

Is i2b2 for you?

Monitoring and Evaluation of Urban Health Outcomes using Open-source Population Health Software

William G. Adams, MD

Professor of Pediatrics

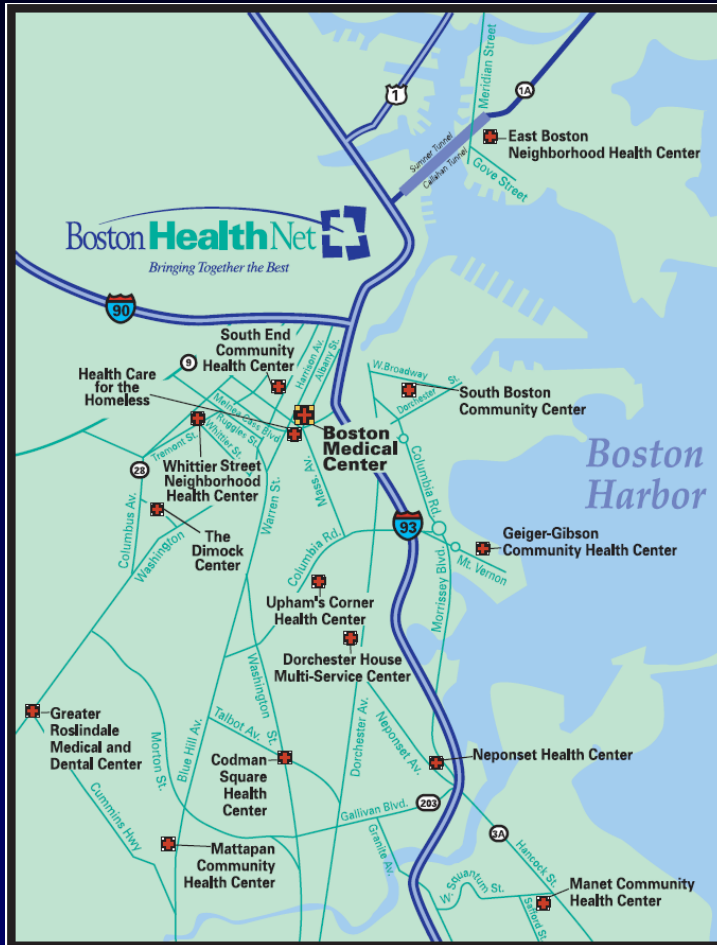
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The “EcoSystem”



- BMC is largest safety net provider in New England
- Nearly all CHCs are FQHCs
- EHR-based care
 - BMC since 1999
 - CHCs since 2003

A Vision

- Data is open - privacy is protected
- Researchers focus on the question - not the query
- Researchers ask complex clinical research questions *themselves*
- Data is standardized so the same question can be asked at multiple sites
- 10 hypotheses -> 1 great question

i2b2

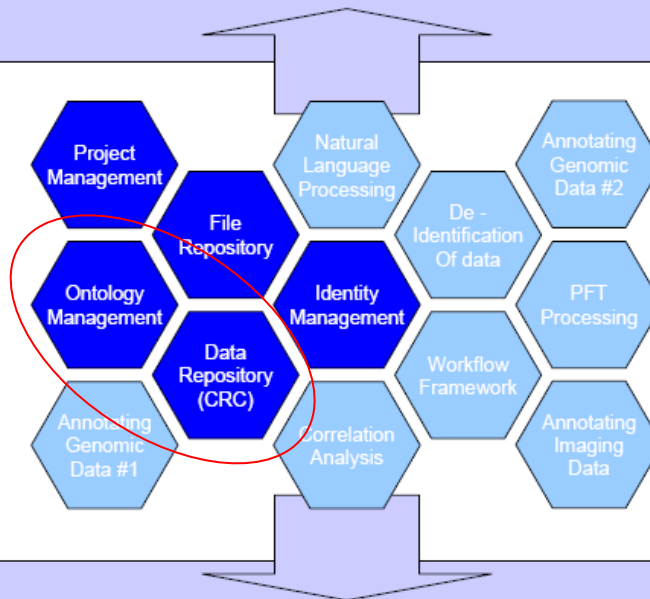
- “Informatics for Integrating Biology with the Bedside”
- Open-source software based on the MGH Research Patient Data Repository (RPDR)
- Collection of modules or “cells” constitute the i2b2 “hive”
 - De-identified clinical data repository
 - Data linked to standardized vocabularies
 - Query and analytic tools
 - Two applications: web-client and Workbench (java)

i2b2 Key Concepts

- Data integration and mapping
 - Disparate data mapped to common format
- Master Patient Index (MPI)
 - Data for individuals linked
- De-identification
- Patient sets
 - Outcomes measured via nested queries that identify populations

Enterprise-wide repurposing and distribution
of medical record data for research

i2b2 Hive



Use of medical record data in clinical studies
focused upon genomics and pharmacology

i2b2 Core Data Elements

- Patients
- Observations (Facts)
- Concept Libraries (Ontologies)

Massachusetts Health Disparities Repository (MHDR)

Clinical Data

Data:

- Demographic
- Insurances
- Services
- Medications
- Problems
- Labs
- Clinical Observations

Sites:

- Boston Medical Center
- Dorchester House MSC
- Codman Square HC
- Healthcare for the Homeless
- Greater Roslindale MDC
- Whittier Street HC
- Mattapan CHC
- South End CHC
- South Boston CHC
- Uphams Corner CHC

Staging Area

Functions:

- MPI linkage
- Data cleaning
- Standardization (LOINC, CPT, RxNorm, ICD9, SNOMED CT)

i2b2

Database

- People (1.4+ mil)
- Facts (1+ billion)
- Concepts

Tools

- Query Cell
- HOME Cell

BMC-i2b2

- BMC only
- Web accessible
- Aggregate data
- No additional IRB

MHDR

- BMC + CHCs
- RDP access (with SAS, STATA)
- HOME Cell and data extracts
- IRB approval required

i2b2 Workbench

File Search Window Help Run

i2b2 Workbench for i2b2 i2b2 Admin Status: ● i2b2

Navigate Terms Find Terms Query Tool Home View

Demographics

- Age
 - >= 65 years old
 - >= 85 years old
 - 0-9 years old
 - 10-17 years old
 - 18-34 years old
 - 35-44 years old
 - 45-54 years old
 - 55-64 years old
 - 65-74 years old
 - 75-84 years old
 - not recorded
- Gender
- Language
- Marital Status
- Race
- Religion
- Vital Status
- Zip codes

Diagnoses

GE Centricity

GE Centricity New

Vitals

- Blood Pressure
 - Diastolic
 - Lying
 - Sitting
 - Standing
 - Unspecified
 - Systolic
- Growth
- O2 Saturation
- Pulse
- Respiratory Rate
- Temperature

Query Name: 45-64 year olds

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
45-54 years old								
55-64 years old								

↑
Facts

Ontology

Add Group

Count

Analysis Types

- ☐ Patient list
- ☒ Number of pa...
- ☐ Gender patien...
- ☐ Vital Status p...
- ☐ Race patient ...
- ☐ Age patient b...
- ☐ TimeLine
- ☐ TimeLine
- ☐ Number of ra...
- ☐ Number patie...
- ☐ Number patie...
- ☐ Number patie...
- ☐ Number of pa...
- ☐ Number of pa...
- ☐ Number of pa...
- ☐ Aggerate valu...
- ☐ Numerator pa...
- ☐ patient_yearl...
- ☐ patient_mont...
- ☐ patient_recen...
- ☐ patient_mont...
- ☐ WithStrata_p...
- ☐ patient_entire...
- ☐ patient_recen...
- ☐ patient_entire...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...

The terms of this group are joined then intersected with other groups

Drag terms from Navigate, Find and Workplace into this group

Drag terms from Navigate, Find and Workplace into this group

Previous Queries Workplace

Get Everyone Run Query Above Patient(s) returned: 293671

Navigate Terms Find Terms

Search by Names Search by Codes

Containing

Find

- Benign essential hypertension
- Benign essential hypertension antepartum
- Benign essential hypertension complicating pregnar
- Benign essential hypertension complicating pregnar
- Benign essential hypertension with delivery
- Benign essential hypertension, postpartum
- Benign essential hypertension, with delivery, with n
- Benign intracranial hypertension
- Benign renovascular hypertension
- Benign secondary hypertension
- Chronic venous hypertension without complications
- Edema or excessive weight gain in pregnancy, with
- Elevated blood pressure reading without diagnosis
- Essential hypertension
- Hypertension
- Hypertension complicating pregnancy, childbirth, ar
- Hypertension secondary to renal disease, antepart
- Hypertension secondary to renal disease, complicat
- Hypertension secondary to renal disease, complicat
- Hypertension secondary to renal disease, postpart
- Hypertension secondary to renal disease, with deliv
- Hypertension secondary to renal disease, with deliv
- Malignant essential hypertension
- Malignant renovascular hypertension
- Malignant secondary hypertension
- Ocular hypertension
- Other benign secondary hypertension
- Other malignant secondary hypertension
- Other pre-existing hypertension complicating pregn

Previous Queries Workplace

Query Tool Home View

Query Name: 45-64 years old with HTN

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
45-54 years old			Essential hypertension					
55-64 years old			Benign essential hypertension					
			Hypertension					

The terms of this group are joined then intersected with other groups

The terms of this group are joined then intersected with other groups

Drag terms from Navigate, Find and Workplace into this group

Add Group

Analysis Types

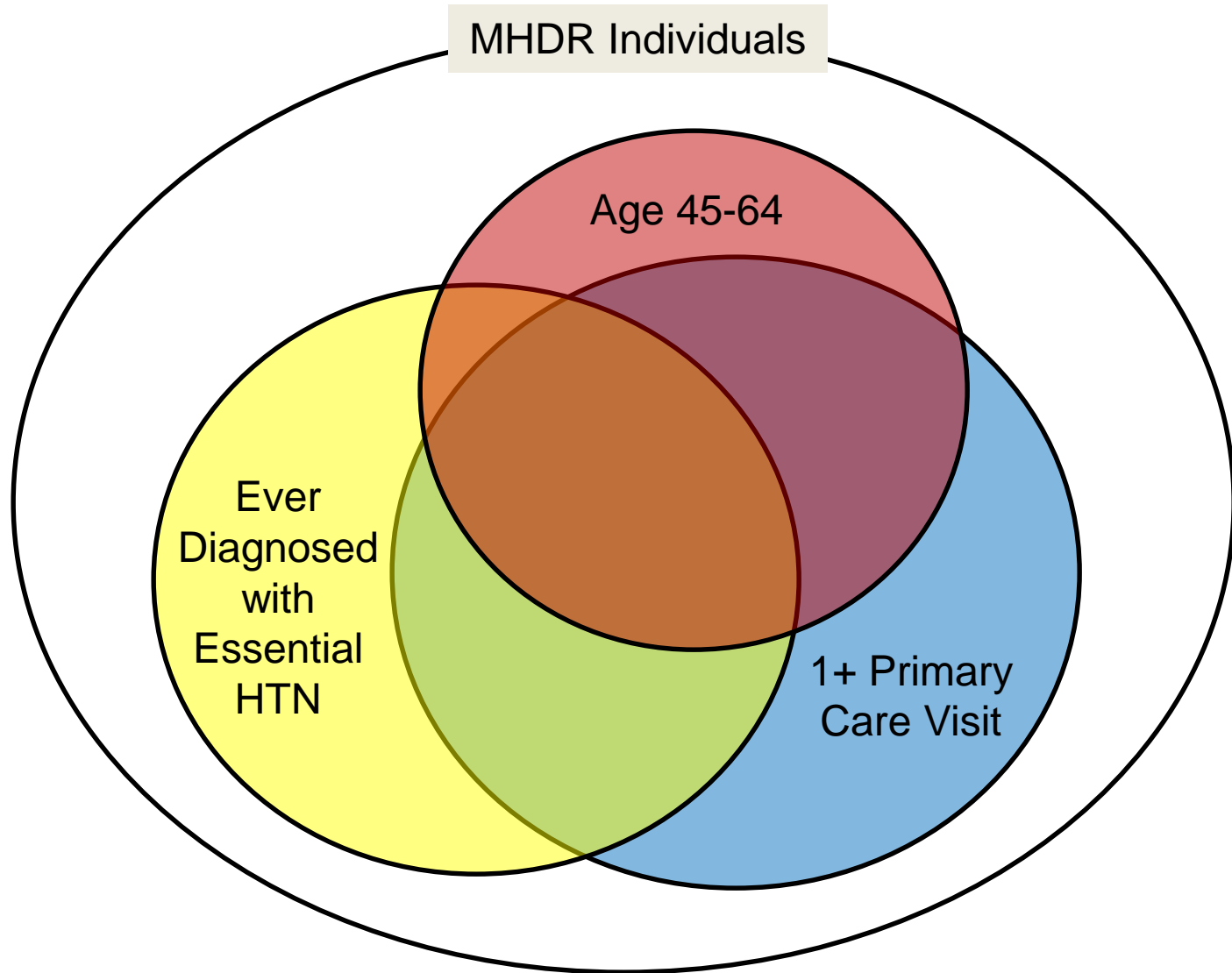
- ☐ Patient list
- ☒ Number of pa...
- ☐ Gender patien...
- ☐ Vital Status p...
- ☐ Race patient ...
- ☐ Age patient b...
- ☐ TimeLine
- ☐ TimeLine
- ☐ Number of ra...
- ☐ Number patie...
- ☐ Number patie...
- ☐ Number of pa...
- ☐ Number of pa...
- ☐ Number of pa...
- ☐ Aggerate valu...
- ☐ Numerator pa...
- ☐ patient_yearl...
- ☐ patient_mont...
- ☐ patient_recen...
- ☐ patient_mont...
- ☐ WithStrata_p...
- ☐ patient_entire...
- ☐ patient_recen...
- ☐ patient_entire...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...
- ☐ WithStrata_p...

☐ Get Everyone

Run Query Above

Patient(s) returned: 32130

Patient Sets Example



Staging Area (PHI containing data)

Billing Data – Site 2							
MRN	Visit_date	Location	Dx1	Dx2	CPT1	CPT2	PrimIns
ABCD	2/15/2010	PediPulm	123.4	125.8	90214	90213	Uninsured
ABCD	2/15/2010	MCV	70				

Link Table		
ID	MRN	Site
12	1234	Site1
12	ABCD	Site2



i2b2 Repository (de-identified data)

Patients				
ID	Birth_Date	Sex_Cd	Race_Cd	...
12	11/07/2000	M	B	

Observation_facts						
ID	Concept_Cd	Start_Date	Value	Location_Cd	End_Date	...
12	PrimCareVis	1/22/2010	Site1	Site1		
12	Dx	1/22/2010	123.4	Site1		
12	Dx	1/22/2010	125.8	Site1		
12	Proc	1/22/2010	90124	Site1		
12	Proc	1/22/2010	90254	Site1		
12	Ins	1/22/2010	Medicaid	Site1		
12	PediPulm	2/22/2010	Site2-PediPulm	Site2		
12	Dx	2/22/2010	123.4	Site2		
12	Hct	2/22/2010	11.1	Site2		
12	MCV	2/22/2010	70	Site2		

Value considerations

- i2b2 uses standard coding systems (ontologies) like ICD9, ICD10, LOINC, RxNorm, SNOMED-CT
- Observations have five main components: Pt ID, start/end dates, concept ID, and value
- Concepts with the same code can mean different things

Navigate Terms

Find Terms

Search by Names

Search by Codes

Containing

diabetes

Find

Any Category

- 637 DIABETES W MCC
- 638 DIABETES W CC
- 639 DIABETES W/O CC/MCC
- Diabetes insipidus
- Diabetes mellitus
 - Diabetes mellitus with hyperosmolarity - 921
 - Diabetes mellitus without mention of complication - 60676
 - Diabetes with ketoacidosis - 1438
 - Diabetes with neurological manifestations - 13169

Workplace

- aalegler
- alcoe
- alschmal
- alwalkey
- alweinst
- amgarg
- amsobota
- anfarrel
- anking
- aucalder
- badams
- biadams
- briacobs

Previous Queries

- OPI-OPI-OPI-opi@14:48:18 [10-10-2015] [malaroch]
- OPI-OPI-OPI-opi@14:47:29 [10-10-2015] [malaroch]
- OPI-OPI-OPI-opi@14:46:43 [10-10-2015] [malaroch]
- OPI-OPI-OPI-opi@14:45:55 [10-10-2015] [malaroch]
- OPI-OPI-OPI-opi@14:44:34 [10-10-2015] [malaroch]
- OPI-OPI-OPI-opi@14:43:46 [10-10-2015] [malaroch]

Query Tool

Query Name:

Temporal Constraint:

Treat all groups independently

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently			Treat Independently			Treat Independently		

drop a
term
on here

Run Query

Clear

Print Query

0 Groups

New Group

Query Status

Navigate Terms

Find Terms

Search by Names Search by Codes

Containing diabetes

Find Any Category

- 637 DIABETES W MCC
- 638 DIABETES W CC
- 639 DIABETES W/O CC/MCC
- Diabetes insipidus
- Diabetes mellitus
- Diabetes mellitus complicating pregnancy, childbirth, or the puerperium
- Diabetes mellitus of mother, complicating pregnancy, childbirth, or the puerperium, unspecified as to episode
- Diabetes mellitus of mother, with delivery
- Diabetes mellitus of mother, with delivery, with complications

Workplace

- aalegler
- alcoe
- alschmal
- alwalkey
- alweinst
- amgarg
- amsobota
- anfarrel
- anking
- aucalder
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- biadams
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Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently			Treat Independently			Treat Independently		
Diabetes mellitus - 65470								

Choose value of Diabetes mellitus (Test:ICD9:250)

Searches by Lab values can be constrained by the high/low flag set by the performing laboratory, or by the values themselves.

