. Files were then used to create a hospital demographic dataset for marital status, employment status, and insurance type, by *newptID*. Clinic and hospital demographic datasets were merged and tested for consistency before resolving into a single Hospital Demographic Dataset.

The complete hospital database was merged with newptID dataset, which was used to classify each encounter as preDPC, DPC or post DPC (omitted) by *Check in Date*. *Patient Account Type* was recoded as 'ED' (emergency department), 'IP' (inpatient) or 'OP' (outpatient/same day surgery/ancillary services). Number of encounters was summed for preDPC and DPC periods. Extraneous variables were removed and data re-shaped for number of encounters, by DPC period, and merged with Hospital Demographic Dataset. Completed clinic and hospital datasets were then merged, by *newptID* and DPC period, to create the final dataset for the analysis.

Descriptive statistics:

Descriptive statistics on the individual level characteristics for standard and scholarship members were performed. This included assessing the following characteristics: age, sex, marital status, distance from clinic, and employment status. Continuous variables were described using mean and standards of deviation. Frequencies and percentages were calculated for categorical variables. Descriptive analyses were also performed for the following clinical characteristics: malignancy, controlled diabetes, uncontrolled diabetes, substance abuse, mental health disorders, neurologic disorders, controlled hypertension, cardiovascular disease, stroke, COPD/asthma, genitourinary disorders, chronic pain, obesity, other chronic conditions and number of chronic conditions. Members were characterized for length of DPC membership. The outcome variables, number of ED, IP and OP encounters, were examined separately. Bivariate analysis using chi-squared statistics was performed to determine if there was a relationship between potential confounding variables and membership type.

The Analysis:

> Specific Aim 2: Using a longitudinal approach, test if enrollment in DPC is associated with reduced ED and IP encounter rates, and if these decreased rates are offset by increased OP encounter rates for the uninsured, as compared with their baseline rates (pre-DPC). Test for potential effect modification between important variables and enrollment in DPC.

Univariate Analysis: Using a negative binomial approach, the primary predictor (*DPC*), membership type, gender, age, distance to primary care, employment and marital status, and type and number of chronic conditions were independently tested for association with the outcome of interest (*ED, IP*, or *OP* encounters). Age groups were set by convention and variable distribution. All predictor variables except *Number of Chronic Conditions* were binary or categorical; p-values for categorical variables were reported at the group level. *Number of Chronic Conditions* was tested for normality using the Shapiro-Wilks test (p-value < 0.0001). No transformations were needed for the predictor variables.

Multivariate Analysis: Multilevel mixed-effects negative binomial regression analysis (menbreg) was used to determine the association between patient characteristics/chronic conditions and DPC enrollment with the rate of hospital encounters. The negative binomial regression approach was used to reduce the likelihood of over-dispersion often observed in Poisson models when the variance is greater than the mean. Indeed, the variance of ED encounters was 4.7 times the mean and the variance of OP/Ancillary encounters was 6.5 times the mean. While the variance of IP encounters was only 1.5 times the mean, the negative binomial approach was used to maintain a consistent analysis structure. The model was set for the unique identifier (*newptID*) and by period (DPC). The continuous variable, *daysdpc,* was used as the offset.

Backwards-stepwise selection was used to narrow the list of potential independent variables. All variables with a significance level of 0.25 in the univariate analysis were included in the original model. A significance level of > 0.05 resulted in elimination from the model. After creating the Preliminary Main Effects Model, removed variables were added back and retained if they showed a significance level < 0.05. Removed variables were tested for potential

confounding of the primary predictor, *DPC*. If the *DPC* coefficient changed by more than 10%, the variable was returned to the model.

Main Effects Models were tested for collinearity and over-dispersion. We examined whether the estimated variance $\sigma^2_{\text{menbreg}}$ was close to the mean number of encounters. The over-dispersion parameter, alpha, was investigated using the likelihood ratio test to ensure the mixed effects negative binomial regression was the appropriate method for analysis over the negative binomial regression model without random effects. Potential influential points were identified through: 1) plotting residuals against predicted values, 2) fitted values against predicted values, 3) predicted means against fixed only predict means, and 4) Anscombe residuals against deviance residuals. Models without potential influential points were tested against the Main Effects Model for changes in the coefficient of the primary predictor, *DPC*. If the *DPC* coefficient changed by more than 10%, the influential point was removed from the model.

Interaction terms: Interaction terms were created for *DPC* and the following variables of interest: *member type, sex, type and number of chronic conditions, age group, length DPC membership*, *marital* and *employment status*. *Length of membership*, a categorical variable, was tested as the length of exposure was expected to associate with the strength of the response. Multivariate mixed effect longitudinal negative binomial models were built for covariates and their interactions; important interactions with significance at the level of < 0.05 were described in the results section and the resulting models included in the Appendix.

Human Subjects Protections

All unique patient identifiers were de-identified using a three-stage randomization process to create the variable *newptID,* matched to GroupcastID and MRN. Patient data was reassigned the new variable so that all personal identifiers, except for dates, could be removed prior to release from PeaceHealth Medical Center. DPC start and cancel dates were retained to define the enrollment period and to classify encounters as 'pre-DPC' or 'DPC'.

The Oregon Health & Science University (OHSU) Institutional Review Board (IRB) granted a Waiver of Consent for the data because primary data acquisition, cleaning and de-identification

were performed behind the PeaceHealth secured firewall. A Data Use Agreement was signed between OHSU and PeaceHealth and data sets containing the personal identifier *Encounter Date of Service* was exchanged. OHSU's IRB considered the data exempt from review.

Results

Describing the Direct Primary Care Population

The individual-level characteristics of standard and scholarship DPC members are presented in Table 3. There are significantly more male scholarship members than standard members (scholarship: 61.1%; standard: 37.0%). Scholarship members are twice as likely to be unemployed (scholarship: 54.8%; standard: 25.6%) and describe themselves as single or divorced (scholarship: 67.9%; standard: 34.0%); standard members are less likely to provide information on employment (scholarship: 4.5%; standard: 38.6%) or marital status (scholarship: 2.3%: standard: 33.0%). Although there are no scholarship members under age 18, the mean age and age distribution for the two groups are not statistically different ($mean_{scholarship}$: 45.5±11.8 years; $mean_{standard}$: 44.7±16.5 years; $p = 0.348$).

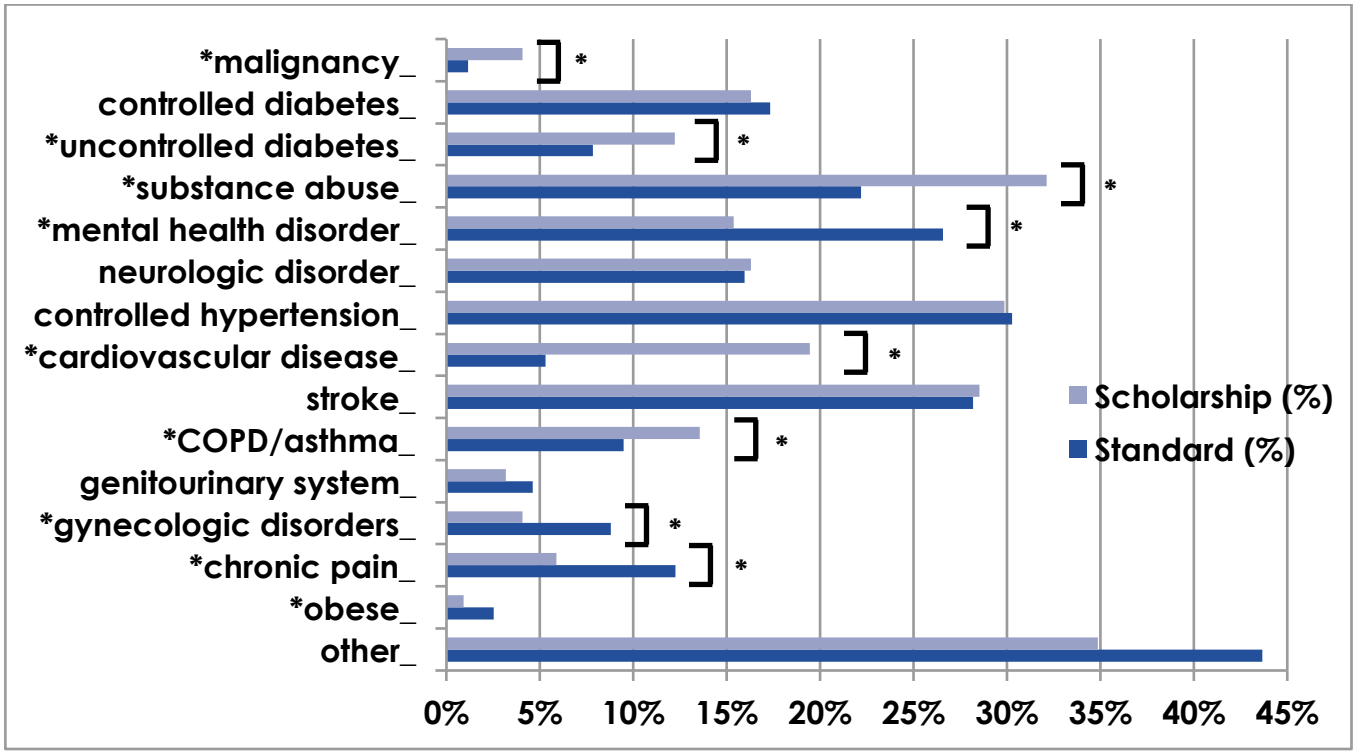
Scholarship members are granted 4 months free DPC membership; some are granted extensions, to stabilize a medical condition, and a few elected to become standard members. As a consequence, scholarship members exhibit a significantly shorter membership period than do standard members (scholarship: 182.72 ± 120.88 days; standard: 382.44 ± 245.28 days; $p < 0.0001$). Forty-two percent of standard members retained DPC memberships for over a year, as compared with seven percent of scholarship members.

Table 3: Descriptive statistics for DPC demographics, number and type of chronic conditions, by Member type (standard members, n = 433; scholarship members, n = 221)

parameter	Levels	standard, n = 433 Percent or mean [std]	scholar, n = 221 Percent or mean [std]	p-value*
Gender				
	male	37.0%	61.1%	<0.001
	female	63.1%	38.9%	
Employment status				
	Employed FT	21.0%	24.9%	
	Employed PT/Self	8.3%	11.8%	
	Retired	2.1%	2.3%	<0.001
	Child	4.4%	1.8%	
	Not Employed	25.6%	54.8%	
	Unknown	38.6%	4.5%	
Marital status				
	married/partner	32.1%	25.8%	
	single	24.9%	46.2%	
	divorced/separated	9.0%	21.7%	<0.001
	widowed	0.9%	4.1%	
	unknown	33.0%	2.3%	
Age group at end of study				
	0-18 years	9.4%	0.0%	
	19-34 years	17.1%	19.0%	
	35-44 years	15.9%	25.8%	0.895
	45-51 years	13.9%	18.6%	
	52-58 years	21.0%	21.7%	
	59+ years	22.9%	14.9%	
Length DPC				
	Mean number days DPC	382.44 [245.28]	182.72 [120.88]	< 0.001
	3-6 months	25.2%	68.8%	
	6-9 months	18.9%	19.0%	<0.001
	9-12 months	14.3%	5.4%	
	over 12 months	41.6%	6.8%	
Chronic Conditions				
	malignancy	1.2%	4.1%	0.004
	controlled diabetes	17.3%	16.3%	0.636
	uncontrolled diabetes	7.9%	12.2%	0.016
	Substance abuse	22.2%	32.1%	0.001
	mental health disorder	26.6%	15.4%	<0.001
	neurologic disorder	16.0%	16.3%	0.869
	controlled hypertension	30.3%	29.9%	0.884
	cardiovascular disease	5.3%	19.5%	<0.001
	stroke	28.2%	28.5%	0.900
	COPD/asthma	9.5%	13.6%	0.032
	genitourinary system	4.6%	3.2%	0.186
	Gynecologic disorders	8.8%	4.1%	0.001
	chronic pain	12.2%	5.9%	0.001
	obese	2.5%	0.9%	0.020
	other	43.7%	34.8%	0.002
Number Chronic Conditions				
	continuous, 0 - 10	2.36 [1.92]	2.37 [1.96]	0.956

* Population specific difference between standard and scholarship members

Figure 2: Proportion of DPC Members (by Membership Type) with Indicated Chronic Condition



* indicates statistically significantly different proportion with given chronic condition (<0.05)

Although scholarship and standard members exhibit similar frequencies of chronic conditions (μ =2.4 ± 1.9) they show differing disease prevalence. These differences are presented above in Figure 2. Scholarship members are more likely to have uncontrolled diabetes (scholarship: 12.2%; standard: 7.9%), some form of cardiovascular disease (CVD) (scholarship: 19.5%; standard: 5.3), COPD/asthma (scholarship: 13.6%; standard: 9.5%) or suffer from substance abuse issues (scholarship: 32.1%; standard 22.0%). By contrast, standard members are more likely to be seen for mental health disorders (scholarship: 15.4%; standard: 25.6%) or chronic pain (scholarship: 5.9%; standard: 12.2%). Table 4 presents the mean number of hospital encounters by DPC period. As scholarship members were recruited following a hospital encounter, they exhibited an expected higher frequency of ED and IP encounters than their standard counterparts.

Table 4: Descriptive Statistics for DPC Encounters by DPC period and member type.

Outcome Variables	Levels	standard, n = 433	scholar, n = 221	p-value
		mean* (std)	mean* (std)	
ED				
	preDPC	0.78 [2.30]	1.35 [2.63]	0.003
	DPC	0.20 [0.70]	0.34 [0.91]	0.026
IP				
	preDPC	0.133 [0.39]	1.20 [0.91]	< 0.001
	DPC	0.10 [0.59]	0.25 [0.91]	0.011
OP				
	preDPC	0.45 [1.93]	0.43 [1.06]	0.569
	DPC	0.34 [0.96]	0.52 [1.79]	0.089

* mean frequency of encounters, *not adjusted for time*

ED encounters:

Identifying factors associated with risk of ED encounters

Table 5 presents the results of the univariate analysis. Exposure to primary care was associated with reducing the overall rate of ED encounters by 22% (95% CI: 0 – 38%). The crude rate of ED visits prior to enrollment was 17 ED encounters per 100 patient years (95% CI: 13 – 22) and this was reduced to 14 ED encounters per 100 patient years after enrolling in DPC (95% CI: 10 – 18). This association strengthened over time, as the rate of ED encounters decreased with increasing length of membership. Enrollment over a year was associated with a 43% decreased rate of ED encounters (95% CI 11 – 61%). Overall, scholarship members were associated with 137% more ED encounters than their standard counterparts (95%CI: 72 – 228%).

Chronic conditions associated with higher rates of ED encounters include substance abuse (RR = 1.74, 95% CI [1.22, 2.47]), mental health disorders (RR = 1.84, 95% CI [1.28, 2.63]), neurologic disorders (RR = 1.66, 95% CI [1.10, 2.51]) and chronic pain (RR = 1.93, 95% CI [1.18, 3.15]) – as compared with their unaffected counterparts. Age is also associated with the rate of ED encounters. Using age 19 – 34 as the referent level, those under age 19 show an 86% decreased rate of ED encounters (95% CI 67 – 94%) and those over age 59 show a 59% decreased rate of ED encounter (95% CI 49 – 81%).

Table 5: Univariate Analysis for Factors Contributing to the Rate of ED Encounters among DPC Members and Crude Rate of ED Visits (standard members, n = 433; scholarship members, n = 221)

parameter	levels	Univariate RR (95% CI)	p-value
Crude ED Encounter Rate	*pre*	0.17 (0.13, 0.22)	0.052
	intervention	0.14 (0.10, 0.18)	
DPC	*pre*	reference	0.052
	intervention	0.78 (0.62, 1.00)	
Member type	*standard*	reference	< 0.001
	scholarship	2.37 (1.72, 3.28)	
Sex	*male*	reference	0.420
	female	1.14 (0.83, 1.58)	
Distance	*Vancouver*	reference	
	10 - 25 miles	1.01 (.68, 1.51)	0.025
	over 25 miles	.14 (.03, .60)	
Chronic Conditions	*malignancy*	0.70 (0.21, 2.33)	0.565
	controlled diabetes	0.67 (0.38, 1.18)	0.161
	uncontrolled diabetes	0.91 (0.52, 1.59)	0.735
	Substance abuse	1.74 (1.22, 2.47)	0.002
	mental health disorder	1.84 (1.28, 2.63)	0.001
	neurologic disorder	1.66 (1.10, 2.51)	0.016
	controlled hypertension	0.92 (0.63, 1.35)	0.684
	cardiovascular disease	1.11 (0.65, 1.88)	0.710
	stroke	1.50 (1.06, 2.12)	0.024
	COPD/asthma	1.18 (0.71, 1.96)	0.524
	genitourinary system	0.44 (0.17, 1.11)	0.083
	gynecologic disorders	1.40 (0.78, 2.53)	0.257
	chronic pain	1.93 (1.18, 3.15)	0.009
	obese	0.36 (0.10, 1.36)	0.132
	other	1.01 (0.72, 1.40)	0.973
NumberCHR	*continuous*	1.12 (1.03, 1.22)	0.007
Age groups	*age 0 - 18*	.14 (.06, 0.33)	
	age 19 - 34	reference	
	age 35 - 44	.84 (0.53, 1.33)	< 0.001
	age 45 - 51	0.58 (0.35, 0.97)	
	age 52 - 58	0.45 (0.28, 0.72)	
	over 59	0.31 (0.19, 0.51)	
Length DPC	*3-6 month dpc*	reference	
	6-9 month dpc	0.99 (0.64, 1.53)	0.017
	9-12 month dpc	0.65 (0.38, 1.13)	
	over 1 year dpc	0.57 (0.39, 0.89)	
Marital Status	*married*	reference	0.255
	unmarried	1.19 (0.88, 1.62)	
Employment Status	*FT employed*	reference	
	PT/Self/Unemployed	1.31 (0.95, 1.81)	0.173
	Child	0.89 (0.42, 1.88)	

*Not significant in the multivariable model and therefore omitted

Individual level ED encounter rates and Model Building for covariates that influence ED encounter rates

A preliminary main effects model was indicated that included controlled diabetes, number of chronic conditions, the individual level predictors employment status and age, and the main predictor of interest, DPC. None of the covariates tested confounded the primary predictor, DPC (See Appendix, Table A). Four potential influential points were identified. However, removing these points did not significantly influence the model so the subjects were retained in the model.

Table 6: Multivariate Longitudinal Negative Binomial Regression Analysis of ED Encounters by DPC members: The Main Effects Model

Parameter	Reference Levels	Rate Ratio (95% CI)	p-value
DPC	Dichotomized, preDPC	0.63 (0.41, 0.96)	0.031
Controlled Diabetes	Dichotomized, no diabetes	0.58 (0.35, 0.98)	0.043
Number of Chronic Conditions	Continuous	1.18 (1.07, 1.30)	0.001
Age groups:			
0 - 18 years	19 - 34 years	0.49 (0.13, 1.88)	<0.001
35 - 44 years		0.80 (0.52, 1.23)	
45 - 51 years		0.52 (0.32, 0.85)	
52 - 58 years		0.38 (0.23, 0.62)	
over 59 years		0.27 (0.16, 0.45)	
Employment:			
under employed	Employed Full Time	1.39 (1.01, 1.92)	0.119*
child		0.93 (0.31, 2.77)	

*under employed significance at 0.046; mode with Employment has lower AIC than model without Employment

The main effects model shows exposure to DPC is associated with a 37% reduced rate of ED encounters (95% CI: 4 – 59%), after adjusting for the effects of controlled diabetes, number of chronic conditions, age group, and employment status (Table 6). Members with controlled diabetes were associated with a 42% reduced rate of ED encounters (95% CI: 2 – 65%) over those with no diabetes. Age was significantly associated with the rate of ED encounters. Members aged 45 - 51 were associated with a 48% reduced rate of ED encounters over those aged 19 – 35 (95% CI: 15 – 68); members aged 52 – 58 were associated with a 62% reduced rate of ED encounters (95% CI: 38 – 77%) and members over age 59 were associated with a 73% reduced rate of ED encounters (95% CI: 55 – 84%). Underemployed members were associated with a 39% increased rate of ED encounters (95% CI: 1 – 92%) over those who were employed full-time. The number of chronic conditions was significantly associated with the rate

of ED encounters, with each additional chronic condition increasing the rate of ED encounters by a factor of 1.18 (95% CI: 1.07, 1.30).

Significant interactions were identified between DPC and mental health issues, age over 59 years, as well as DPC membership over a year; marginally significant interactions were found with member type and sex (p-values = 0.086 and 0.056, respectively)(See Appendix, Table B).

After adjusting for the effects of controlled diabetes, number of chronic conditions, employment and age, women were associated with a 49.7% (18.5% - 68.9%) decreased rate of ED visits after DPC enrollment while men failed to see a statistically significant change (RR = 0.836, 95% CI [0.499, 1.399]). Those without mental health disorders were associated with a 45.7% lower rate of ED encounters after DPC enrollment (95% CI [13.6 – 66.0%]) while those with mental health disorders did not show a significant change (RR = 0.956, 95% CI [0.548, 1.667]). Older DPC members were associated with lower ED encounter rates than those aged 19 – 34, after DPC enrollment. Those over age 59 years of age were associated with a 72.1% decreased rate of ED encounters (95% CI: 33.4 – 88.3%) and members between ages 45 – 51 were associated with a 48.8% decreased rate of ED encounters (95% CI: 0.2 - 73.7%) after DPC enrollment; the baseline group, age 19 – 34, failed to show a statistically significant change in ED rates after DPC enrollment (RR = 0.835, 95% CI [0.515, 1.353]). Most importantly, members enrolled in DPC over a year were associated with 61.9% lower rates of ED encounters (95% CI 39.3 – 76.1%).

Because studies proposed access to primary care is associated with reduced rates of ED bouncebacks,[17] we hypothesized scholarship members would respond more strongly to DPC enrollment than standard members. However, we found the opposite. After adjusting for the effects of controlled diabetes, number of chronic conditions, employment and age, standard members were associated with a 54.7% decreased rate of ED visits (95% CI: 13.1 – 66.1%) after DPC enrollment whereas scholarship members failed to see a statistically significant change (RR = 0.855, 95% CI [0.20, 1.410]).