☒ No Value☐ By Value

OK

Cancel

one or
more of
these

AND

drop a
term
on here

Run Query

Clear

Print Query

1 Group

New Group

Query Status

Navigate Terms

Find Terms

Search by Names

Search by Codes

Containing

diabetes

Find

Any Category

- 637 DIABETES W MCC
- 638 DIABETES W CC
- 639 DIABETES W/O CC/MCC
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- Diabetes mellitus of mother, with delivery, with

Workplace

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Treat Independently			Treat Independently			Treat Independently		
Diabetes mellitus - 65470								

Choose value of Diabetes mellitus (Test:ICD9:250)

Searches by Lab values can be constrained by the high/low flag set by the performing laboratory, or by the values themselves.

- ☐ No Value
- ☒ By Value

Please select a value:

ADMITTING

PRIMARY

PROBLEM

SECONDARY

OK

Cancel

drop a
term
on here

Run Query

Clear

Print Query

1 Group

New Group

Query Status

i2b2 Compatible Data

- Demographics
- Problems/Diagnoses
- Medications
- Clinical Observations
- Procedures
- Laboratory Data
- Genomic Data
- Much more...

i2b2 and Health Services Research

- i2b2 excels at cohort identification
- Lacked functionality to describe clinical processes and outcomes *over time*
- Outcomes research possible with:
 - New ontologies
 - New data (GIS, services, insurance, etc)
 - Temporal modeling of facts as exposures and outcomes

New MHDR Ontologies

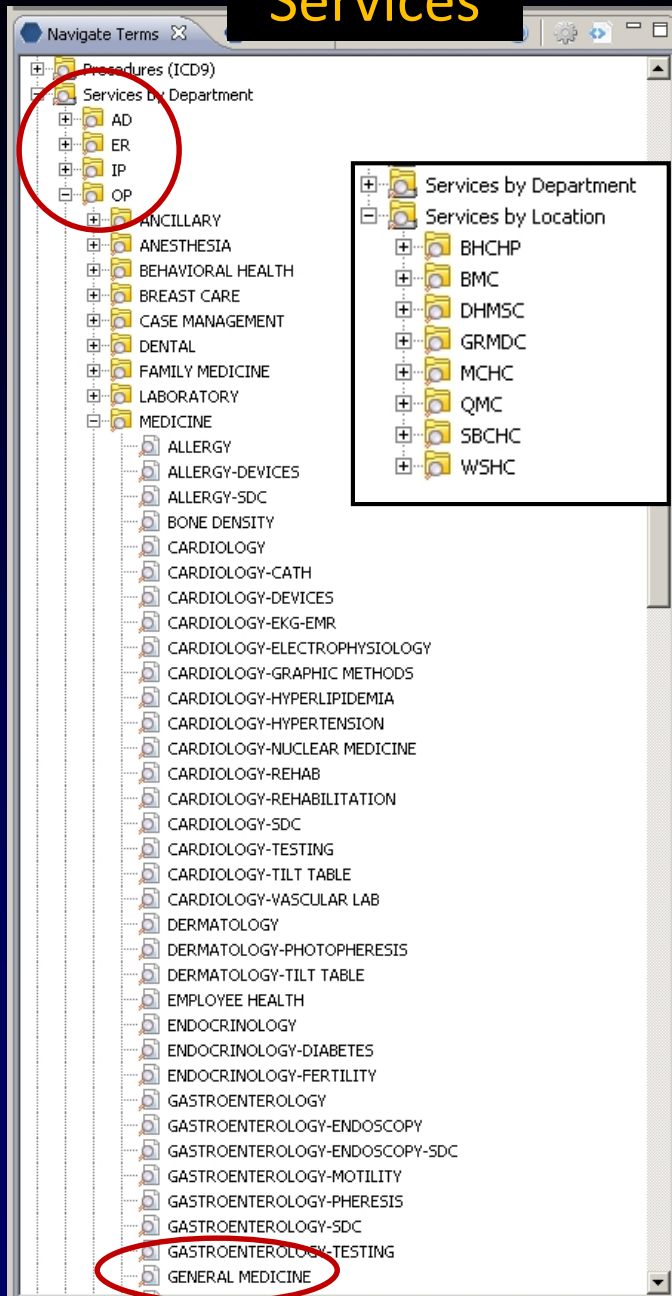
Administrative:

- Clinical Services (e.g. GIM, Pediatrics)
 - By location and specialty
 - Coding: custom ontology
- Insurance (e.g. BCBS, Medicaid)
 - By payer type (e.g. Commercial, Medicaid)
 - Coding: Custom

Clinical:

- Vital Signs (e.g. Blood Pressure, Growth)
 - Coding: SNOMED-CT

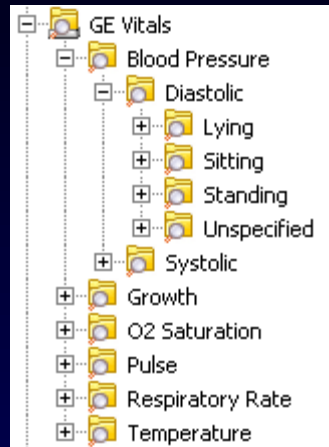
Services



Coding: Custom

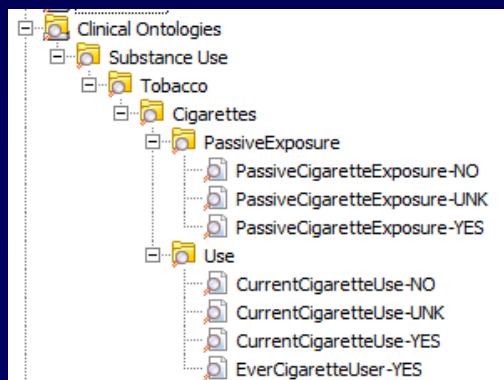
New Ontologies

Vital Signs



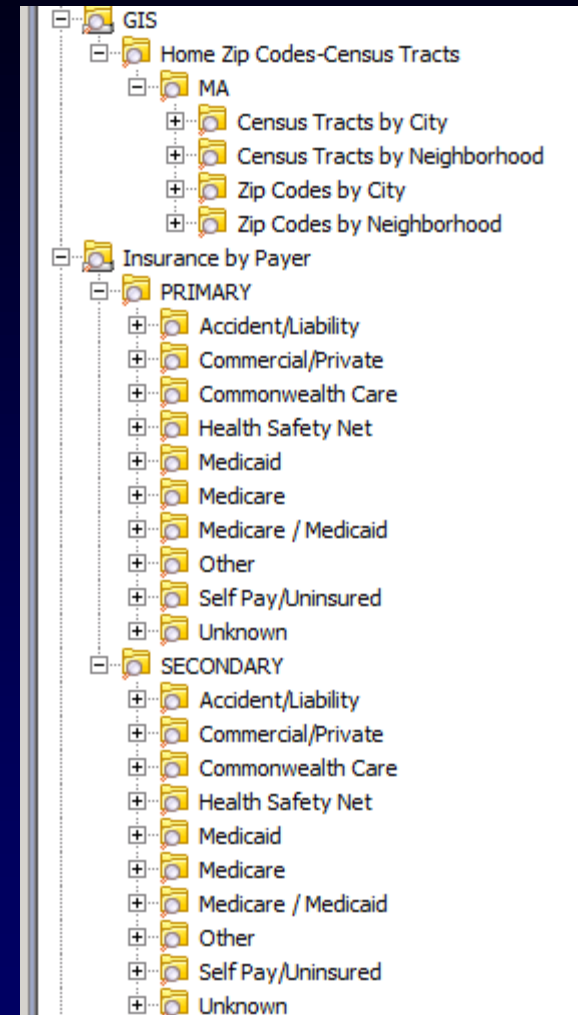
Coding: SNOMED-CT

Substance Use



Coding: Custom

GIS and Insurance



Coding: Census - Zip Code - Custom

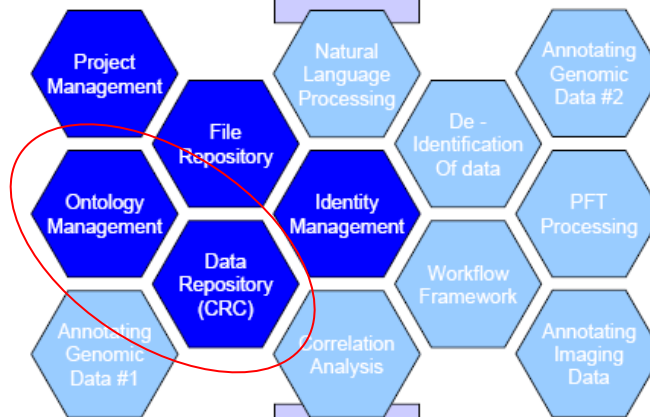
The HOME Cell

A new i2b2 Health Outcome Monitoring and Evaluation (HOME) Cell to model and assess relationships between:

- *any* exposure fact(s)
- *any* outcome fact(s)
- *many* temporal relationships
- stratified by *any* i2b2 query population
- during discrete reference intervals

Enterprise-wide repurposing and distribution
of medical record data for research

i2b2 Hive



**Health
Outcome
Monitoring
and
Evaluation
(HOME)**

Use of medical record data in clinical studies
focused upon genomics and pharmacology

HOME Cell Components

- Baseline query from i2b2 Query Cell
- Constraints:
 - **Occurrence**: temporal relationships between facts
 - **Value**: extends occurrence constraint to specify numeric values/ranges
 - **Age**: models subject's age at time of fact
- Strata: i2b2 queries define sub-populations
- Reference interval: period (month, year, date interval) to optionally further constrain data

HOME Cell Example: Hypertension Control 45-64 Years Old

Initial Query

i2b2work - Remote Desktop Connection

i2b2 Workbench

File Window Help

i2b2 Workbench for MHDR

Bill Adams Status: ● i2b2

Navigate Terms Find Terms Query Tool HOME View

Query Name: HL 1-4 pop

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
FAMILY MEDICINE GENERAL MEDICINE			Essential hypertension			Blood Pressure		

Add Group

Analysis Types

- ☐ Patient list
- ☒ Number of pa...
- ☐ Gender patien...
- ☐ Vital Status p...
- ☐ Race patient ...
- ☐ Age patient b...
- ☐ TimeLine

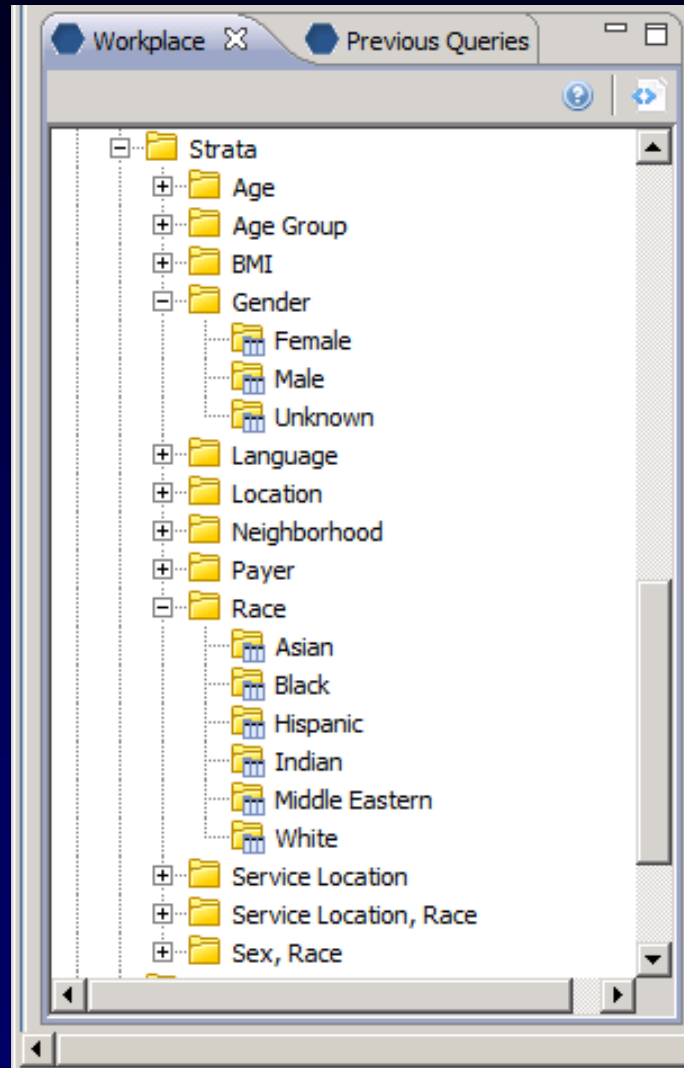
Previous Queries Workplace

- HL 1-4 pop [03-15-2012] [biadams]
- HL 1-4 pop [03-15-2012] [biadams]
- BMC/Umass pop [03-14-2012] [aaalegr]
- Warfari-MHDR-VT@11:43:30 [03-14-2012] [v...
- HOME:BMC/Umass EHTN [03-14-2012] [aaaleg]
- Warfarin Oral T@11:38:12 [03-14-2012] [MPF]

Drag terms from Navigate, Find and Workplace into this group

Get Everyone Run Query Above Patient(s) returned: 62966

Strata Queries



Denominator Population

The screenshot displays the i2b2 Workbench for MHDR interface. The top navigation bar includes 'Navigate Terms', 'Find Terms', and 'Query Tools'. The 'Query Tools' tab is active, showing a 'HOME View' with a 'Start' button and a 'Population:Denominator' label. The 'InitialQuery' section shows 'HL 1-4 pop' and an 'Add Group' button. The 'Constraints' section is divided into two columns. The left column has a 'Constraint by Age(s)' section with 'Age' set to '>= 18 Years' and 'at: FAMILY MEDICINE'. The right column has a 'Constraint by occurrence(s)' section with 'Concept1' set to 'Diastolic' and 'Relationship' set to 'Follows'. The 'Previous Queries' section at the bottom left lists several queries, including 'HL 1-4 pop [03-15-2012] [biadams]' and 'BMC/Umass pop [03-14-2012] [aaiegler]'. Red circles highlight the 'InitialQuery' section, the 'Constraint by Age(s)' section, and the 'Constraint by occurrence(s)' section.