IP encounters:

Table 7: Univariate Analysis for Factors Contributing to the Rate of IP Encounters among DPC Members and Crude Rate of IP Visits (standard members, n = 433; scholarship members, n = 221)

parameter	levels	univariate RR (95% CI)	p-value
Crude IP Encounter	*preDPC*	0.14 (0.12, 0.17)	< 0.001
	DPC	0.05 (0.03, 0.08)	
DPC	*preDPC*	reference	< 0.001
	intervention	0.32 (0.18, 0.58)	
Member type	*standard*	reference	< 0.001
	scholarship	8.63 (6.66, 11.18)	
Sex	*male*	reference	< 0.001
	female	0.51 (0.40, 0.67)	
Distance	*Vancouver*	reference	
	10 - 25 miles	0.74 (0.52, 1.04)	0.095
	over 25 miles	0.52 (0.21, 1.29)	
Chronic Conditions	*malignancy*	2.54 (1.27, 5.08)	0.008
	controlled diabetes	1.03 (0.67, 1.57)	0.905
	uncontrolled diabetes	1.62 (1.09, 2.43)	0.018
	substance abuse	1.77 (1.34, 2.32)	< 0.001
	mental health disorder	0.95 (0.70, 1.30)	0.762
	neurologic disorder	1.15 (0.81, 1.62)	0.427
	controlled hypertension	0.83 (0.59, 1.16)	0.264
	cardiovascular disease	2.90 (2.05, 4.12)	< 0.001
	stroke	1.38 (1.05, 1.82)	0.023
	COPD/asthma	1.62 (1.09, 2.42)	0.017
	genitourinary system	1.32 (0.72, 2.42)	0.376
	gynecologic disorders	0.53 (0.30, 0.96)	0.036
	chronic pain	0.98 (0.64, 1.51)	0.939
	obese	0.62 (0.22, 1.72)	0.355
	other	0.82 (0.63, 1.08)	0.158
Number of Chronic Conditions	*continuous*	1.10 (1.03, 1.17)	0.003
age groups	*age 0 - 18*	0.10 (0.03, 0.34)	
	age 19 - 34	reference	
	age 35 - 44	1.24 (0.84, 1.84)	0.001
	age 45 - 51	1.05 (0.68, 1.61)	
	age 52 - 58	0.95 (0.63, 1.41)	
	over 59	0.59 (0.38, 0.92)	
length DPC	*3-6 month dpc*	reference	
	6-9 month dpc	0.62 (0.44, 0.88)	< 0.001
	9-12 month dpc	0.31 (0.19, 0.52)	
	over 1 year dpc	0.39 (0.28, 0.54)	
Marital Status	*married*	reference	0.002
	unmarried	1.50 (1.15, 1.94)	
Employment Status	*FT employed*	reference	
	PT/Self/Unemployed	1.22 (0.93, 1.61)	0.0294
	Child	0.46 (0.21, 1.05)	

Identifying factors associated with increased risk of IP encounters

Table 7 presents the results of the univariate analysis. Exposure to primary care was associated with reducing the overall rate of IP encounters by 67.5% (95% CI: 42.5 – 81.7%). The crude rate of IP visits prior to DPC enrollment was 14 IP encounters per 100 patient years (95% CI: 12 – 17); this was reduced to 5 IP encounters per 100 patient years (95% CI: 3 – 8) following DPC enrollment. The association strengthened over time, peaking between 9 and 12 months with DPC enrollment for 9 – 12 months associated with a 68.8% decreased rate of IP encounters (95% CI: 48.0 – 81.3%) over those enrolled 3 – 6 months. Overall, scholarship members were associated with 8.6 times more IP encounters than their standard counterparts (95%CI: 6.7 – 11.2 times). Women were associated with a 48.5% decreased rate of IP encounters over their male counterparts (95% CI: 33.4 – 60.2%). Marital status was associated with the rate of IP encounters, with unmarried members associated with a 49.5% increased rate of IP encounters over members who were married or with life partner (95% CI [15.4 – 93.7%]). Children were associated with the lowest rate of IP encounters, with a 90.2% (95% CI [66.4 – 97.1%]) decreased rate of IP encounters over the baseline population (ages 19 – 34). Members over 59 years of age were associated with a 40.8% reduced rate of IP encounters over the baseline population (95% CI [8.3 – 61.8%]).

Chronic conditions associated with the highest rates of IP encounters, over their unaffected counter parts, include cardiovascular disease (RR = 2.90, 95% CI: 2.05, 4.12), malignancies (RR =2.54, 95% CI: 1.27, 5.08), substance abuse issues (RR= 1.77, 95% CI: 1.34, 2.32), congestive obstructive pulmonary disease (COPD)/asthma (RR = 1.62, 95% CI: 1.09, 2.42) and stroke (RR = 1.38, 95% CI: 1.05, 1.82).

Individual level IP encounter rates and Model Building for covariates that influence IP encounter rates

We selected for a parsimonious preliminary main effects model that included member type, sex, substance abuse, stroke and the main predictor of interest, DPC (Table 8). Only gynecologic disorders confounded our primary predicted coefficient. However, we rejected inclusion of this covariate, as it restricts the model to women. Two potential influential members were identified. These had low frequency of IP encounters during the pre-intervention period (n_{IPpre} = 0, 3) and high frequency during the DPC period (n_{IPpost} = 10).

Table 8: Multivariate longitudinal negative binomial regression analysis of IP Encounters by DPC members

Parameter	Reference level	Rate Ratio (95% CI)	p-value
DPC membership	preDPC	0.36 (0.20, 0.64)	0.001
Member type	Standard	7.83 (6.02, 10.18)	< 0.0001
Substance Abuse	No substance abuse	1.37 (1.09, 1.71)	0.006
Cardiovascular Disease	No CVD	1.43 (1.09, 1.89)	0.01
Stroke	No Stroke	1.31 (1.04, 1.65)	0.02

Removing one of these points changed the coefficient for the primary predictor, DPC, by more than 10% ($RR_{w/o\ influential\ member}$ = 0.598 [0.287 – 0.773%]; $RR_{w\ influential\ member}$ = 0.356 [0.199, 0.639]) indicating this member may significantly influence the model. This member was excluded from the model, as shown in Table 9.

Table 9: Multivariate longitudinal negative binomial regression analysis of IP Encounters by DPC members, excluding influential member

Parameter	Reference level	Rate Ratio (95% CI)	p-value
DPC membership	preDPC	0.40 (0.23, 0.71)	0.002
Member type	Standard	7.90 (6.08, 10.26)	< 0.001
Substance Abuse	No substance abuse	1.35 (1.08, 1.69)	0.009
Cardiovascular Disease	No CVD	1.41 (1.07, 1.85)	0.015
Stroke	No Stroke	1.30 (1.04, 1.64)	0.024

The main effects model, excluding the influential member, shows that exposure to DPC is associated with a 60% (95% CI: 29 – 77%]) reduced rate of IP encounters after adjusting for the effects of member type, substance abuse, CVD and stroke. Members diagnosed with substance abuse were associated with a 35% *increased* rate of IP encounters (95% CI: 8 – 69%) over those with no history of substance abuse. Members with cardiovascular disease were associated with a 41% *increased* rate of IP encounters (95% CI: 7 – 85%) while members suffering from stroke were associated with a 30% *increased* rate of IP encounters (95% CI: (4 –64%) over their respective, unaffected counterparts. Most strikingly, scholarship members were associated with a 7.9 fold (95% CI: 6.1 – 10.3 fold) higher rate of IP encounters over standard members. Standard members were associated with an overall crude rate of 4.7 IP encounters per 100 patient years (95% CI: 3.6 - 6.1) while scholarship member were associated with 36.9 IP encounters per 100 patient years (95% CI: 30.2 - 44.9).

Significant interactions were identified between DPC and 1) uncontrolled diabetes, 2) stroke, 3) chronic pain and 4) number of chronic conditions (See Appendix, Table D). After adjusting for the effects of membership type, substance abuse, cardiovascular disease and stroke, access to primary care was not associated with the rate of IP encounters for those with uncontrolled diabetes (RR = 0.764, 95% CI: 0.327 – 1.783), chronic pain (RR = 1.211, 95% CI: 0.510 - 2.878), or stroke (RR = 0.626, 95% CI: 0.333 - 1.179), but was associated with reduced rates of IP encounters for their corresponding, unaffected counterparts. After DPC enrollment members without diabetes were associated with a 69% decreased rate of IP encounters (95% CI: 42 – 83%), those without chronic pain were associated with a 70% decreased rate of IP encounters (95% CI: 44 – 84%), and those without evidence of stroke were associated with a 74% decreased rate of IP encounters (95% CI: 50 – 87%).

Not surprisingly, the rate ratio for IP encounters before and after DPC enrollment is inversely related to the number of chronic conditions. Those with no chronic conditions were associated with an 86% decreased rate of IP encounters (95% CI: 66 – 94%) after DPC enrollment. Members with three chronic conditions were associated with a 67% decreased rate of IP encounters (95% CI: 40 – 82%), and members with five or more chronic conditions fail to show a statistically significant change in the rate of IP encounters after DPC enrollment ($RR_{5\ chronic}$ = 0.555, 95% CI (0.298, 1.035); $RR_{7\ chronic}$ = 0.944, 95% CI (0.439, 2.031)).

Given the higher rate of IP encounters among scholarship members, we tested whether standard and scholarship members responded differently to the DPC program and found scholarship members were associated with a 68.5% overall decreased rate of IP encounters (95% CI: 42 – 83%]), while standard members failed to show a statistically significant change in IP encounter rates (RR = 0.19, 95% CI: 0.253 - 1.067).

The rate of IP encounters increases with increases by a factor of 1.15 (95% CI [1.03, 1.28]) with each additional chronic condition for standard members. Standard members with one chronic condition show a 15% increased rate of IP encounters (95% CI [3.7, 66.0]). This increases to 52.2% for those with 3 chronic conditions (95% CI [9.8, 110.9]) and to 166.3% for those with 7 chronic conditions (95% CI [24.3, 470.3]). Scholarship members failed to show a statistically significant change in the rate IP encounters based on number of chronic conditions ($RR_{1\ chronic}$ =

0.99, 95% CI [0.92, 1.07]; $RR_{3\ chronic}$ = 0.97, 95% CI [0.78, 1.21]; $RR_{7\ chronic}$ = 0.94, 95% CI [0.56, 1.57]). The rate ratio between standard and scholarship members decreases with increasing number of chronic conditions. Scholarship members with one chronic condition experience 10.2 times the rate of IP encounters over scholarship members with one chronic condition (95% CI [7.3, 14.5]) while scholarship members with 7 chronic conditions show a 4.2 fold higher rate over their standard counterparts (95% CI [2.4, 7.3]).

OP/Ancillary Encounters:

Identifying factors associated with risk of OP/Ancillary encounters

Table 10 presents the results of the univariate analysis. Unlike ED and IP encounters, exposure to primary care was associated with a 3-fold *increased* overall rate of OP/Ancillary encounters (95% CI: 2.21 - 4.09). The crude baseline rate of OP/Ancillary encounters is 7 encounters per 100 patient years (95% CI: 5 – 11) and this increases to 22 encounters per 100 patient years (95% CI: 16 – 32) after enrolling in DPC. Scholarship members were associated with an 87% (95% CI: 26 - 177%) increased rate of OP/Ancillary encounters over standard members, and females were associated with a 61% (95% CI: 8 - 140%) increased rate of OP/Ancillary encounters over their male counterparts.

As presented in Table 10, all 14 chronic conditions were associated with higher rates of OP/Ancillary encounters. Only age group 0 - 18 (74% decrease, 95% CI: 38 – 96%]) and unmarried (41% decrease, 95% CI: 14 – 59%) were associated with decreased OP encounter rates over their corresponding counterparts.

Individual level OP/Ancillary encounter rates and Model Building for covariates that influence OP/Ancillary encounter rates

We selected for a preliminary main effects model that included sex, uncontrolled diabetes, CVD, stroke, COPD/asthma, chronic pain, and the main predictor of interest, DPC. The model is shown in Table 11. Two potential influential points were identified. However, as these failed

Table 10: Univariate Analysis for Factors Contributing to the Rate of OP/Ancillary Encounters among DPC Members (standard members, n = 433; scholarship members, n = 221)

parameter	levels	univariate RR (95% CI)	p-value
DPC	*pre*	reference	< 0.001
	intervention	3.00 (2.21, 4.09)	
Member type	*standard*	reference	0.002
	scholarship	1.87 (1.26, 2.77)	
Sex	*male*	reference	0.019
	female	1.61 (1.08, 2.40)	
Distance	*Vancouver*	reference	
	10 - 25 miles	0.80 (0.49, 1.30)	0.186
	over 25 miles	0.32 (0.08, 1.24)	
Chronic Conditions	*malignancy*	6.70 (2.29, 19.58)	0.001
	controlled diabetes	1.15 (0.63, 2.11)	0.641
	uncontrolled diabetes	2.46 (1.36, 4.43)	0.003
	substance abuse	1.28 (0.83, 1.97)	0.269
	mental health disorder	1.62 (1.04, 2.51)	0.031
	neurologic disorder	1.87 (1.15, 3.04)	0.011
	controlled hypertension	1.39 (0.98, 2.16)	0.147
	cardiovascular disease	2.98 (1.70, 5.22)	< 0.001
	stroke	2.54 (1.71, 3.78)	< 0.001
	COPD/asthma	2.20 (1.25, 3.87)	0.006
	genitourinary system	1.62 (0.66, 3.96)	0.290
	gynecologic disorders	1.76 (0.89, 3.49)	0.103
	chronic pain	3.23 (1.87, 5.60)	< 0.001
	obese	3.88 (1.25, 12.10)	0.019
	other	1.57 (1.07, 2.30)	0.022
NumberCHR	*continuous*	1.35 (1.23, 1.48)	< 0.001
Age groups	*age 0 - 18*	0.16 (0.04, 0.62)	
	age 19 - 34	reference	
	age 35 - 44	1.01 (0.52, 1.95)	0.001
	age 45 - 51	1.70 (0.88, 3.31)	
	age 52 - 58	1.87 (1.02, 3.47)	
	over 59	1.93 (1.04, 3.59)	
Length DPC	*3-6 month dpc*	reference	
	6-9 month dpc	1.02 (0.60, 1.74)	0.001
	9-12 month dpc	0.51 (0.25, 1.01)	
	over 1 year dpc	0.89 (0.56, 1.42)	
Marital Status	*married*	reference	0.006
	unmarried	0.59 (0.41, 0.86)	
Employment Status	*FT employed*	reference	
	PT/Self/Unemployed	1.42 (0.94, 2.13)	0.011
	Child	0.32 (0.10, 0.99)	

to impact the coefficient for the primary predictor, DPC, these members were retained in the model. Similarly, none of the covariates tested confounded our primary predictor coefficient (See Appendix, Table E).

Table 11: Multivariate longitudinal negative binomial regression analysis of OP/Ancillary Encounters

Parameter	Reference level	Rate Ratio (95% CI)	p-value
DPC	preDPC	2.12 (1.37, 3.28)	0.001
Sex	Male	1.49 (1.03, 2.16)	0.035
Uncontrolled Diabetes	No/controlled diabetes	1.76 (1.03, 2.98)	0.037
Cardiovascular Disease	No CVD	1.85 (1.23, 3.04)	0.015
Stroke	No Stroke	1.75 (1.22, 2.53)	0.003
COPD/Asthma	No COPD/Asthma	2.09 (1.27, 3.44)	0.004
Chronic Pain	No chronic pain	1.75 (1.06, 2.89)	0.028
Marital Status	Married/partner	0.66 (0.46, 0.93)	0.02

The main effects model shows that exposure to DPC was associated with a 112% increased rate of OP/Ancillary encounters (95% CI: 37 – 226%), after adjusting for the effects of gender, uncontrolled diabetes, CVD, stroke, COPD/asthma, chronic pain, and marital status. Unlike ED and IP encounters, both standard and scholarship members were associated with a statistically significant *increased* rate of OP encounters after DPC enrollment. Standard members were associated with an 82% increased rate of OP/Ancillary encounters (95% CI: 14 – 191%) and scholarship members were associated with a 231% increased rate of OP encounters (95% CI: 79 – 511%). Women were associated with 49% (95% CI: 3 – 116%) increased rate of OP/Ancillary encounters over their male counterparts. Only unmarried individuals were associated with a 34% *decreased* rate of OP/Ancillary encounters (95% CI: 7 – 54% decrease) over their married counterparts.

Several chronic conditions are associated with increased rates of OP/Ancillary encounters: COPD/asthma (RR = 2.09, 95% CI: 1.27 – 3.44), CVD (RR = 1.85, 95% CI: 1.23, 3.04), uncontrolled diabetes (RR = 1.76, 95% CI: 1.03 – 2.98), stroke (RR = 1.75, 95% CI: 1.22 – 2.53) and chronic pain (RR = 1.75, 95% CI: 1.06 – 2.89).

Only marital status was found to interaction with DPC enrollment. No difference was observed for those self-identified as married/life partner (RR = 1.32, 95% CI [0.78, 2.24]) while those self-identified as unmarried were associated with a 2.5 fold increased rate of OP/Ancillary encounters following DPC enrollment (95% CI: 1.1 – 4.8 fold]), after adjusting for the effects of gender, uncontrolled diabetes, CVD, stroke, COPD/asthma and chronic pain (See Appendix Table F).

Discussion

Main effects models were built to estimate the rates for ED, IP, and OP/Ancillary encounters and to define the covariates associated with these rates. These models were used to test if rates vary by membership type and to determine if DPC enrollment was associated with decreased rates of hospital encounters. Table 12 summarizes the crude and adjusted rates for hospital encounters during the baseline and DPC enrollment periods; Figure 3 visually presents the adjusted relative rates of hospital encounters by membership type during the baseline and DPC enrollment periods.

Table 12: Comparison of Outcome Predicted Rates* between Crude, Main Effects Model, and Main Effects Model with DPC*Member type Interaction Term. RR: relative risk; Rate Ratio: RR[DPC]/RR[baseline]

			ED[1]		IP[2]		OP[3]	
			RR* [95% CI]	rate ratio	RR* [95% CI]	rate ratio	RR* [95% CI]	rate ratio
crude	standard	baseline	1.39 [1.04, 1.85]	0.68 [0.49, 0.93]	0.52 [0.39, 0.68]	0.47 [0.22, 0.99]	0.52 [0.39, 0.68]	2.51 [1.72, 3.65]
		DPC	0.94 [0.66, 1.33]		0.24 [0.12, 0.48]		1.72 [1.16, 2.54]	
	scholar	baseline	2.89 [2.10, 4.00]	1.06 [0.74, 1.54]	4.89 [4.25, 5.63]	0.28 [0.14, 0.53]	0.98 [0.62, 1.56]	4.31 [2.61, 7.10]
		DPC	3.08 [2.06, 4.59]		1.37 [0.74, 2.56]		4.24 [2.60, 6.89]	
main effects model[1,2,3]	group	baseline	3.61 [2.35, 5.57]	0.63 [0.41, 0.96]	0.47 [0.36, 0.61]	0.36 [0.20, 0.64]	0.79 [0.49, 1.29]	2.12 [1.37, 3.28]
		DPC	2.27 [1.23, 4.17]		0.17 [0.09, 0.31]		1.69 [0.92, 3.12]	
main effects DPC*Member	standard	baseline	3.6 [2.32, 5.59]	0.54 [0.34, 0.87]	0.44 [0.33, 0.58]	0.52 [0.25, 1.06]	0.85 [0.51, 1.42]	1.82 [1.15, 2.91]
		DPC	1.95 [1.05, 3.64]		0.23 [0.12, 0.43]		1.55 [0.84, 2.86]	
	scholar	baseline	3.79 [2.36, 6.08]	0.85 [0.52, 1.41]	3.73 [3.06, 4.54]	0.32 [0.17, 0.58]	0.78 [0.45, 1.33]	3.31 [1.79, 6.11]
		DPC	3.24 [1.68, 6.25]		1.17 [0.64, 2.13]		2.56 [1.25, 5.25]	

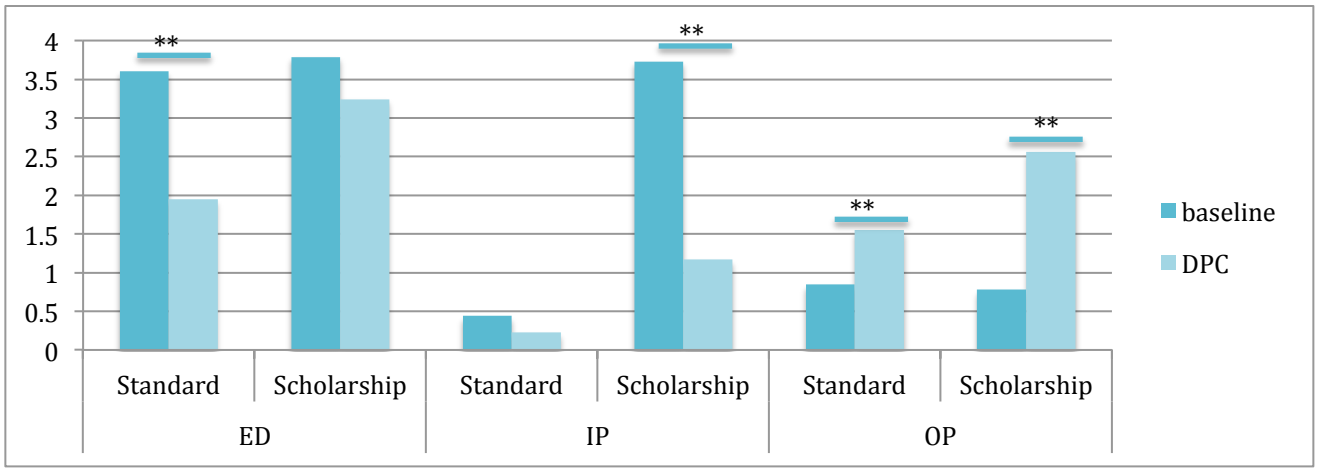
*** RR:** number encounters per 10 patient years

[1]**Main Effects Model for ED** includes adjustments for DPC, controlled diabetes, number of chronic conditions, age group, and employment status. [2]**Main Effects Model for IP** includes adjustments for DPC, membership type, substance abuse, CVD and stroke. [3]**Main Effects Model for OP** includes adjustments for DPC, sex, uncontrolled diabetes, CVD, stroke, COPD/Asthma, chronic pain and marital status

Important findings for ED encounter rates:

The crude analysis indicated DPC enrollment was associated with decreased rates of ED encounters for standard (32 %) but not scholarship members (6 % increase). The main effects model failed to indicate a group (membership) effect for rate ratio of ED encounters, but found DPC enrollment was associated with a 37% overall reduced rate of ED encounters, after adjusting for the effects of controlled diabetes, number of chronic conditions, age groups and employment status.