i2b2 Workbench for MHDR

Bill Adams Status: ● i2b2

Navigate Terms Find Terms Query Tools HOME View

Start Population:Denominator Outcomes:Numerator Strata Display/Execute Data Graph

InitialQuery

HL 1-4 pop Add Group

Constraints

Occurance Add Exclude

Constraint by Age(s)

Age >= 18 Years at: FAMILY MEDICINE Apply reference interval to: Concept

Constraint by Age(s)

Age >= 18 Years at: GENERAL MEDICINE Apply reference interval to: Concept

Constraint by occurrence(s)

Concept1 Relationship

Diastolic Follows

Concept2 Max/min Days

Essential hypertension by Min 1

Apply reference interval to: Concept 1

Previous Queries Workplace

- HL 1-4 pop [03-15-2012] [biadams]
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Numerator Population

i2b2 Workbench - Remote Desktop Connection

i2b2 Workbench

File Window Help

i2b2 Workbench for MHDR

Bill Adams Status: ● i2b2

Navigate Terms Find Terms

Query Tool HOME View

Start Population:Denominator Outcomes:Numerator **Start** Display/Execute Data Graph

InitialQuery

Denominator query is set as the initial query for Numerator Add Group

Constraints

Occurance Add ☐ Exclude

Constraint by value(s)

Select	Value concept	Relationship
Latest	Diastolic	Following
First/latest	Occurance Concept	Max/min Days
First	Essential hypertension	by Min 1

Operator Max

< 90

Apply reference interval to: Value

Operator Min Max

☒ Filter IN values BETWEEN 30 to 250

Constraints

Occurance Add ☐ Exclude

Constraint by value(s)

Select	Value concept	Relationship
Latest	Systolic	Following
First/latest	Occurance Concept	Max/min Days
First	Essential hypertension	by Min 1

Operator Max

< 140

Apply reference interval to: Value

Operator Min Max

☒ Filter IN values BETWEEN 30 to 250

Previous Queries Workplace

- HL 1-4 pop [03-15-2012] [biadams]
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Strata

i2b2work - Remote Desktop Connection

i2b2 Workbench

File Window Help

i2b2 Workbench for MHDR

Bill Adams Status: ● i2b2

Navigate Terms Find Terms Query Tool HOME View

Start Population:Denominator Outcomes:Numerator Strata Display/Execute Data Graph

Strata Query List

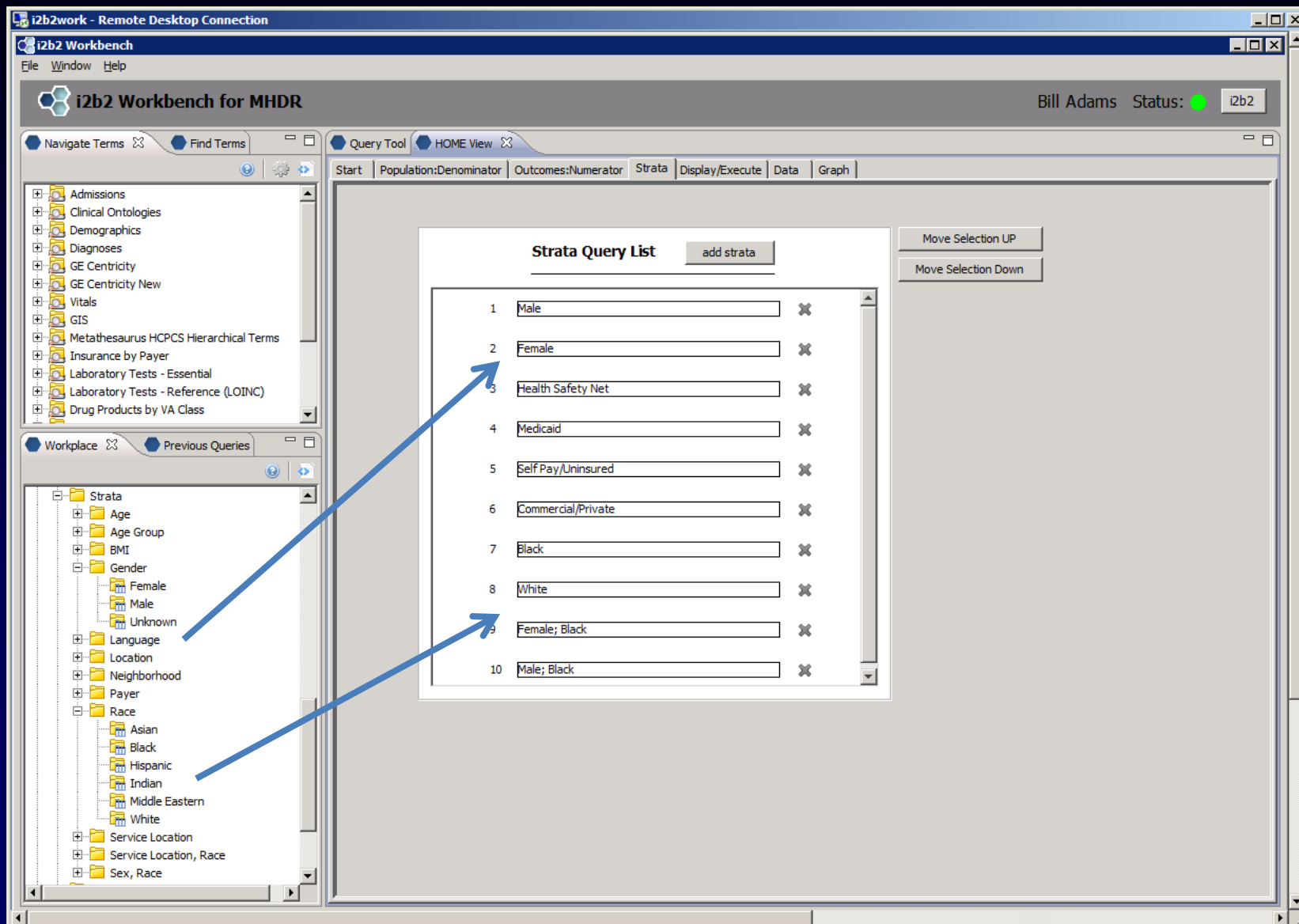
Move Selection UP

Move Selection Down

1	Male	×
2	Female	×
3	Health Safety Net	×
4	Medicaid	×
5	Self Pay/Uninsured	×
6	Commercial/Private	×
7	Black	×
8	White	×
9	Female; Black	×
10	Male; Black	×

Workplace

- Strata
 - Age
 - Age Group
 - BMI
 - Gender
 - Female
 - Male
 - Unknown
 - Language
 - Location
 - Neighborhood
 - Payer
 - Race
 - Asian
 - Black
 - Hispanic
 - Indian
 - Middle Eastern
 - White
 - Service Location
 - Service Location, Race
 - Sex, Race



Display/Execute: Percent

Query Tool HOME View

Start Population:Denominator Outcomes:Numerator Strata Display/Execute Data Graph

Display Execute

Type

Outcome: Percent

☐ Filter IN Values

Type Min Max

Interval: Year Date range: 01-01-2004 to 12-31-2010

Execute

Save Query

Name: HomeQueryName Export

Sample Result Set

Query Tool HOME View

Start Population:Denominator Outcomes:Numerator Strata Display/Execute Data Graph

Interval	Strata	SD	SN	SN/SD	SDXN	SDXN/SD
2004	Male				2096	47.41
2005	Male				2297	43.58
2006	Male				2372	42.02
2007	Male	6058	3655	60	2403	39.67
2008	Male	6580	3984	60		
2009	Male	7329	4485	61		
2010	Male	7992	4989	62		
2004	Female	6076	3305	54	2771	45.61
2005	Female	7096	4245	59	2851	40.18
2006	Female	7648	4747	62	2901	37.93
2007	Female	8119	5135	63	2984	36.75
2008	Female	8828	5598	63	3230	36.59
2009	Female	9538	6171	64	3367	35.3

Strata Denominator Count

Strata Numerator Count

Proportion

Interval	Strata	SD	SN	SN/SD
2004	Male	4421	2325	52
2005	Male	5271	2974	56
2006	Male	5645	3273	57
2007	Male	6058	3655	60
2008	Male	6580	3984	60
2009	Male	7329	4485	61
2010	Male	7992	4989	62

2004	Self Pay/Uninsured	116	65	56	51	43.97
2005	Self Pay/Uninsured	140	72	51	68	48.57
2006	Self Pay/Uninsured	157	87	55	70	44.59
2007	Self Pay/Uninsured	202	128	63	74	36.63
2008	Self Pay/Uninsured	265	145	54	120	45.28
2009	Self Pay/Uninsured	307	188	61	119	38.76

Save As

Display:

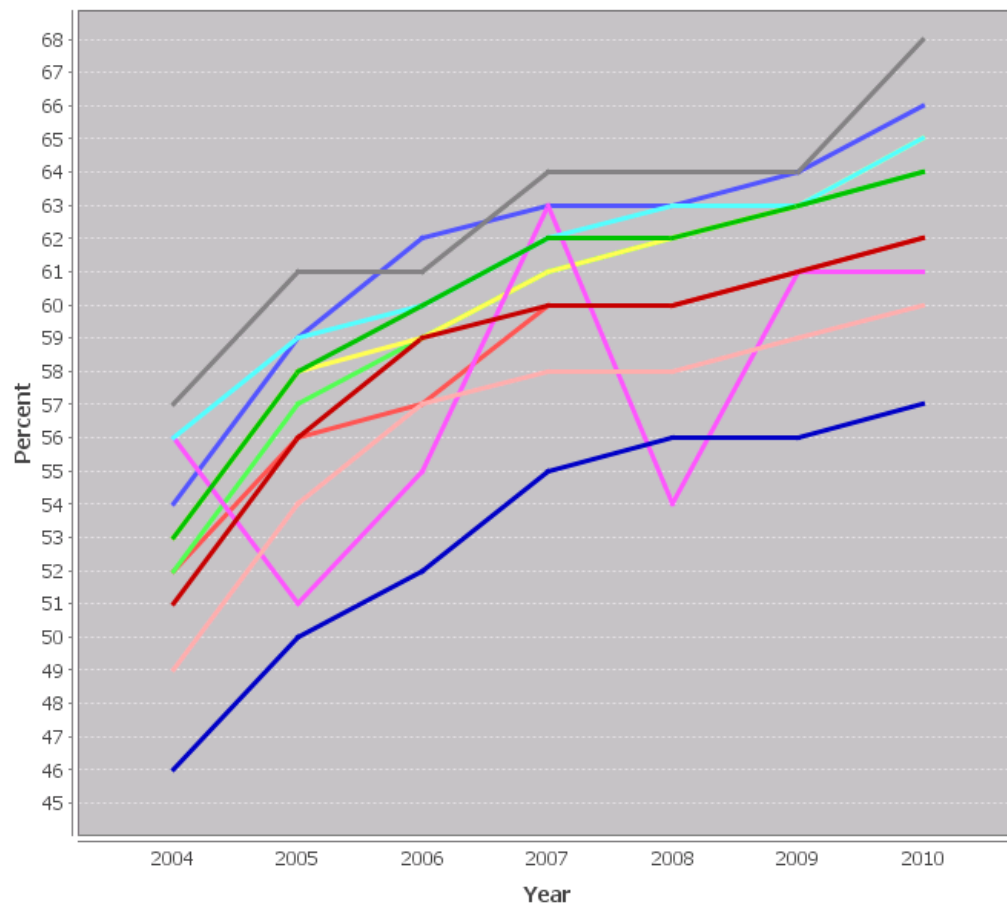
- ☒ Linear(Percent)
 ☐ Linear(Avg)
 ☐ Linear(SD)
 ☒ Denominator
 ☒ Numerator
 ☒ Excluded Numerator

Refresh

Strata Query List

- ☒ Male
☒ Female
☒ Health Safety Net
☒ Medicaid
☒ Self Pay/Uninsured
☒ Commercial/Private
☒ Black
☒ White
☒ Female; Black
☒ Male; Black
☒ All

HOME: Blood Pressure Control for Persons Over 18 with Essential Hypertension

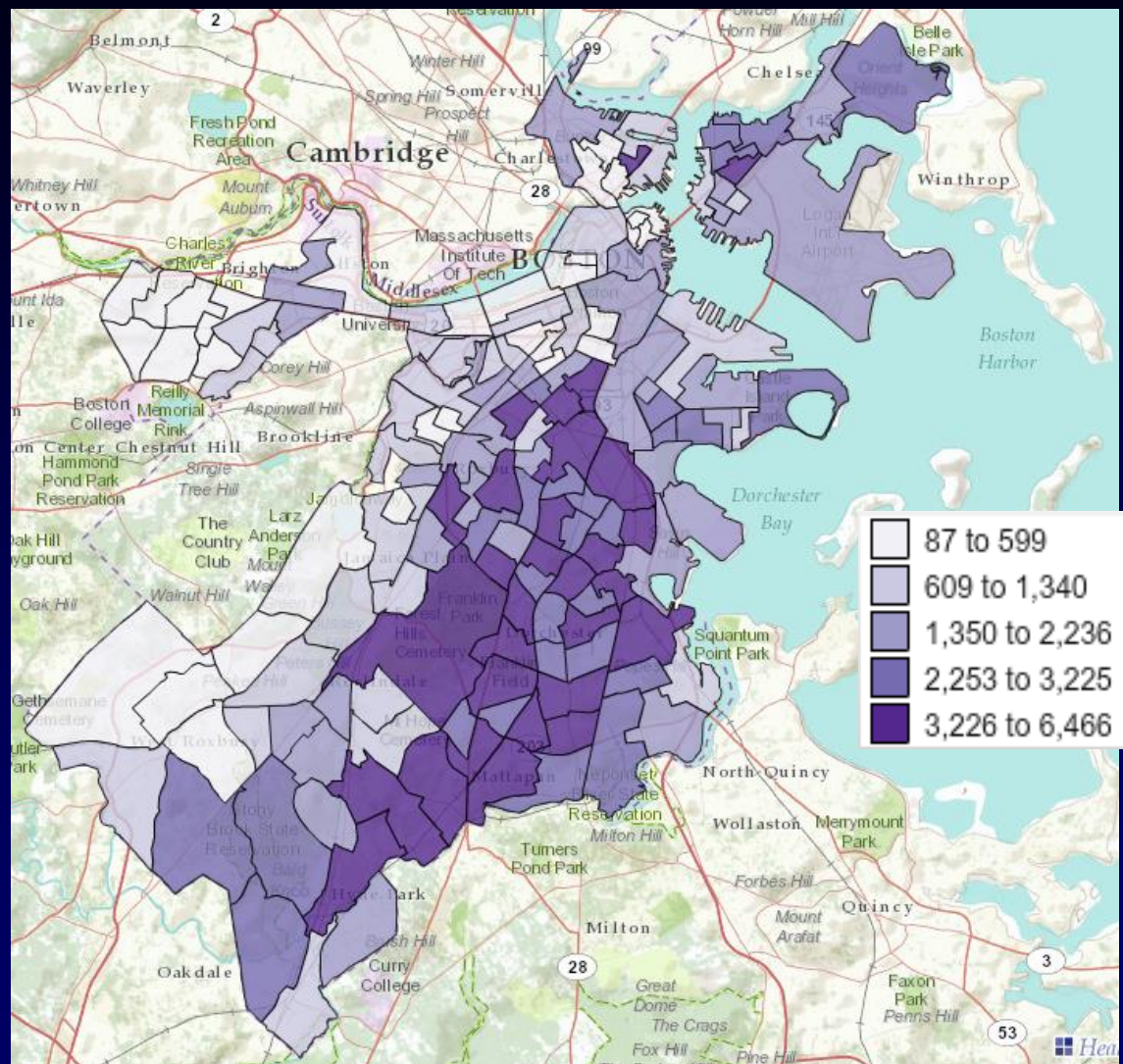


Male-SN:SD Female-SN:SD Health Safety Net-SN:SD Medicaid-SN:SD Self Pay/Uninsured-SN:SD
 Commercial/Private-SN:SD Black-SN:SD White-SN:SD Female; Black-SN:SD Male; Black-SN:SD
 All-SN:SD

I2b2 + HOME ?