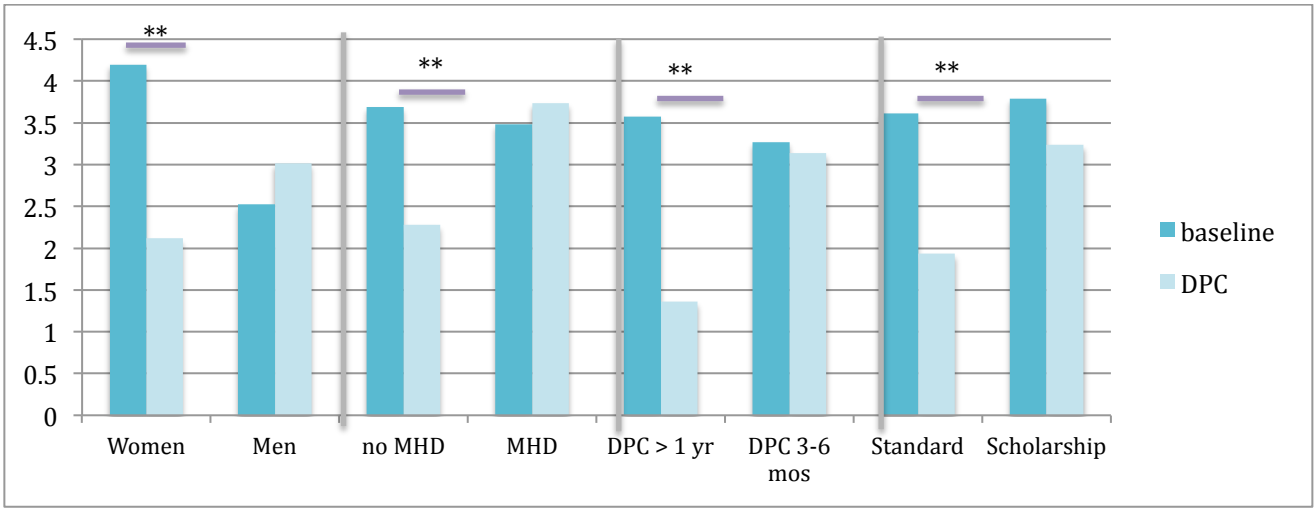
Figure 3: Adjusted Relative Rates of Hospital Encounters, per 10 patient years



** indicates significant difference between preDPC and DPC periods (< 0.05)

Inclusion of the interaction between DPC and membership type indicated standard and scholarship members experienced the same adjusted rate of ED encounters during the baseline period, but that DPC enrollment was associated with a 46 % adjusted rate reduction among standard members but only a 15 % rate reduction among scholarship members. This was surprising as we expected scholarship but not standard members to be associated with reduced ED rates. Most scholarship members were enrolled in DPC's managed care program, designed to stabilize a patients' acute or chronic conditions. Scholarship membership therefore represents a 'sicker' population. They were associated with 17% higher crude rate of clinic encounters (95% CI: 1 – 35%) over their standard counterparts. It is possible our inability to show reduced ED encounter rates after DPC enrollment for scholarship members relates to their shorter mean membership length ($\mu_{Scholar}$ = 183 days; $\mu_{Standard}$ = 382 days). Once scholarship members have their acute or chronic conditions stabilized they are no longer eligible for the free membership and many leave the program. Any encounters occurring during this short enrollment period, therefore, would result in relatively high rates. (See limitations section). The association between DPC and ED encounter rates for these important interactions are presented below in Figure 4.

Figure 4: Adjusted Relative Rate of ED Encounters, per 10 Patient Years, for groups significantly associated with reduced ED Encounter Rates after DPC Enrollment (and their unaffected counterparts)



** indicates significant difference between preDPC and DPC periods (< 0.05)

Surprisingly, older members were associated with lower ED encounter rates than members from the 19 – 34 age group. Although this could mean older DPC members were healthier than younger members, this could also reflect that older members with multiple chronic conditions qualify for Medicaid, based on diagnoses from their DPC physician. For example, a diagnosis of congestive heart failure qualifies a member for Medicaid and would remove them from the study.

Women were associated with a more favorable response to primary care access than their male counterparts, as indicated by reduced ED encounters rates. This is not wholly unexpected. Related to this finding, women are associated with a 24% increased crude rate of clinic encounters over their male counterparts, suggesting women may be more likely to treat their health conditions in the clinic rather than the ED.

Those with mental health disorders were associated with a 62% increased crude rate of OP encounters and a 34% increased crude rate of clinic encounters over their unaffected counterparts. Whereas those with no mental health disorders were associated with reduced rates of ED encounters those with mental health disorders were not. The DPC program does not provide mental health services in the clinic. Embedding a mental health professional in the clinic could possibly contribute to reduced ED rates among those with mental health disorders.

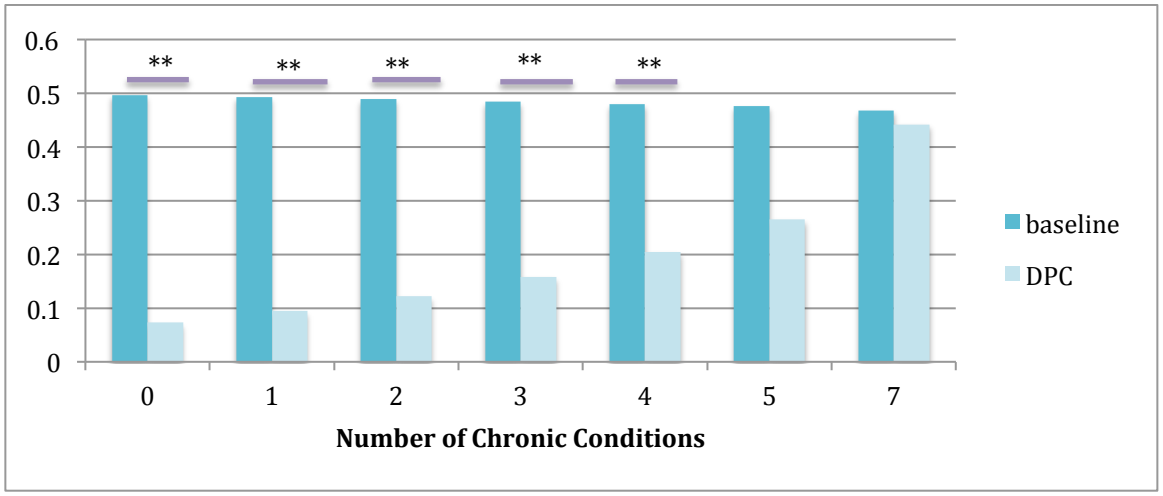
Important findings for IP encounter rates:

The crude analysis indicated DPC enrollment was associated with decreased rates of IP encounters for both standard (53 %) and scholarship members (72 %). The main effects model indicated a group (membership) effect for IP encounters: DPC enrollment was associated with a 64% decreased adjusted rate of IP encounters for DPC members, after adjusting for the effects of membership type, substance abuse, CVD and stroke, where scholarship members were associated with 7.8 times the rate of IP encounters of standard members during the baseline period. Inclusion of the interaction between DPC and membership type indicated that scholarship members were associated with 8.5 times the adjusted rate of IP encounters over standard members during the baseline period. After DPC enrollment standard members were associated with a 48 % (RR = 0.52, 95% CI: 0.25 – 1.06) adjusted rate reduction for IP encounters (not statistically significant) while scholarship members were associated with a 68 % (95% CI: 42 – 83%) rate reduction. These results were consistent with our hypothesis that DPC enrollment would reduce hospital rates for scholarship members to a greater extent than for standard members. Given the shorter enrollment period for scholarship members described above, it is likely that the full impact of primary care access is underestimated in this rate.

Enrollment in DPC did not change the IP encounter rates among those with uncontrolled diabetes, chronic pain or stroke, although it was associated with decreased rates among those without these conditions. Each of these chronic conditions was associated with higher clinic encounters rates than for their unaffected counterparts. Those with uncontrolled diabetes were associated with a 34% (8 – 67%) increased crude rate of clinic encounters and those with stroke were associated with a 42% (95% CI: 23 – 63%) increased crude rate of clinic encounters, over their unaffected counterparts. Diabetes is a condition that the DPC care management team focuses its efforts; an increase in IP encounters among those with uncontrolled diabetes was surprising, although this result is balanced by reduced rates among those with controlled diabetes. Those with chronic pain were associated with a 2.1 fold (95% CI: 1.75 – 2.60 fold) increased rate of clinic encounters over those without chronic pain. Managing chronic pain is an enormous problem for primary care clinics. That these patients showed increased rates of clinic and IP encounters after DPC enrollment suggests that new, innovative approaches should be explored to manage this patient population.

Those with fewer than four chronic conditions were associated with lower IP encounter rates after DPC enrollment while those with 5 or more chronic conditions fail to show a change, consistent with primary care managing some chronic conditions better than others. The number of chronic conditions was also associated with increased rates of clinic encounters (not shown), with the rate of encounters increasing by a factor of 1.15 for each chronic condition. This means that more primary care was provided to those with multiple chronic conditions, and that primary care was able to manage relatively complex patients (up to four chronic conditions). The association between number of chronic conditions and rates of IP encounters are presented in Figure 5.

Figure 5: Adjusted Relative Rate of IP Encounters, per 10 patient years, by Number of Chronic Conditions



** indicates significant difference between preDPC and DPC periods (< 0.05)

Important findings for OP/Ancillary encounter rates:

Whereas many studies look at the relationship between access to health care and rates of ED and IP encounters, its impact on OP/Ancillary encounter rates has been mostly overlooked. OP/Ancillary services represent a complex mix of specialty medicine, rehabilitation, imaging, chemotherapy/radiation therapy, same-day-surgery, as well as mental and behavioral health services. Some studies include wellness and prevention - including primary care – as an

outpatient encounter. OP encounter rates, therefore, will vary greatly depending upon what is included.

In the present study, OP/Ancillary encounter rates *increased* after DPC enrollment. The crude analysis indicated DPC enrollment was associated with *increased* rates of OP/Ancillary encounters for both standard (2.5 fold) and scholarship (4.3 fold) members. The main effects model indicated no group (membership) effect for OP/Ancillary encounters, but that DPC enrollment was associated with a 2.2 fold increased rate of OP/Ancillary encounters, after adjusting for the effects of sex, uncontrolled diabetes, CVD, stroke, COPD/asthma, chronic pain and marital status. The interaction between DPC and membership type was introduced into main effects model. While the baseline rate of OP/Ancillary encounters was similar for standard and scholarship members, DPC enrollment was associated with an 82.4% *increased* adjusted rate of OP/Ancillary encounters for standard members and a 228.2% *increase* for scholarship members.

Only marital status was associated with distinct OP/Ancillary rates following DPC enrollment: unmarried members were associated with a 2.5 fold increased rate of OP/Ancillary encounters after DPC enrollment while married/life partners failed to show a change. Unmarried members were associated with 34% reduced rate of OP/Ancillary encounters, despite this increase after DPC enrollment.

Studies show the presence of health insurance increases the likelihood of seeking health care by as much as15%.[31] As DPC covers primary care - but not ED, IP or OP/Ancillary services - it is not surprising that DPC enrollment *did not increase* ED and IP encounter rates. DPC provides a low cost alternative – or substitute - for higher cost ED and IP services. When DPC detects health events early in the disease process, early intervention may be associated with additional reductions in ED and IP encounter rates. However, when primary care is not sufficient for diagnosis, treatment or management of chronic or acute health events, supplemental – or complementary – services in the form of OP/Ancillary services are employed.[32] By this mechanism it is not surprising that DPC enrollment is associated with *increased* rates of OP/Ancillary encounters. To assist patients unable to afford such services, the DPC program includes access to a patient advocate who provides information and referrals to free, low cost,

and subsidized health services. Some of the increase in OP/Ancillary encounters likely results from advocates referring patients into low cost/charity care treatment within the PeaceHealth network. The dataset did not collect specifics related to the OP encounters, preventing further exploration into these possibilities.

Strengths and Limitations

Two limitations intrinsic to any longitudinal study are loss to follow-up and information bias related to the 'maturation' of the population. As this study is based entirely on PeaceHealth billing records, any absence of encounters could mean the patient did not use medical services for that period or that the patient used another medical center (loss to follow up). This bias is more problematic during the pre-intervention period, which assumes all patients use and reside in the area serviced by PeaceHealth. During the intervention period patients are known to reside in the PeaceHealth service area and their association with PeaceHealth for DPC increases the likelihood of using PeaceHealth for other medical needs. Loss to follow-up would *underestimate* the true rate of hospital encounters, especially during the pre-intervention period. Consequently, the association we detect between access to primary care and reduced rates of ED and IP encounters is likely *an underestimation of the true effect*. A sensitivity analysis using a 2-year pre-intervention period supports this hypothesis by increasing the association between DPC and reductions in ED and IP encounter rates (Appendix, Table J).