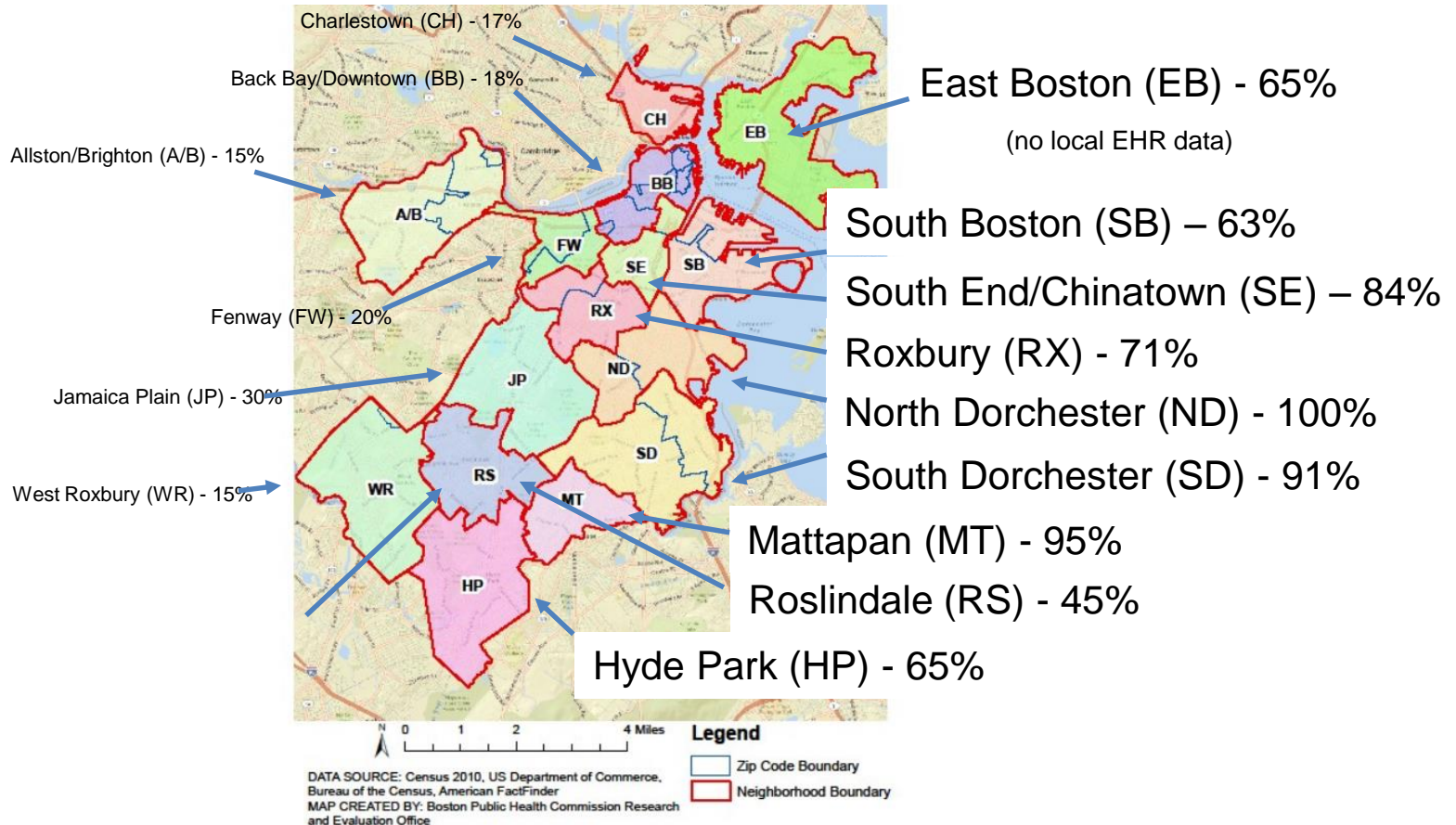


Catchment Area for the MHDR, 2005-2011



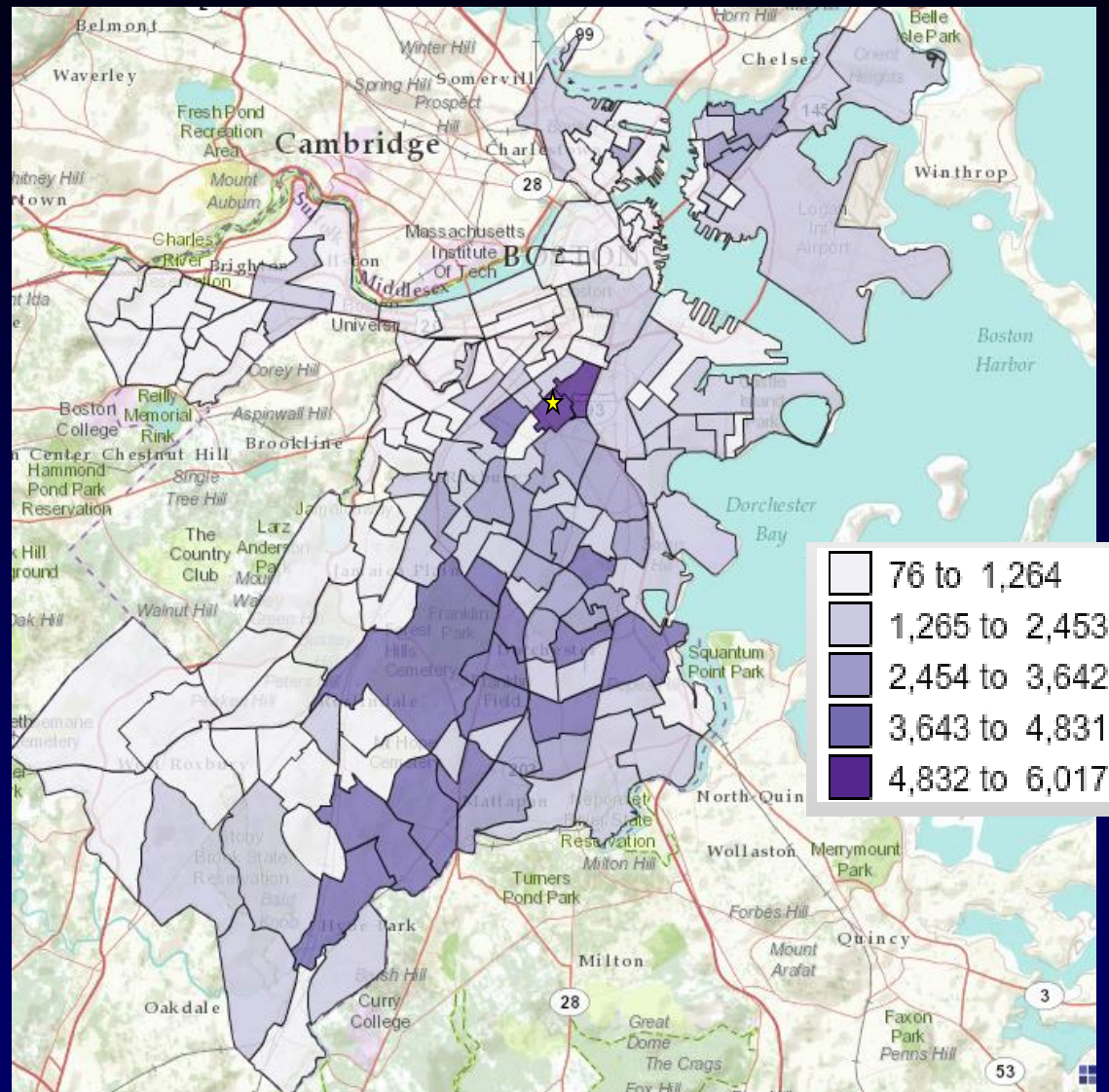
Note: This map shows the number of people, by census tract of residence (2008-2011), who had at least one visit to an MHDR clinical center from 2005-11. Census tracts with fewer than 20 patients are not included.

Percent of patients with any BHN Contact during 2011-2014 by Zip Code of residence 2011-2014*



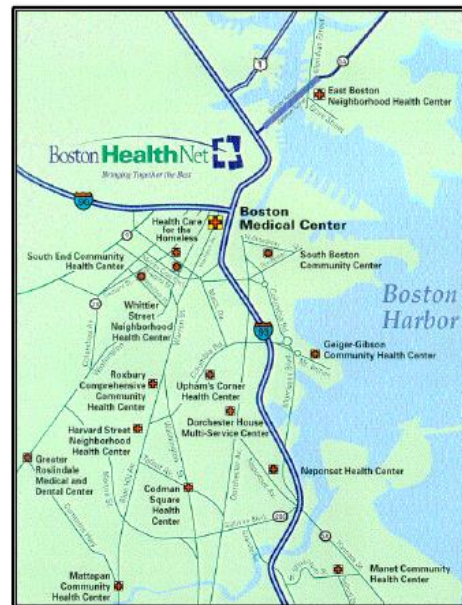
* % of patients with address zip code noted at least once 2011-2014 divided by 2010 US Census count for that area

Catchment Area for Boston Medical Center



Note: Number of people, by census tract of residence (2008-2011), who had at least one visit to the clinical center from 2005-11.

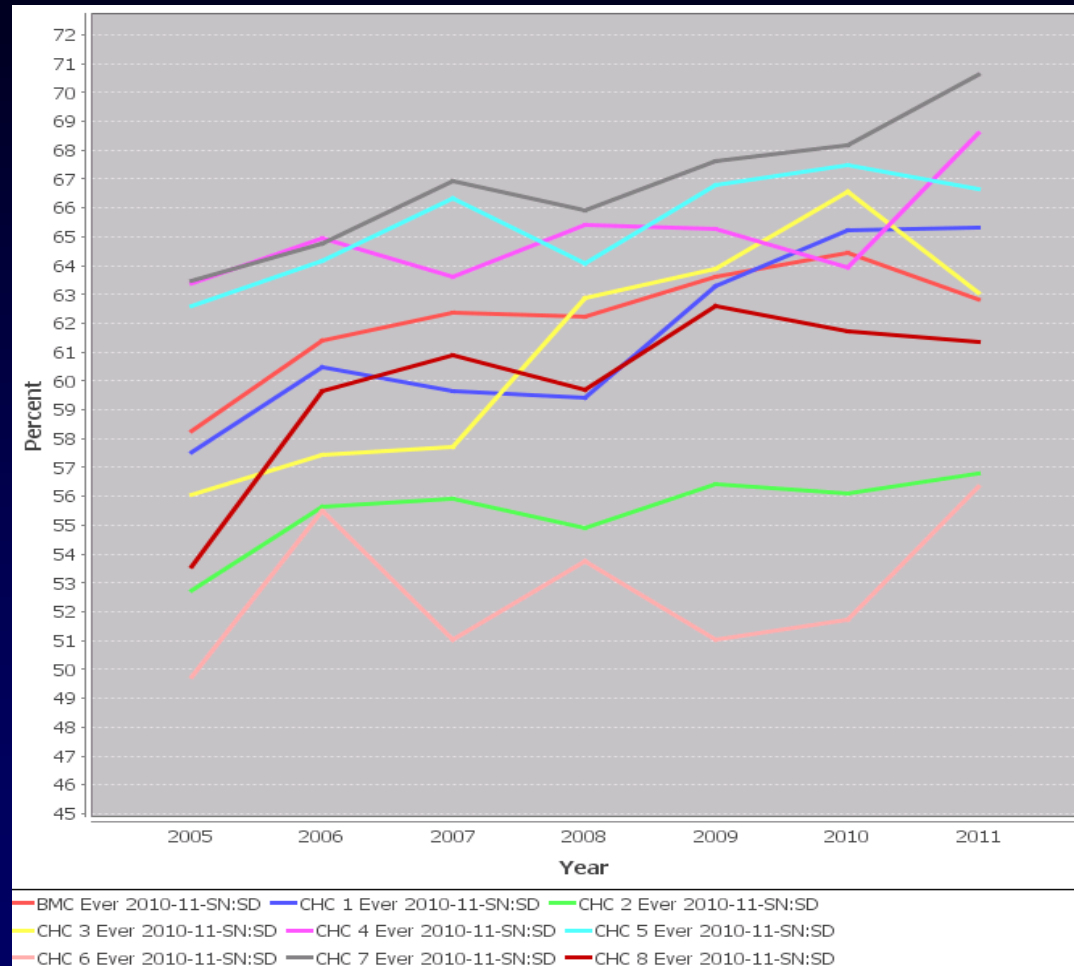
Cardiovascular Health and Disparities: Boston, 2005-2011



Preliminary findings prepared by William G. Adams, MD^{1,2}, Nancy Kressin, PhD^{3,4}, Cathryn Byrne-Dugan, MD/MPH¹, and Aaron Legler, MPH⁴.

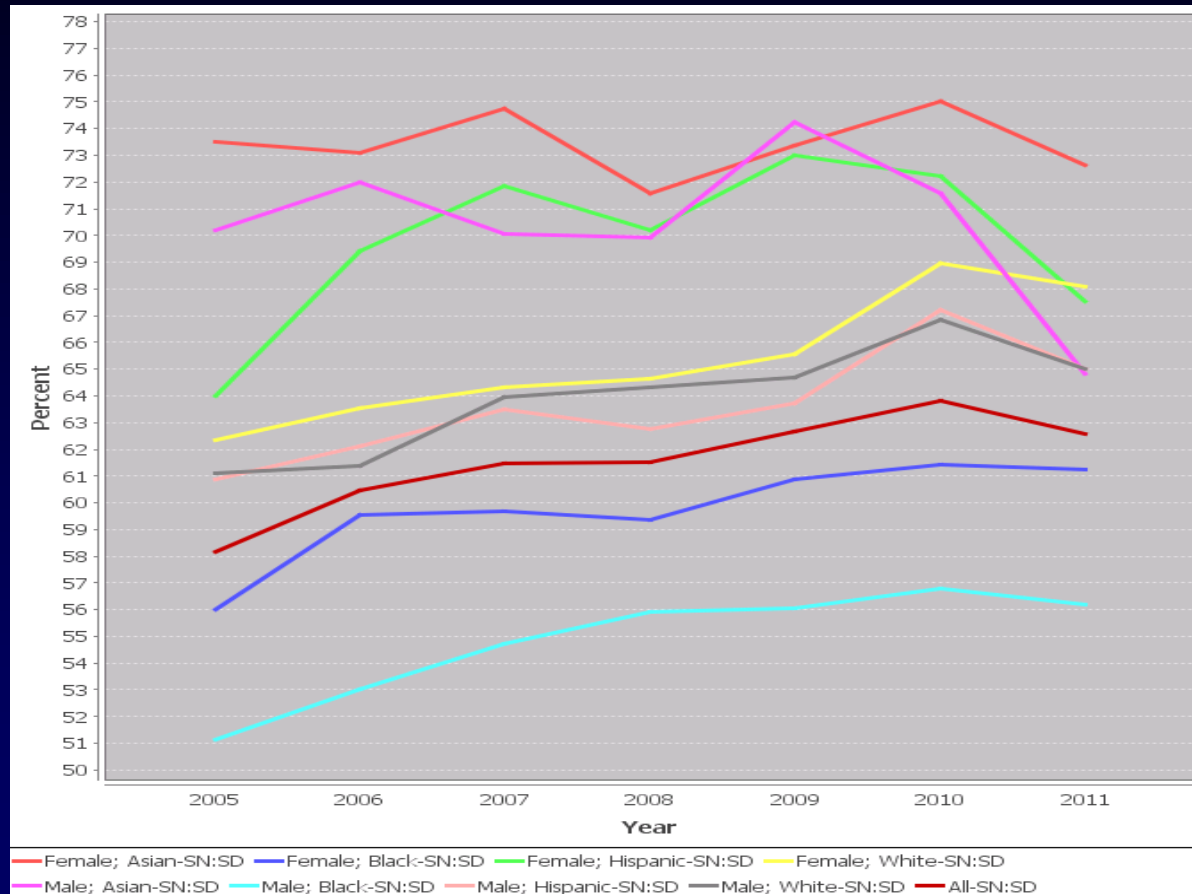
¹Department of Pediatrics, ²BU-Clinical and Translational Sciences Institute, ³Department of Medicine, ⁴Health Disparities Research Program, Boston University School of Medicine/Boston Medical Center