OP encounters based on hospital billing records included ancillary services such as hospice and home health services, encounter types that are excluded in many analyses. As these encounter types are associated with reducing the cost of health care they were included in the analysis. OP encounters also included imaging services that can be costly and are sometimes excluded when analyzing rates of health care services. Inclusion of imaging may overestimate the rate of OP encounters for the population.

The second limitation, information bias, results from demographic changes during the study period as well as loss of information (did not report) of specific demographic variables. These effects could change the strength of the association between specific covariates and encounter rates, but not the overall association between encounter rates and the primary predictor. For example, loss of information prevented inclusion of the effects of race or income into the

models, variables known to be associated with the rate of hospital encounters.[33] Loss of information also limited interpretation of the association between marital or employment status and the rate of hospital encounters. 33% of standard members failed to report employment status. Of those who did report, 23% of standard and 30% of scholarship members changed employment status at least once. The last reported employment status (during the DPC enrollment period) was used for the analysis. Marital status was similarly impacted. 33% of standard members failed to report marital status; only 4% of standard and 7% of scholarship members changed their marital status over the course of the study. While it is likely members who were unemployed or underemployed might be embarrassed and less likely to report employment status than those who have full-time employment (differential bias), the reasons for not reporting marital status are more complex and likely to result in non-differential bias. In both cases, loss of information is not likely to association between encounter rates and DPC enrollment.

Misclassification of chronic conditions is a major limitation for concluding associations between specific chronic conditions and encounter rates. Clinic office billing records were limited to three ICD-9 codes, meaning it is unlikely to capture all co-morbidities for a complex patient. Patients with multiple clinic encounters could have different ICD-9 codes were applied at each visit, increasing the likelihood of capturing multiple chronic conditions. Even so, the type and number of chronic conditions impacting the sickest patients was likely to be underestimated. Therefore, the association between number of chronic conditions/specific chronic conditions with increased risk of hospital encounters is likely to be *underestimated* and biased towards the null.

The HCUP indicator tool was used to identify and initially classify chronic conditions. However, the tool did not identify chronic conditions of interest to PeaceHealth's DPC Care Managers. Therefore, chronic conditions were re-classified to address the clinic's concerns. This included generating categories for controlled diabetes, uncontrolled diabetes, controlled hypertension, CVD, substance abuse, and chronic pain. This reclassification scheme could have resulted in misclassifying or dropping important codes, causing an *underestimation* in any true association between a chronic condition and rate of hospital encounters. Furthermore, not all chronic conditions identified by HCUP were tested in this analysis; several were lumped into

"Other Chronic Conditions." Because this category did not provide useful information, "Other" was dropped from the analysis.

Selection Bias is a potential issue for membership type. Scholarship members were selected following an ED or IP encounter and were known to have acute or chronic conditions requiring medical attention. Because they were sicker, they were enrolled into the DPC managed care program to stabilize their medical conditions. Historically, primary care provides the follow-up care critical to reducing IP readmission and ED bounce-back rates.[18] Therefore, we hypothesized scholarship membership would be strongly associated with reduced ED and IP encounters rates; we detected significant reductions only for IP encounter rates. It is possible that the long pre-intervention length – coupled with the short scholarship period (4 months) - may have biased against detecting a primary care benefit for ED encounter rates. For example, a scholarship member with five ED encounters in the two months prior to enrollment but with a preDPC period of 2 years would have a pre-intervention rate of 2.5 encounters per patient year. If the same scholarship members had one encounter in the four months of DPC enrollment, they would show an intervention rate of 3.3 encounters per patient year – an increase over the pre-intervention rate. Any encounters during the short DPC scholarship period will appear over inflated, relative to a long pre-intervention period. By contrast, if the patient was evaluated over a shorter preDPC period and a longer intervention period (possibly extending beyond the DPC membership) the rate ratio is likely to change. Short scholarship membership periods may be sufficient to stabilize a patient's health issues but may not be long enough to demonstrate reduced encounter rates.

Standard members self elect for DPC. Some may enroll because they have chronic conditions that would benefit from access to primary care. We expect these members to be associated with reduced ED or IP encounter rates after DPC enrollment. Other standard members may be healthy but enroll because DPC provides a 'safety net' of primary care. These standard members are expected to have no previous history of hospital encounters (68% of standard members have no ED encounters; 88% have no IP encounters) and would not be associated with reduced rates of ED or IP encounters. Because we expected the standard population to be healthier, we did not anticipate the observed association between DPC enrollment and reduced rates of ED encounters among standard members.

All bias in this study drive the associations towards the null, meaning the observed association between access to primary care and reduced ED and IP encounter rates must be an *underestimation* of the true effect.

Public Health Implications and Future Studies

In the fourth quarter of 2014, the uninsured rate for U.S. adults dropped to 12.9%, the lowest since Gallup began tracking in 2008. Hispanics remain the most at risk, with an uninsured rate of 32.4%, followed by Blacks with a rate of 20.9%. White Americans show the lowest risk of being uninsured, at 11.9%.[34] The U.S. Census Bureau shows Clark County Washington to fare slightly better than the national average, with a rate of 12.8±1.1% during 2013[35] (most recent data available). With an estimated population of 443,817 in 2013, this means Clark Country has an estimated 56,809 (± 4882) uninsured residents. [36] This is the population DPC looks to serve.

Even with Medicaid expansion and individuals gaining health insurance through the Insurance Market Exchanges, large numbers of people remain uninsured. Some individuals elect to not insure because of financial hardships such as homelessness, eviction, domestic violence, substantial debt, or because they live in a state that did not expand eligibility for Medicaid.[37] Others simply chose not to insure. Unfortunately, some do not insure because they do not qualify. This group includes legal immigrants who do not yet qualify for insurance subsidies, undocumented immigrants, and DACA (Deferred Action for Childhood Arrivals) individuals.

> "DACA-eligible individuals currently have the same access to health care and health insurance as undocumented immigrants… [They]
> - Cannot get comprehensive health insurance under Medicaid or CHIP…
> - Cannot buy health insurance in the ACA health insurance marketplace, even at full cost
> - Are not eligible for federal tax credits to make private health insurance affordable…
> - Cannot apply for the high-risk insurance pool…
> - Will likely not be eligible for the Basic Health Program" [38]

For these individuals, options for primary care are limited to community health centers, free clinics, or a low-cost program such as DPC. Unlike their other options, DPC promises easy access to a primary care physician or team, long-term management of chronic conditions, and continuity of care. Chronic conditions are the most common, costly and preventable diseases in

the U.S., and many of these conditions are managed most effectively through coordinated, longitudinal, preventive primary care.[24] This thesis shows the DPC program at PeaceHealth, with its patient centered focus, delivers much needed care that results in reducing ED and IP encounters for the uninsured, especially for those with multiple chronic conditions.

Future studies will test the relevance of DPC after Medicaid expansion and the Health Insurance Mandate of January 1, 2014. In this post-ACA environment DPC can remain viable if combined with a wrap-around catastrophic policy and offered on the Health Insurance Exchange Market. Replicating the efforts of Seattle's Qliance DPC program, which was offered on the 2015 Washington Insurance Exchange, PeaceHealth could combine DPC with a catastrophic plan and market it to small businesses as an inexpensive alternative to standard health insurance.[39] A second pathway for expanding DPC was modeled in the Direct M.D. Care Act (H.R. 3315), which would have expand DPC access to include Medicare and Medicaid populations. The Act, which died in committee, would have reimbursed established DPC practices $100 per month for Medicare beneficiaries and $125 for Medicare-Medicaid dual-eligible.[40] CMS subsequently created its own pilot program, which Oregon is now testing. Application to this program would allow PeaceHealth's DPC program to expand beyond Washington's uninsured.

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Appendix:

PHASE ONE: DATA ANALYSIS FLOWCHART, CREATING THE DATASETS

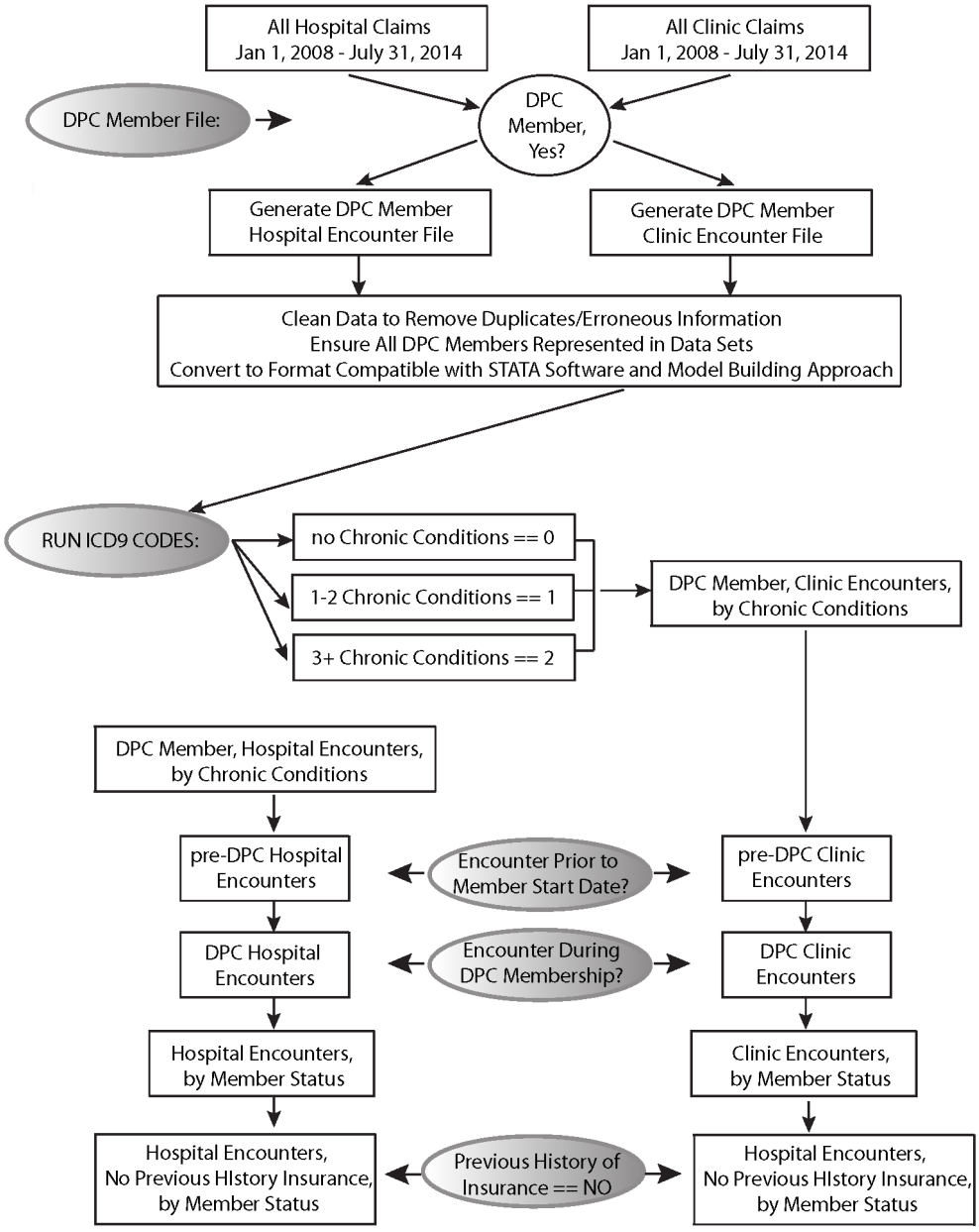

Figure A: Data Analysis Flow Chart for defining pre-DPC and DPC encounters. Each hospital and clinic encounter after January 1, 2010 is classified as pre-DPC or DPC (intervention). Each patient is classified as no Chronic Conditions, 1-2 Chronic Conditions or 3+ Chronic Conditions based on the number of ICD-9 identified Chronic Conditions extracted from patient records. Chronic Conditions is attached to patient ID and is carried throughout the analysis.