Adult Blood Pressure Control by Center Boston, 2005-11



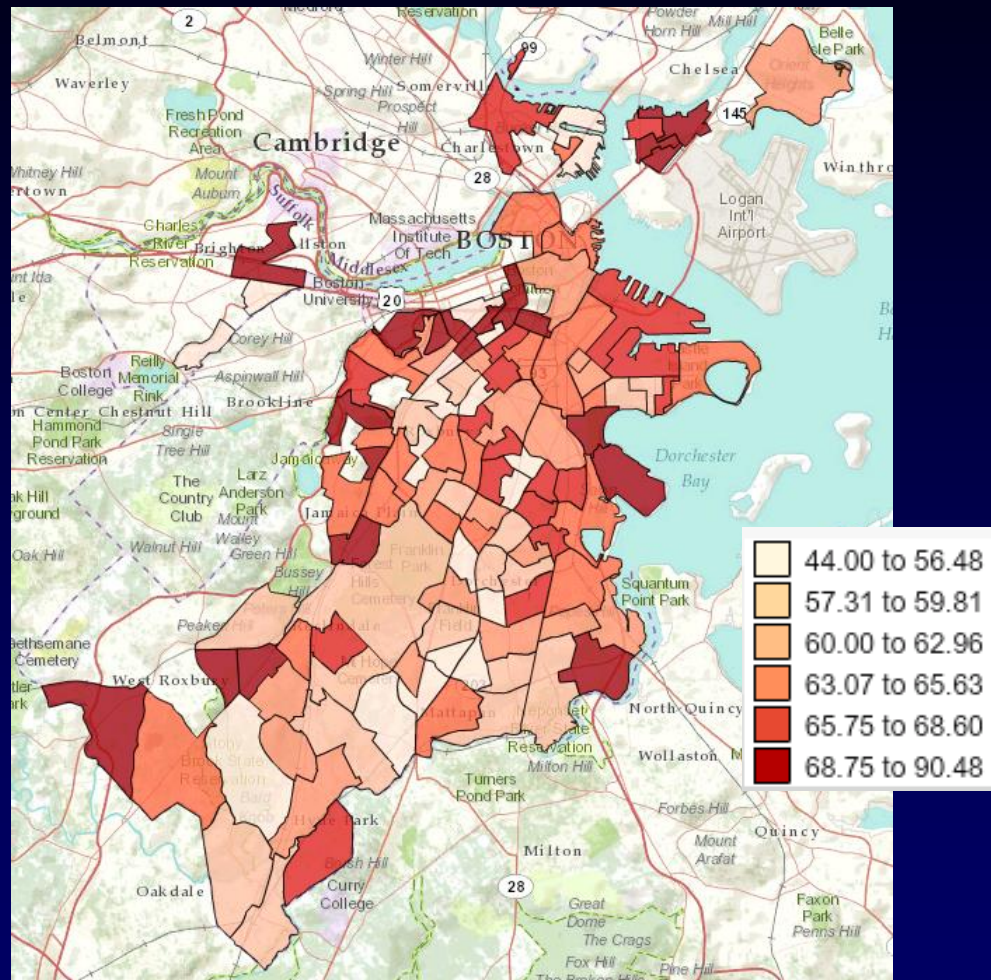
Note: Percent of patients with essential HTN whose latest systolic BP was < 140 and diastolic BP was < 90 during each year for each center.

Blood Pressure Control by Sex-Race Boston, 2005-2011



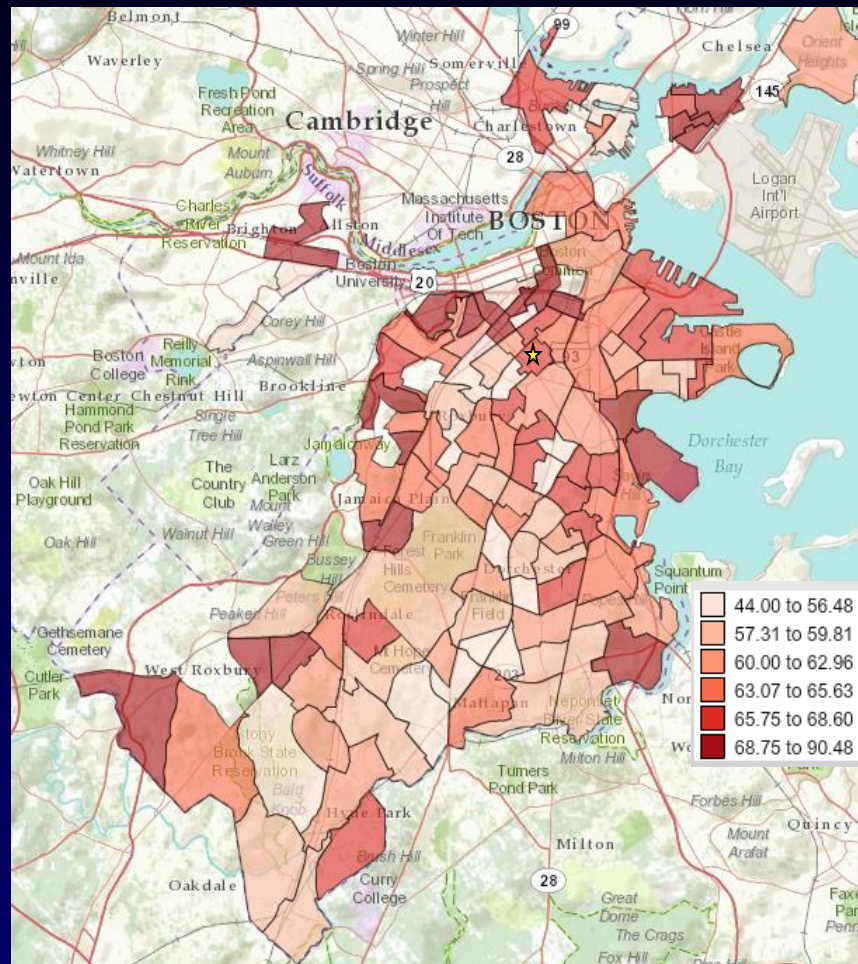
Note: Percent of patients with essential HTN whose latest systolic BP was < 140 and diastolic BP was < 90 during each year for patients of differing race and/or sex.

Blood Pressure Control by Census Tract Boston, 2011



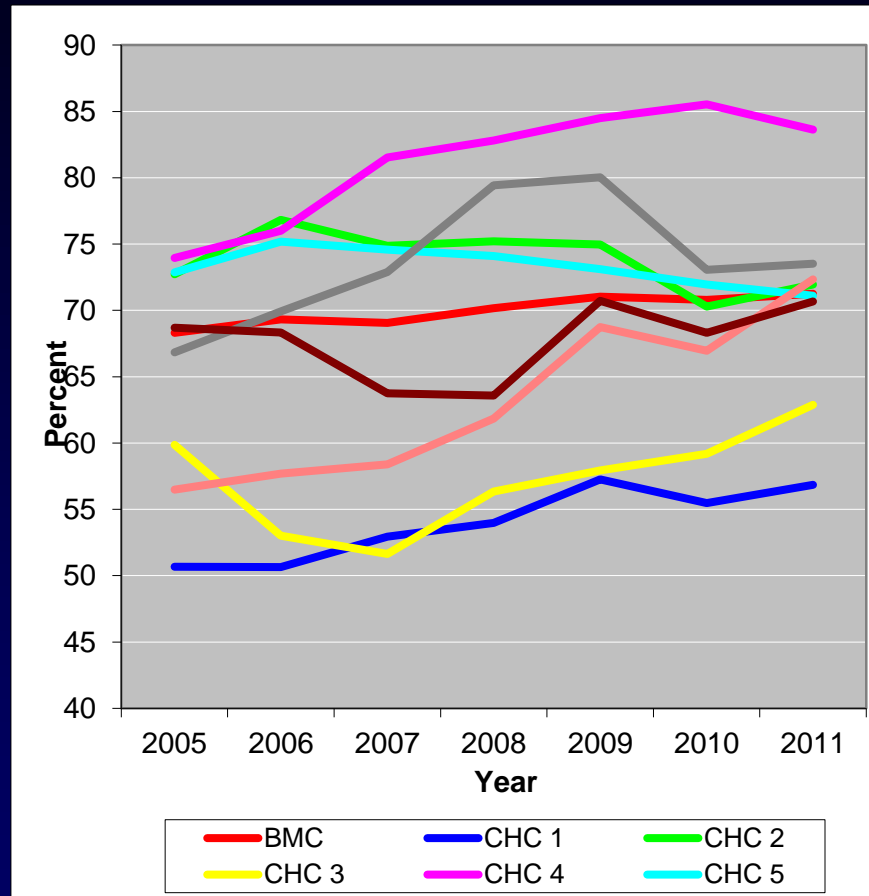
Note: Percent of primary care patients with essential HTN whose latest systolic BP was < 140 and diastolic BP was < 90 by census tract. Patients were assigned to a tract if they had at least one address listed in the tract during 2008-2011.

Blood Pressure Control Rates by Census Tract Boston Medical Center, 2010-11



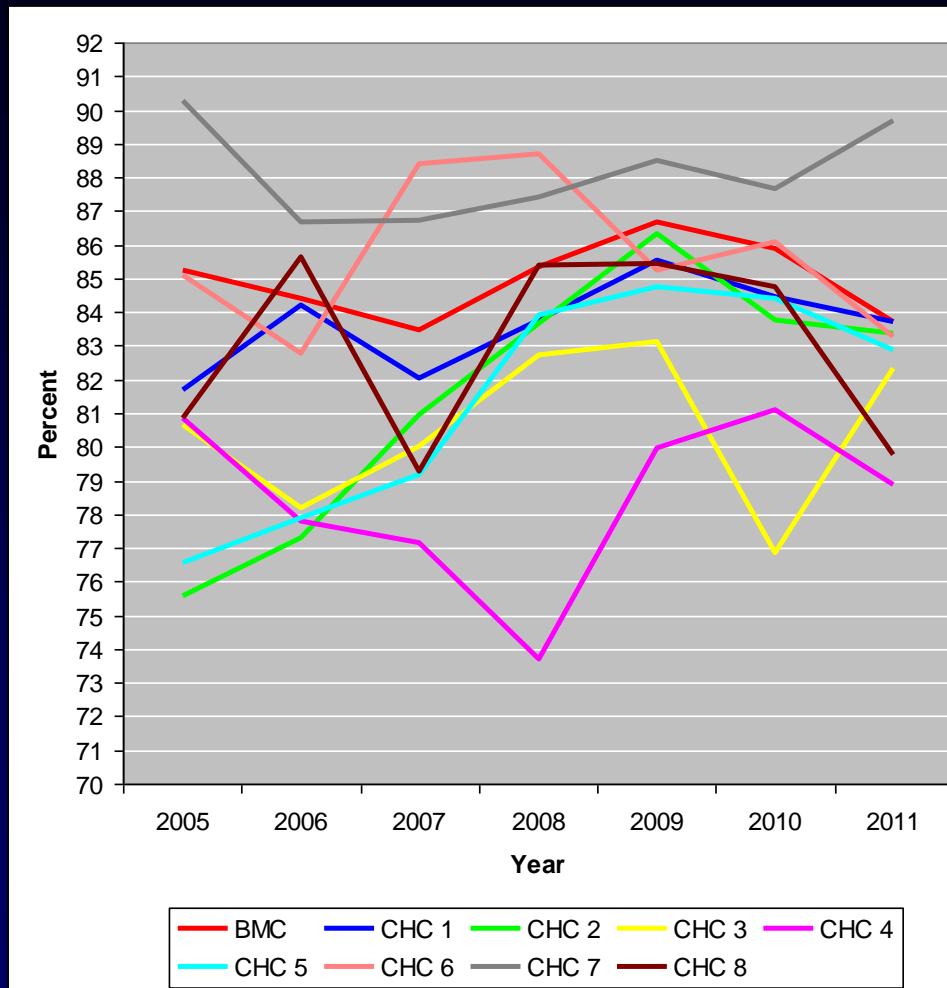
Note: Percent of primary care patients with essential HTN whose latest systolic BP was < 140 and diastolic BP was < 90 by census tract. Patients were assigned to a tract if they had at least one address listed in the tract during 2008-2011.

Lipid Screening by Center Boston, 2005-2011



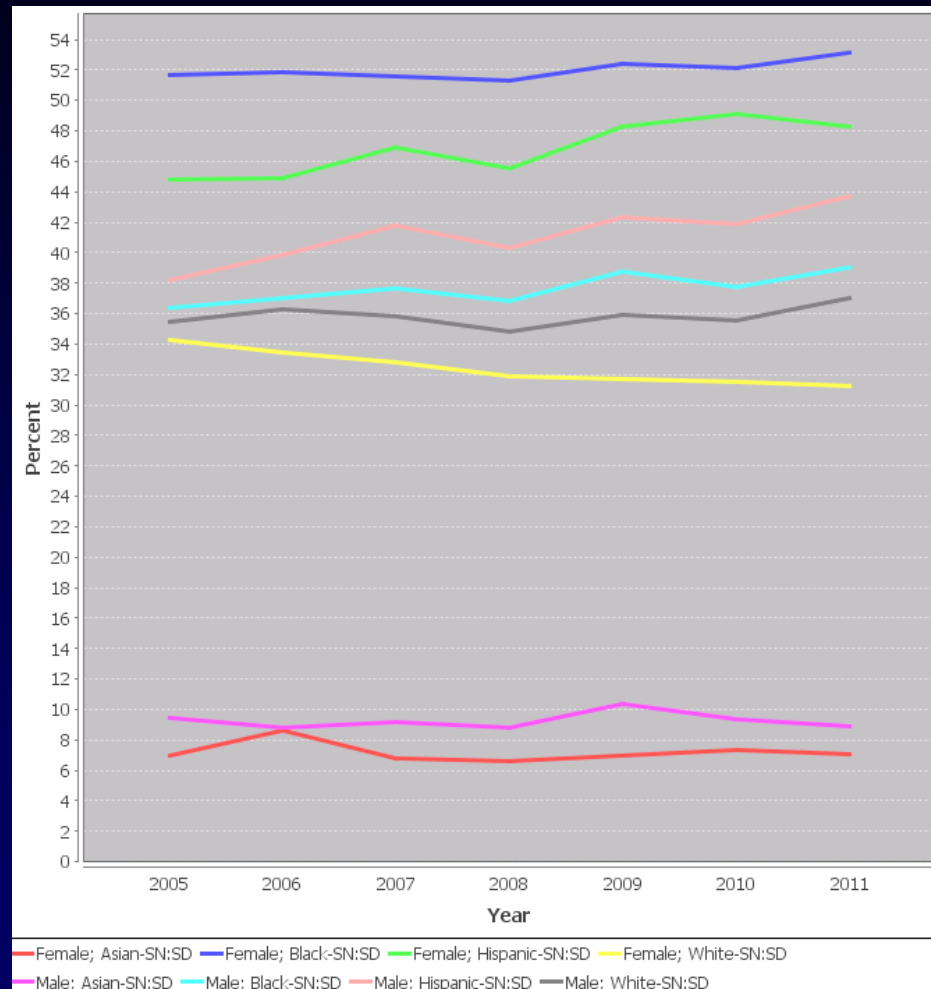
Note: Percent of patients (male ≥ 35 years old or female ≥ 45 years old) with a primary care visit during the year and at least one lipid screening test (HDL, LDL, or Total Cholesterol) within 2 years preceding or 60 days following the visit for each Center .

Lipid Control for High Risk CVD Patients by Center Boston, 2005-2011



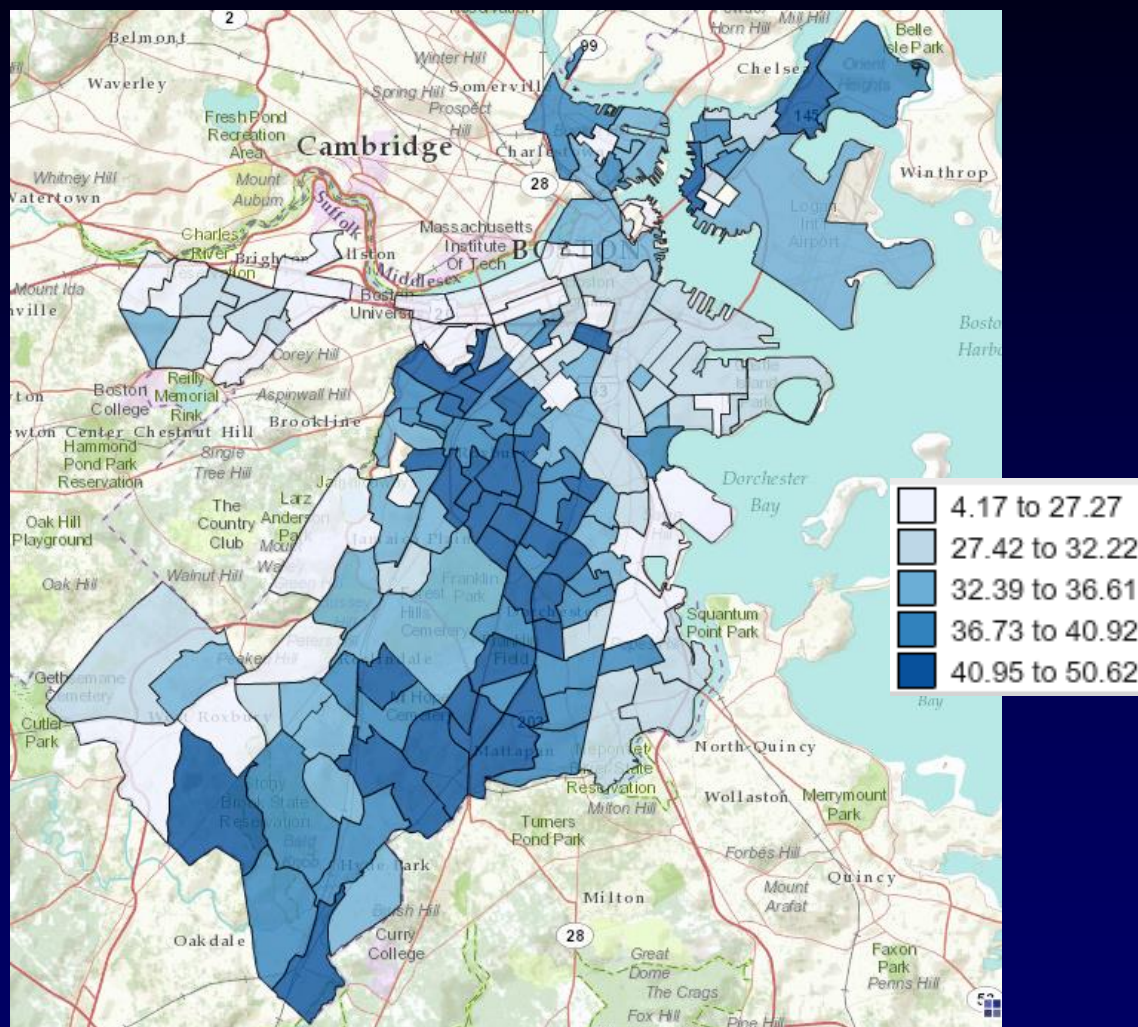
Note: Percentage of high risk CVD patients (≥ 20 years old) with a primary care visit during the reference year who had controlled lipid levels (HDL >50 in females, HDL >40 in males, or Total Cholesterol <200) stratified by CHC..

Adult Obesity by Sex-Race Boston, 2005-2011



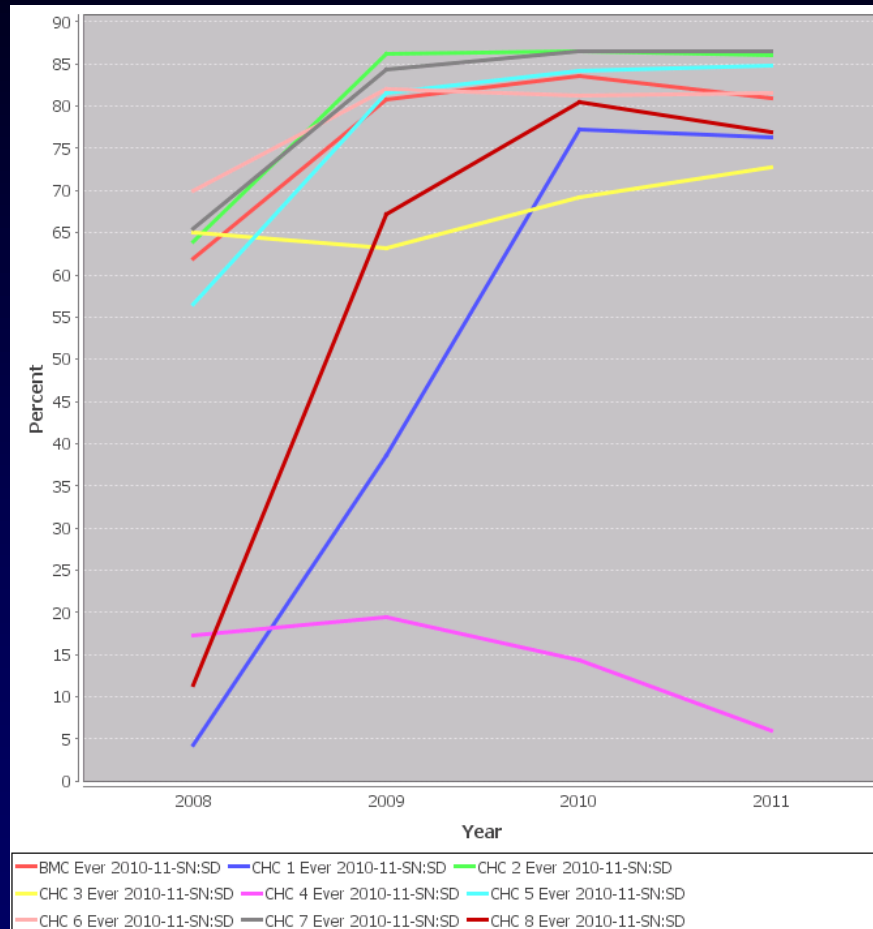
Note: Percent of patients with a primary care visit at 18- 65 years old during the reference year who had a BMI ≥ 30 by race and gender

Adult Obesity in Boston, 2010-2011



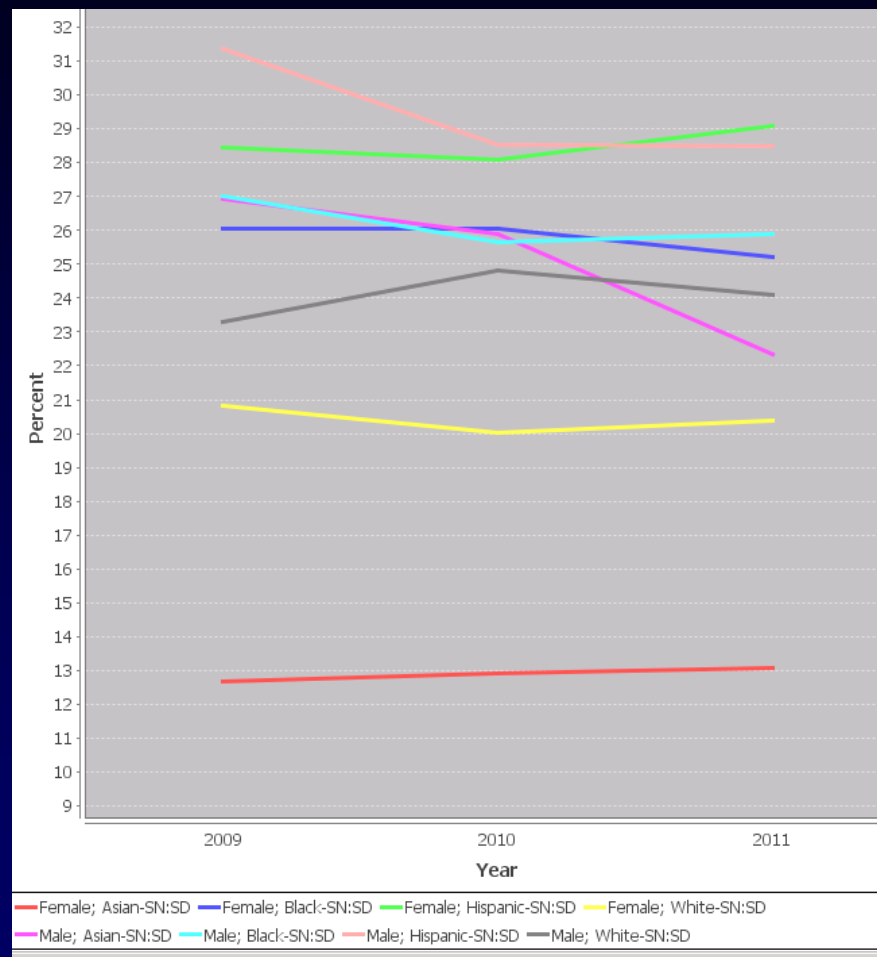
Note: Percent of patients with essential HTN whose latest systolic BP was < 140 and diastolic BP was < 90 during each year for patients of differing race and/or sex.

Childhood Obesity Screening by Center Boston, 2005-2011



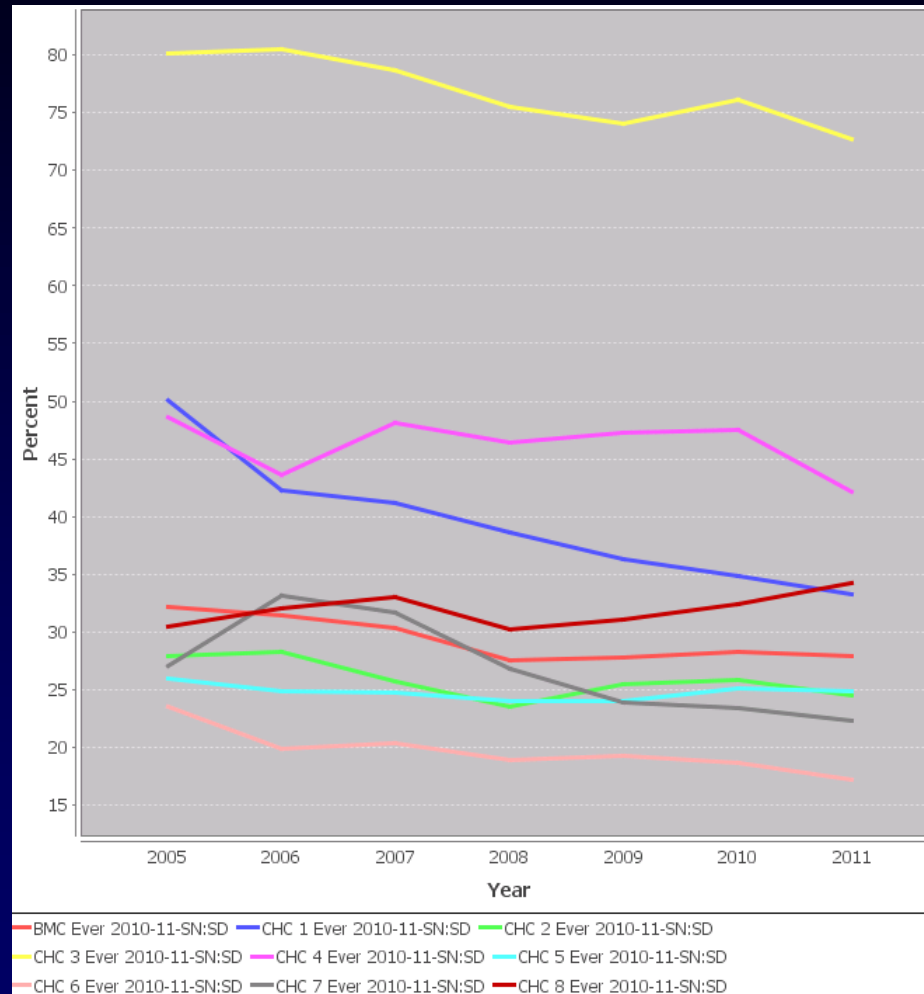
Note: For patients who were seen at each Center during 2010-2011, percent of patients with a primary care visit at 3-18 years old during the reference year who had a recorded BMI %ile by Center.

Childhood Obesity by Sex-Race Boston, 2009-2011



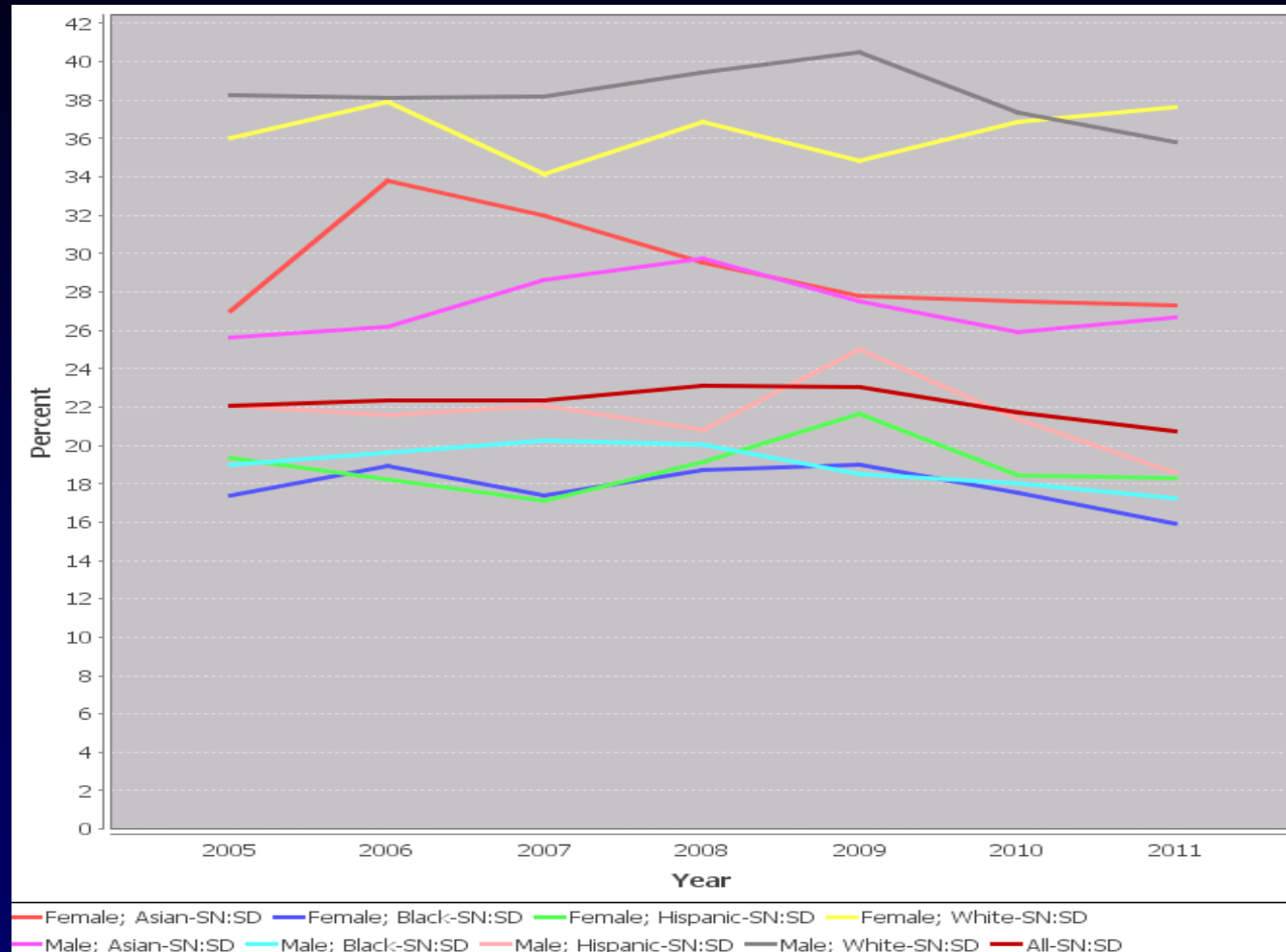
Note: Percent of children with a primary care visit at 3-18 years old during the reference year who had a BMI Percentile $\geq 95^{\text{th}}$ ile by race and/or sex.