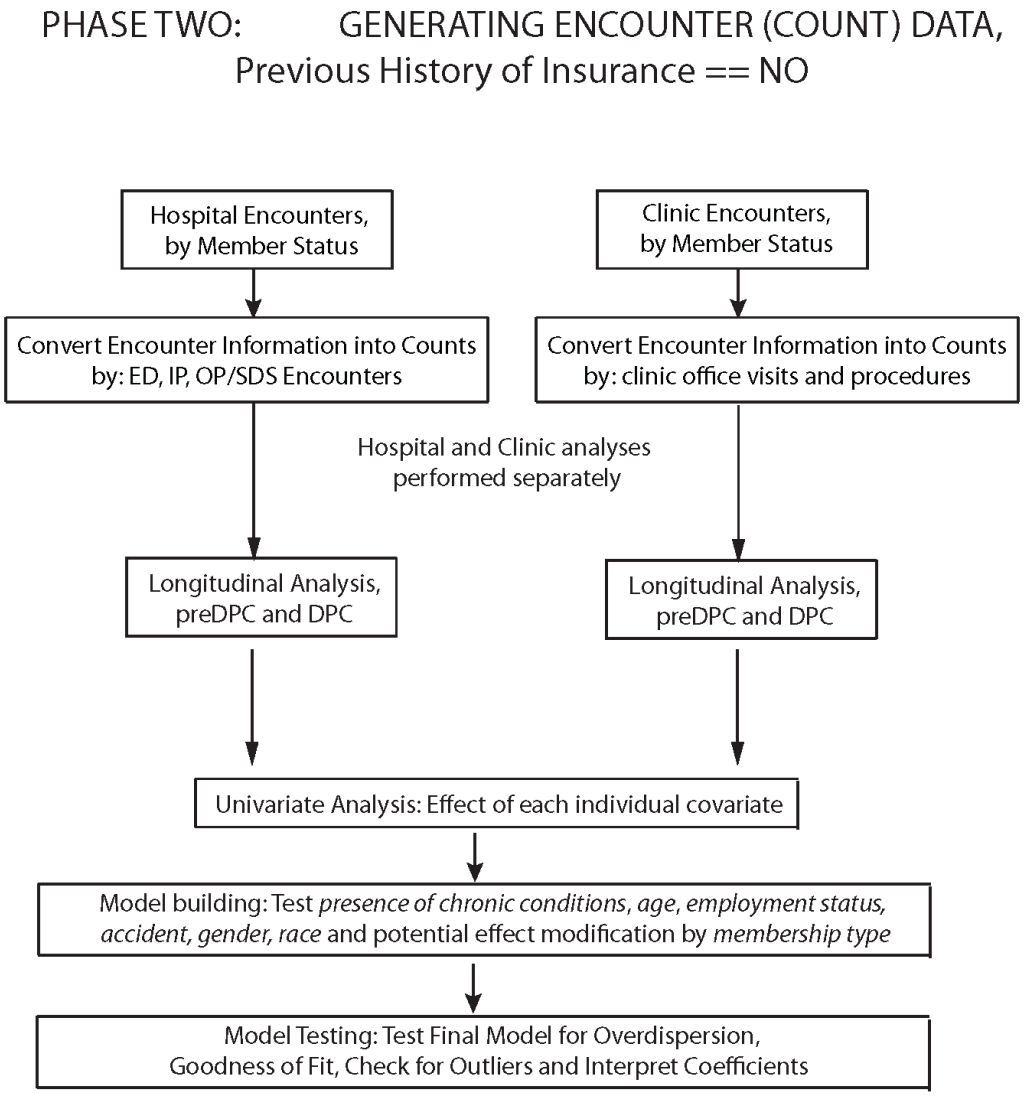

Figure B: Generating Encounter (Counts) Data. Working separately with hospital and clinic billing files, each encounter is summed, by patient ID, and outcome variable, across the pre-DPC and DPC periods. For hospital data this means ED, IP, OP and SDS encounters are separately summed for pre-DPC and DPC for each patient ID for the initial, binary analysis. Regression Model Building using each covariate is used to build a model for estimating the effect of DPC on the rates of encounters. Encounter data is then separated into 4-month bins for pre-DPC and DPC, centered on DPC start date, to create a longitudinal data set which estimates the effect of DPC on encounter rates for individuals and groups. A sub-analysis is performed using subjects containing the variable, *previous history of health insurance,* to estimate the effect of DPC on those without previous access to health care. A reduction in the rate of hospital encounters is used as a proxy for improved health outcomes.

Table A: Potential Confounding between ED Encounters Preliminary Main Effects Model and Removed Covariates

Variables	Reference Level	Member type	State*	Substance abuse**	Mental health disorder**	neurologic disorder**	stroke**	Genito-urinary**	obese**
_cons		-0.64%	0.07%	0.11%	-0.04%	-0.23%	0.00%	-0.06%	0.01%
dpc	**standard**	5.71%	0.78%	1.34%	1.18%	-2.53%	-0.31%	-0.01%	0.45%
controlled diabetes	**no diabetes**	-1.46%	0.57%	5.25%	2.60%	5.23%	2.66%	-2.44%	2.56%
numberCHR	**no Chronic**	-3.50%	0.21%	13.56%	6.45%	10.62%	5.69%	-2.68%	-1.09%
age 0 - 18		12.22%	-0.16%	-2.09%	-2.11%	1.34%	1.03%	2.74%	0.10%
age 35 - 44		-9.50%	-0.53%	-8.01%	1.27%	2.40%	-2.74%	-2.62%	-0.23%
age 45 - 51	**age 19 - 34**	-3.09%	0.00%	-2.06%	2.49%	3.44%	-0.17%	-0.14%	1.25%
age 52 - 58		-1.20%	-0.07%	0.36%	1.77%	1.91%	-0.25%	0.81%	-0.43%
over age 59		0.32%	-0.39%	1.19%	1.68%	0.85%	0.01%	1.13%	0.77%
Under employed	**FT**	5.41%	-0.59%	1.86%	0.62%	-2.57%	-0.52%	-0.72%	1.26%
Child	**employed**	-51.18%	-3.20%	36.29%	39.23%	-15.50%	-23.25%	-5.29%	-1.99%

* compared with reference level, residence in Washington State

** compared with reference level, absence of specific chronic conditions

*** compared with reference level, 3 – 6 months DPC

Testing the Main Effects Model for confounding with removed covariates. Only covariates that change the primary predictor, DPC, by more than 10% are re-introduced into the model. It is not unexpected that number of chronic conditions will interact with specific chronic conditions. These are likely to be collinear. The interaction between 'age 0 -18' and member type is not surprising and there are no scholarship members in this agegroup. Likewise, it is not unexpected that 'child' would interact with chronic conditions that are more prevalent among adults. Thus, these potential confounding variables are not of concern for the model.

Table B: ED Encounter Main Effects Model: Significant Interactions between DPC and Other Important Variables

Parameter	Reference Level	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)
DPC	preDPC	0.63 (0.41, 0.96)	0.54 (0.34, 0.86)	0.84 (0.52, 1.35)	0.96 (0.63, 1.47)	0.54 (0.34, 0.87)	0.84 (0.50, 1.40)
Controlled Diabetes	no diabetes	0.58 (0.35, 0.98)	0.59 (0.35, 1.00)	0.58 (0.34, 0.97)	0.58 (0.35, 0.97)	0.58 (0.35, 0.97)	0.60 (0.36, 1.01)
Number Chronic	continuous	1.18 (1.07, 1.30)	1.17 (1.05, 1.30)	1.19 (1.08, 1.31)	1.20 (1.09, 1.33)	1.19 ((1.08, 1.31)	1.17 (1.06, 1.29)
Age groups: 0 - 18yr		0.49 (0.13, 1.88)	0.48 (0.13, 1.86)	0.47 (0.11, 1.98)	0.48 (0.13, 1.80)	0.54 (0.14, 2.06)	0.50 (0.13, 1.90)
35 - 44 years		0.80 (0.52, 1.23)	0.79 (0.52, 1.22)	0.77 (0.48, 1.23)	0.83 (0.54, 1.27)	0.78 (0.51, 1.20)	0.80 (0.52, 1.23)
45 - 51 years	19 - 34 years	0.52 (0.32, 0.85)	0.53 (0.32, 0.87)	0.57 (0.34, 0.97)	0.53 (0.33, 0.85)	0.51 (0.31, 0.83)	0.52 (0.32, 0.85)
52 - 58 years		0.38 (0.23, 0.62)	0.39 (0.23, 0.64)	0.36 (0.21, 0.62)	0.40 (0.24, 0.64)	0.38 (0.23, 0.61)	0.39 (0.24, 0.63)
over 59 years		0.27 (0.16, 0.45)	0.28 (0.16, 0.47)	0.33 (0.19, 0.57)	0.28 (0.17, 0.46)	0.27 (0.16, 0.45)	0.27 (0.16, 0.45)
Employ: under emp	FT employed	1.39 (1.01, 1.92)	1.38 (1.00, 1.92)	1.41 (1.02, 1.95)	1.40 (1.02, 1.93)	1.38 (0.99, 1.90)	1.37 (0.99, 1.90)
child		0.93 (0.31, 2.77)	0.97 (0.32, 2.90)	0.93 (0.32, 2.76)	1.07 (0.37, 3.11)	0.91 (0.31, 2.68)	0.90 (0.30, 2.66)
Mental health (MH)	no MH		0.93 (0.62, 1.40)				
*intxn with MH			1.76 (1.03, 3.01)				
intxn with DPC:							
no MH			0.54 (0.34, 0.86)				
mental health			0.96 (0.55, 1.67)				
*intxn with 0 -18	age group 19 - 35			1.12 (0.23, 5.52)			
*intxn with 35 - 44				1.12 (0.57, 2.19)			
*intxn with 45 - 51				0.61 (0.27, 1.40)			
*intxn with 52 - 58				1.15 (0.55, 2.41)			
*intxn with > age 59				0.33 (0.12, 0.90)			
intxn with DPC:							
19 - 34 years				0.84 (0.52, 1.35)			
45 - 51				0.51 (0.26, 1.00)			
over 59 years				0.28 (0.12, 0.67)			
DPC 6-9 months	3 - 6 month DPC membership				1.23 (8.1, 1.86)		
DPC 9-12 months					0.86 (0.48, 1.53)		
DPC < 12 months					1.09 (0.73, 1.65)		
*intxn DPC 6-9 m					1.05 (0.56, 1.99)		
*intxn DPC 9-12 m					1.20 (0.53, 2.73)		
*intxn DPC < 12 m					0.40 (0.21, 0.74)		
intxn with DPC:							
dpc 3 - 6 months					0.96 (0.63, 1.47)		
dpc over a year					0.38 (0.24, 0.61)		
Membertype	standard					1.05 (0.76, 1.45)	
*intxn w member						1.57 (0.94, 2.64)	
intxn with DPC:							
standard						0.54 (0.34, 0.87)	
scholarship						0.85 (0.52, 1.41)	

Sex	1.39 (1.02, 1.90)
*intxn with sex	0.60 (0.36, 1.01)
intxn with DPC:	
men	0.83 (0.50, 1.40)
women	0.50 (0.31, 0.82)

* interaction between dpc and specified variable

Table C: Potential Confounding between IP Encounters Preliminary Main Effects Model and Selected Covariates

Variables	malignancy	COPD/ Asthma	Gyn disorders	Other	Number Chronic Cond	Under Employed*	Child*	Unmarried
_cons	-0.01%	-0.25%	-0.09%	0.51%	-0.35%	5.70%	6.03%	5.11%
DPC	2.78%	-1.21%	62.87%	-0.98%	-6.78%	0.54%	0.43%	3.38%
Member type	0.51%	0.73%	5.90%	0.75%	-0.58%	21.73%	22.11%	18.10%
Substance Abuse	0.85%	5.08%	36.39%	-1.06%	12.63%	4.06%	6.03%	8.64%
CVD	-2.29%	-8.48%	-92.24%	-8.99%	14.59%	32.60%	34.81%	26.36%
Stroke	3.09%	3.59%	23.43%	-5.70%	21.97%	13.00%	13.66%	14.79%

*** relative to full time employed**
**** relative to 3 – 6 months DPC enrollment**

Testing the Main Effects Model for confounding with removed covariates. Only covariates that change the primary predictor, DPC, by more than 10% are re-introduced into the model. It is not unexpected that gynecologic disorders change the model, as introduction of this covariate excludes male members. Because of this, gynecologic disorder was not considered for the main effects model despite changing the coefficient for the primary predictor. It is not surprising that member type interacts with the given covariates: the distribution of members by employment status and marital status is significantly different, with a large proportion of standard members failing to provide information on employment or marital status. In addition, there were no child scholarship members, making this interaction not surprising.