Cigarette smoking in Adults by Center Boston, 2005-2011



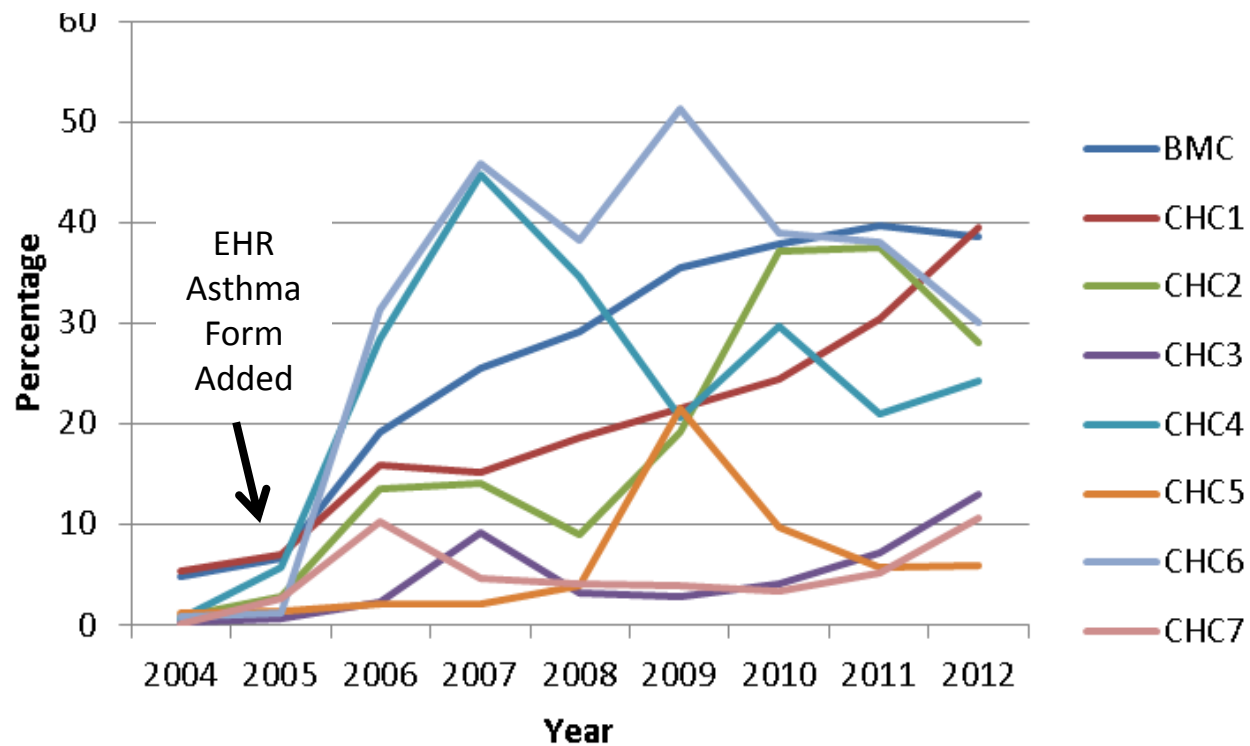
Note: Patients with a primary care visit during the reference year who were ≥ 18 years old at the time of the visit, were screened for cigarette use, and reported being a smoker by CHC

Passive Cigarette Exposure in Children by Sex-Race Boston, 2005-2011



Note: Children with a primary care visit during the reference year who were 0-12 years old at the time of the visit, screened for passive exposure, and reported smoking in the home by race and/or sex.

Percent of Asthma Patients with Assessment of Daytime or Nighttime Symptoms by Center*



Distributed HOME Project

- 5 Collaborating i2b2-enabled CTSAs
- Comparative effectiveness evaluation of medications for hypertension, hypercholesterolemia, childhood asthma, diabetes



- Boston University
- Univ. of Massachusetts
- Univ. of Cincinnati
- Univ. of Alabama at Birmingham
- Univ. of Washington

www.dhome-project.net

Research Objectives

- Describe variation in cardiovascular outcomes (hypertension, dyslipidemia, diabetes) over time in 5 CTSA i2b2 instances distributed across U.S.
- Assess within medication class outcome differences (comparative effectiveness) for commonly used medications (anti-hypertensives, statins, oral hypo-glycemics)

Approach

- Bi-monthly web-based teleconferences
- Shared ontology development (BP, BMI, medications)
- Technical collaborations between sites and from Recombinant/Deloitte
- Shared query development
- Distributed query execution with centralized aggregate data sharing

Definitions – BP control

Denominator:

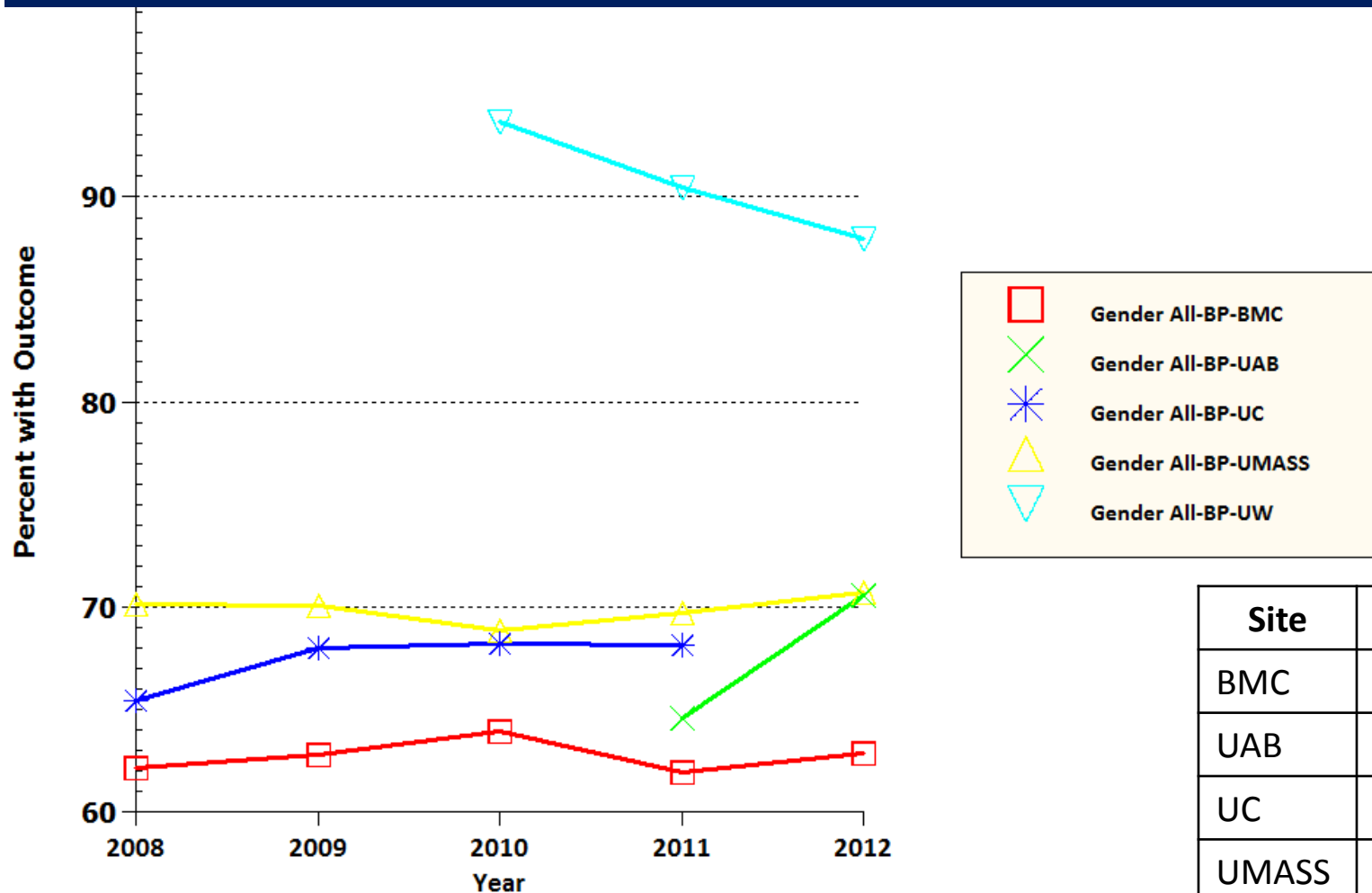
- At least one primary care visit in reference year
- At least one systolic and diastolic BP that followed a diagnosis of essential hypertension during year
- Separate HOME Cell queries for all combinations of BMI (< 30 , 30+) and Age (< 65, Age 65+) during reference year

Numerator

- Most recent systolic BP during year < 140
- Most recent diastolic BP during year < 90

Strata: Race, Gender

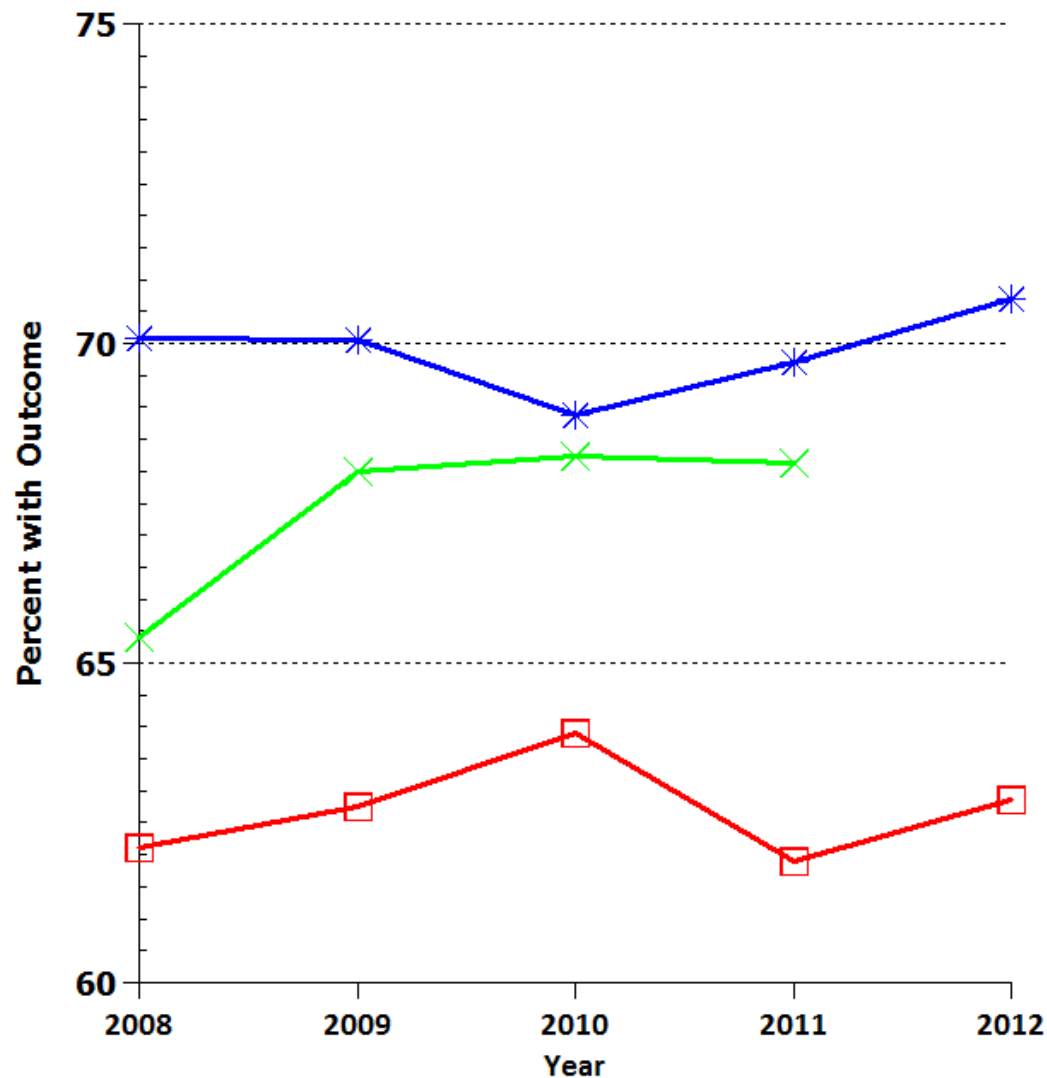
Percent of Patients with Essential Hypertension and Controlled BP*






* n = number of patients for most recent year

Site	n
BMC	24,930
UAB	15,393
UC	19,435
UMASS	16,144
UW	8,913
Total	84,815

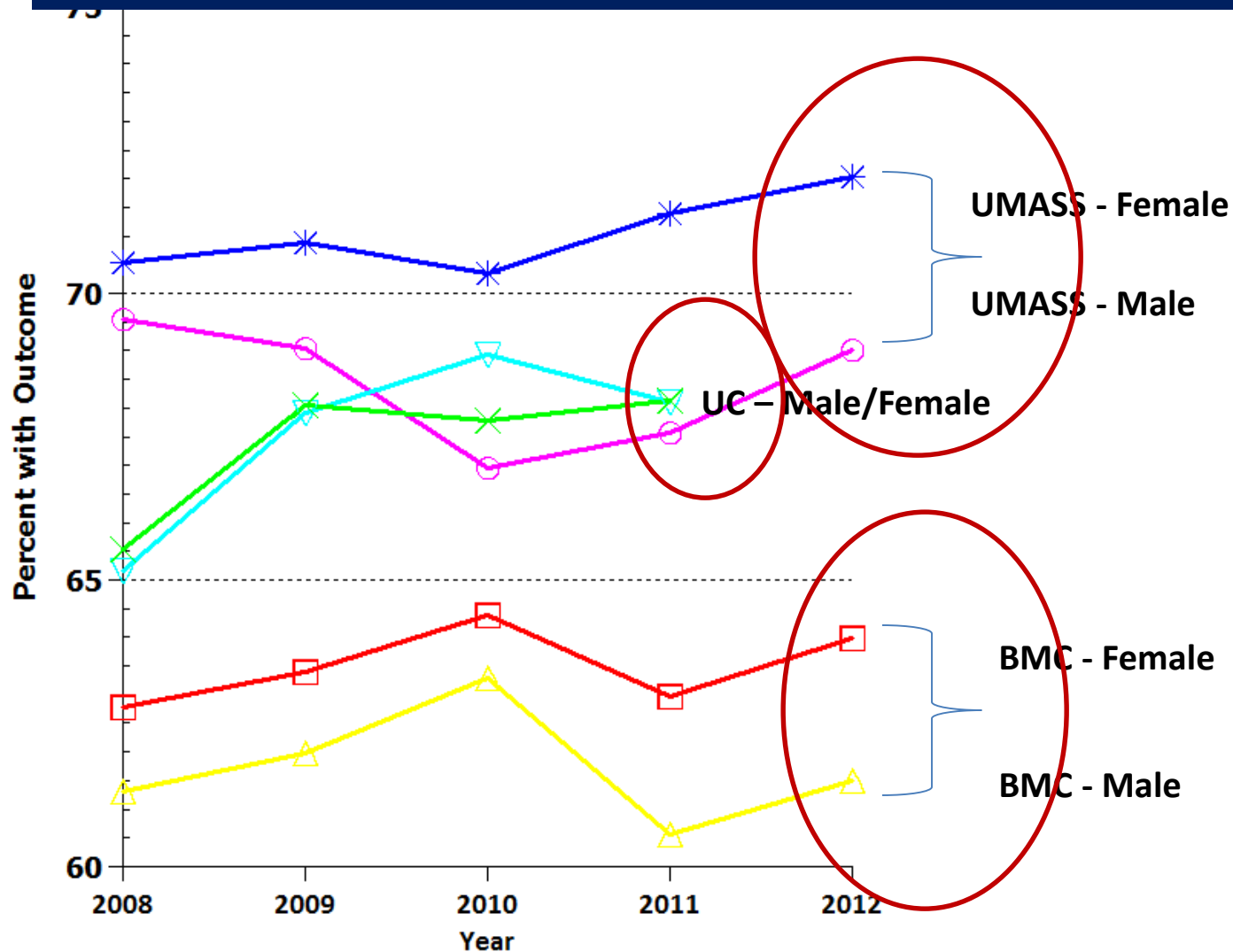
Percent of Patients with Essential Hypertension and Controlled BP on Most Recent Test