It is also not unexpected that number of chronic conditions interacts with specific chronic conditions. Re-introduction of number of chronic conditions will partially overlap with the chronic conditions already entered into the Main Effects Model, and these variables may exhibit collinearity; number chronic should not be put back into the main effects model

Table D: IP Encounter Main Effects Model: Significant Interactions between DPC and Other Important Variables

Parameter	Levels	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)
DPC membership	preDPC	0.36 (0.20, 0.64)	0.31 (0.17, 0.58)	0.26 (0.13, 0.50)	0.31 (0.16, 0.56)	0.15 (0.06, 0.34)
Member Type	Standard	7.83 (6.02, 10.18)	7.76 (5.97, 10.10)	7.88 (6.05, 10.25)	8.10 (6.20, 10.56)	8.04 (6.18, 10.45)
Substance Abuse	no substance abuse	1.37 (1.09, 1.71)	1.37 (1.09, 1.71)	1.37 (1.09, 1.71)	1.35 (1.08, 1.69)	1.32 (1.04, 1.67)
Cardiovascular Disease	no CVD	1.43 (1.09, 1.89)	1.41 (1.07, 1.86)	1.42 (1.08, 1.87)	1.39 (1.05, 1.83)	1.35 (1.01, 1.80)
Stroke	no history of stroke	1.31 (1.04, 1.65)	1.30 (1.03, 1.63)	1.16 (0.91, 1.49)	1.29 (1.02, 1.62)	1.24 (0.96, 1.60)
Uncontrolled Diabetes	no diabetes		1.05 (0.74, 1.50)			
*intxn w unctl'd diabetes			2.46 (1.05, 5.79)			
intxn with DPC:						
no diabetes			0.31 (0.17, 0.58)			
unctl'd diabetes			0.76 (0.33, 1.78)			
*intxn with stroke	no history of stroke			2.44 (1.27, 4.72)		
intxn with DPC:						
no history of stroke				0.26 (0.13, 0.50)		
with stroke				0.63 (0.33, 1.18)		
Chronic Pain	no history of chronic pain				0.94 (0.61, 1.46)	
*intxn with chronic pain					3.97 (1.66, 9.50)	
intxn with DPC:						
no chronic pain					0.31 (0.16, 0.56)	
with chronic pain					1.21 (0.51, 2.88)	
Number Chronic Cond'ns	no chronic cond'ns					0.99 (0.92, 1.06)
*intxn w number chronic						1.30 (1.12, 1.52)
intxn with DPC:						
no chronic conditions						0.15 (0.06, 0.34)
1 chronic condition						0.19 (0.09, 0.40)
3 chronic conditions						0.33 (0.18, 0.60)
5 chronic conditions						0.56 (0.30, 1.04)
7 chronic conditions						0.94 (0.44, 2.03)

* interaction with DPC and specified variable

Table E: Potential Confounding between OP Encounters Preliminary Main Effects Model and Selected Covariates

Model Variable	Member type	Mental Health Disorder	Neurologic Disorders	Controlled Hypertension	Gynecologic Disorder	Obese	"other"	Number Chronic	employment status	Age Groups
_cons	-0.58%	-0.36%	-0.05%	0.50%	7.47%	0.00%	0.60%	-0.97%	-0.09%	-1.03%
DPC	-2.52%	1.16%	-0.30%	-1.20%	-6.95%	-0.31%	0.80%	-0.32%	5.96%	0.34%
Sex	-4.93%	2.95%	1.59%	2.12%	omitted	0.76%	0.43%	1.61%	-6.03%	2.66%
Uncontrolled Diabetes	2.86%	1.57%	6.26%	-8.25%	62.51%	3.34%	-7.61%	29.28%	-3.84%	8.84%
Cardiovascular Disease	4.59%	-0.69%	3.95%	-1.51%	-3.40%	-0.21%	-4.63%	12.08%	24.47%	12.27%
Stroke	0.68%	1.12%	4.30%	-2.63%	24.64%	-0.41%	-0.83%	14.56%	3.88%	4.84%
COPD/Asthma	1.59%	1.22%	1.11%	-1.25%	19.16%	0.22%	-0.61%	11.24%	5.27%	12.14%
Chronic Pain	-3.86%	6.49%	3.55%	-3.43%	27.35%	2.04%	-6.93%	20.55%	23.52%	12.06%
Marital Status	-4.73%	1.78%	-1.05%	-2.13%	2.10%	0.76%	-4.72%	3.47%	-5.24%	14.69%

Testing the Main Effects Model for confounding with removed covariates. Only covariates that change the primary predictor, DPC, by more than 10% are re-introduced into the model. No covariates change DPC in the given model. It is not unexpected that gynecologic disorders change the model, as introduction of this covariate excludes male members. Because of this, gynecologic disorder was not considered for the main effects model. Likewise, it is not unexpected that number of chronic conditions interacts with specific chronic conditions. Re-introduction of number of chronic conditions will partially overlap with the extensive list of chronic conditions entered into the Main Effects Model. In future studies the confounding effects of employment status and age groups with the given chronic conditions could be explored.

Table F: OP Encounter Main Effects Model: Significant Interactions between DPC and Other Important Variables

Parameter	Reference Level	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)	Relative Rate (95% CI)
DPC	preDPC	2.12 (1.37, 3.28)	3.64 (1.96, 6.79)	1.89 (1.21, 2.95)	1.32 (0.78, 2.24)
Sex	Standard	1.49 (1.03, 2.16)	1.97 (1.26, 3.08)	1.52 (1.05, 2.20)	1.48 (1.02, 2.13)
Uncontrolled Diabetes	no substance abuse	1.76 (1.03, 2.98)	1.80 (1.06, 3.04)	1.73 (1.01, 2.96)	1.76 (1.04, 2.97)
Cardiovascular Disease	no CVD	1.85 (1.23, 3.04)	1.87 (1.14, 3.05)	1.79 (1.08, 2.97)	1.84 (1.12, 3.00)
Stroke	no history of stroke	1.75 (1.22, 2.53)	1.78 (1.24, 2.57)	1.77 (1.22, 2.55)	1.74 (1.21, 2.50)
COPD/Asthma	no COPD/Asthma	2.09 (1.27, 3.44)	2.07 (1.26, 3.41)	2.13 (1.29, 3.50)	2.14 (1.31, 3.51)
Chronic Pain	no history of chronic pain	1.75 (1.06, 2.89)	1.76 (1.07, 2.90)	1.76 (1.06, 2.90)	1.73 (1.05, 2.84)
Marital Status	Married	0.66 (0.46, 0.93)	0.66 (0.47, 0.95)	0.65 (0.45, 0.93)	0.46 (0.30, 0.70)
*intxn w sex			0.47 (0.25, 0.90)		
intxn with DPC:					
men			3.64 (1.96, 6.79)		
women			1.72 (1.09, 2.75)		
Genitourinary disorders				0.53 (0.16, 1.74)	
* intxn w gentio disorders				5.96 (1.38, 25.73)	
intxn with DPC:					
no genito disorder				1.89 (1.21, 2.95)	
genitourinary disorder				11.25 (22.68, 47.17)	
* intxn w marital status					2.61 (1.41, 4.83)
intxn with DPC:					
married					1.32 (0.78, 2.24)
not married					3.45 (2.06, 5.77)

* interaction with DPC and specified variable

Table G: Comparison of Outcome Predicted Rates (per 10 patient years) between Crude, Main Effects Model, and Main Effects Model with DPC*Member type Interaction Term. Sensitivity assay: limit length preDPC to 2 years. RR: relative risk Rate Ratio: RR[DPC]/RR[baseline]

			ED[1]		IP[2]		OP[3]	
			RR [95% CI]	rate ratio	RR [95% CI]	rate ratio	RR [95% CI]	rate ratio
Crude	standard	baseline	1.47 [1.07, 2.01]	0.49 [0.29, 0.82]	0.68 [0.52, 0.88]	0.63 [0.40, 0.98]	0.63 [0.42, 0.95]	2.53 [1.74, 3.67]
		DPC	0.72 [0.38, 1.37]		0.43 [0.30, 0.61]		1.59 [1.08, 2.34]	
	scholarship	baseline	3.03 [2.15, 4.26]	0.79 [0.47, 1.33]	6.42 [5.68, 7.25]	0.35 [0.24, 0.51]	0.85 [0.53, 1.36]	4.54 [2.76, 7.42]
		DPC	2.40 [1.27, 4.54]		2.23 [1.56, 3.19]		3.84 [2.37, 6.21]	
Main Effect	group	baseline	4.00 [2.57, 6.16]	0.56 [0.36, 0.87]	0.63 [0.49, 0.80]	0.42 [0.31, 0.56]	0.71 [0.43, 1.16]	2.12 [1.35, 3.32]
		DPC	2.24 [1.20, 4.17]		0.26 [0.19, 0.36]		1.49 [0.79, 2.81]	
DPC* Membertype	standard	baseline	3.91 [2.50, 6.11]	0.50 [0.31, 0.16]	0.57 [0.43, 0.75]	0.59 [0.38, 0.93]	0.77 [0.45, 1.30]	1.82 [1.13, 2.94]
		DPC	1.95 [1.04, 3.68]		0.34 [0.23, 0.49]		1.40 [0.74, 2.63]	
	scholarship	baseline	4.30 [2.67, 6.92]	0.74 [0.45, 1.20]	4.86 [4.08, 5.79]	0.34 [0.23, 0.50]	0.66 [0.37, 1.16]	3.28 [1.75, 6.14]
		DPC	3.19 [1.63, 6.23]		1.65 [1.12, 2.42]		2.15 [1.03, 4.49]	

[1]**Main Effects Model for ED** includes adjustments for DPC, controlled diabetes, number of chronic conditions, age group, and employment status. [2]**Main Effects Model for IP** includes adjustments for DPC, membership type, substance abuse, CVD and stroke. [3]**Main Effects Model for OP** includes adjustments for DPC, sex, uncontrolled diabetes, CVD, stroke, COPD/Asthma, chronic pain and marital status