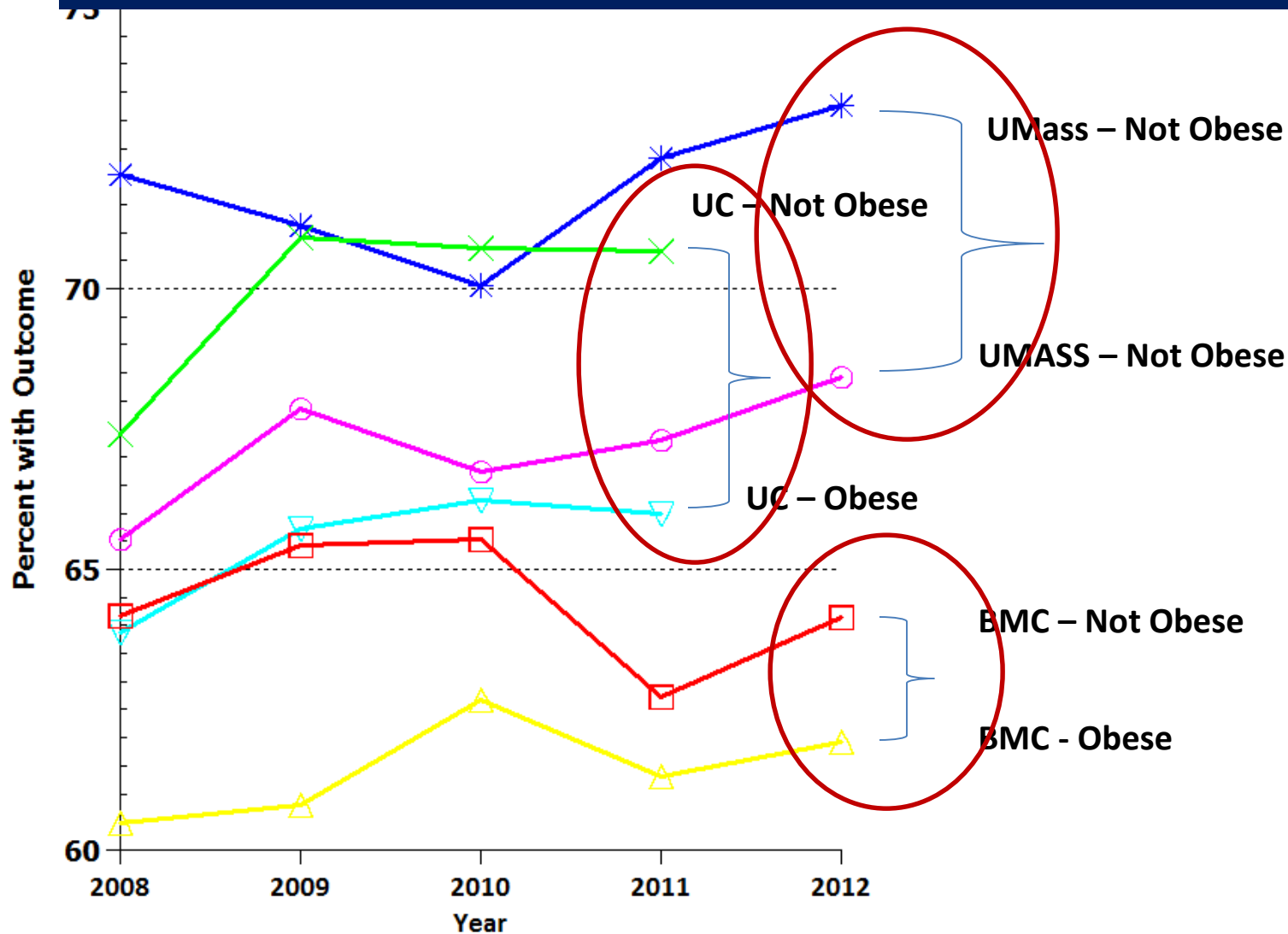
	Gender All-BP-BMC
	Gender All-BP-UC
	Gender All-BP-UMASS

Site	n
BMC	24,930
UC	19,435
UMASS	16,144
Total	60,509

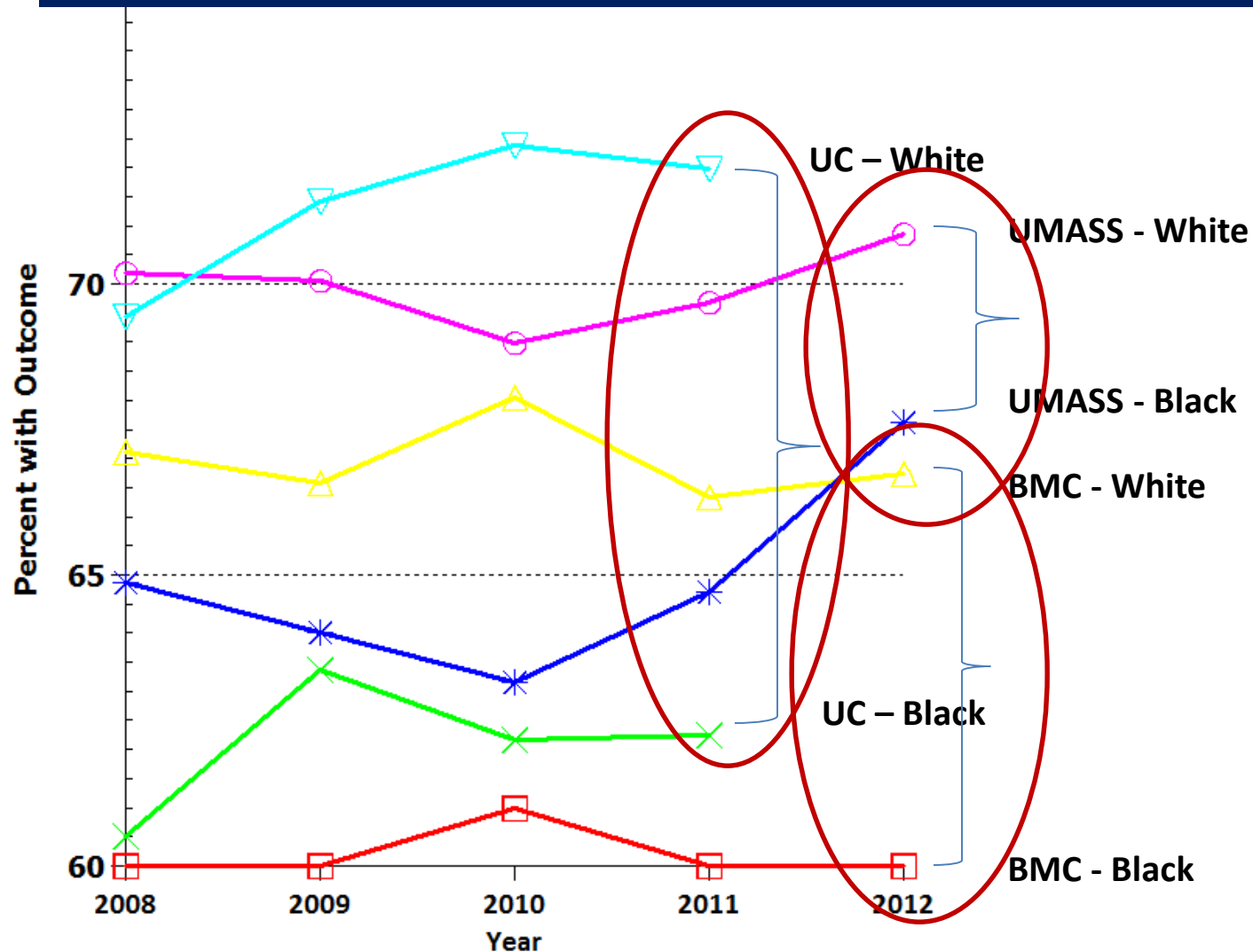
BP Control for Patients with Essential Hypertension by Gender and Site



BP Control for Patients with Essential Hypertension by Obesity and Site



BP Control for Patients with Essential Hypertension by Race and Site

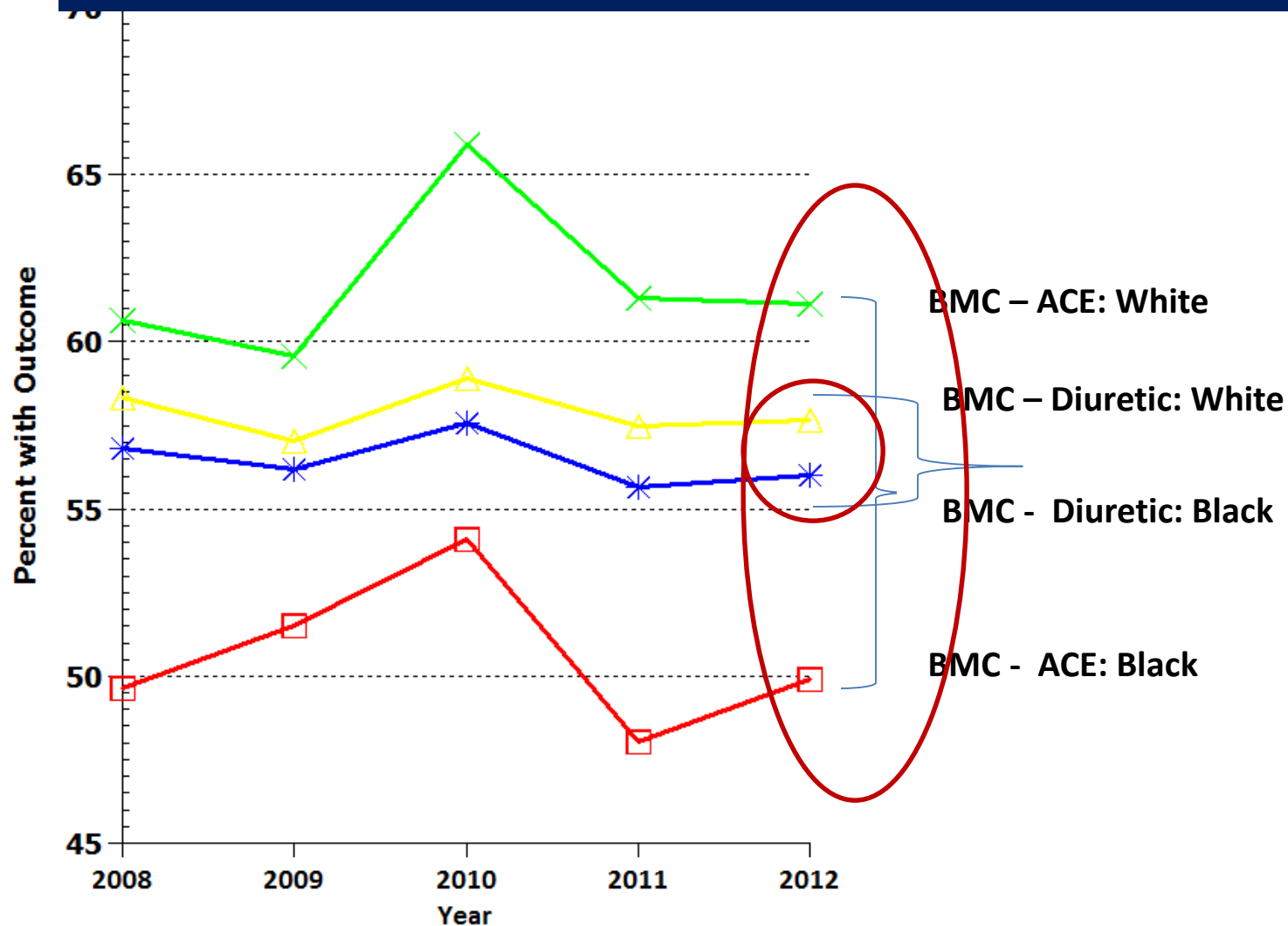


Logistic Regression Models for BP Control 2006-2012*

	BMC (90481 controlled, 53869 not controlled)		UCinn (39434 controlled, 18880 not controlled)		UMass (48679 controlled, 20770 not controlled)	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Year overall		0.0001		<0.0001		<0.0001
2007 vs. 2006	1.01 (0.96, 1.05)	0.81	0.79 (0.62, 1.01)	0.06	0.98 (0.84, 1.15)	0.81
2008 vs. 2006	0.99 (0.94, 1.03)	0.50	0.93 (0.74, 1.17)	0.51	0.87 (0.75, 0.99)	0.049
2009 vs. 2006	1.01 (0.97, 1.06)	0.53	1.03 (0.82, 1.30)	0.79	0.87 (0.76, 0.99)	0.04
2010 vs. 2006	1.07 (1.03, 1.12)	0.002	1.03 (0.82, 1.29)	0.80	0.82 (0.72, 0.94)	0.004
2011 vs. 2006	0.98 (0.94, 1.02)	0.28	1.02 (0.81, 1.28)	0.89	0.88 (0.77, 1.01)	0.06
2012 vs. 2006	1.01 (0.97, 1.02)	0.56	NA		0.92 (0.81, 1.06)	0.25
Asian vs. White	1.12 (1.04, 1.19)	0.002	0.99 (0.83, 1.20)	0.97	1.07 (0.95, 1.20)	0.25
Black vs. White	0.70 (0.68, 0.72)	<0.0001	0.65 (0.63, 0.68)	<0.0001	0.79 (0.73, 0.86)	<0.0001
Hispanic vs. White	0.99 (0.96, 1.03)	0.80	0.72 (0.52, 0.99)	0.046	1.10 (0.99, 1.23)	0.06
Obese vs. Not	0.84 (0.83, 0.86)	<0.0001	0.83 (0.80, 0.86)	<0.0001	0.82 (0.79, 0.85)	<0.0001
Female < 65 vs. Male 65+	1.53 (1.47, 1.58)	<0.0001	1.07 (1.01, 1.14)	0.02	1.26 (1.19, 1.34)	<0.0001
Male < 65 vs. Male 65+	1.18 (1.14, 1.22)	<0.0001	0.93 (0.88, 0.99)	0.02	1.00 (0.94, 1.06)	0.99
Female, 65+ vs. Male 65+	0.90 (0.87, 0.94)	<0.0001	0.91 (0.86, 0.97)	0.005	0.84 (0.79, 0.90)	<0.0001

* Limited to comparisons with significant findings

BP Control for Patients with Essential Hypertension by Medication Class at BMC

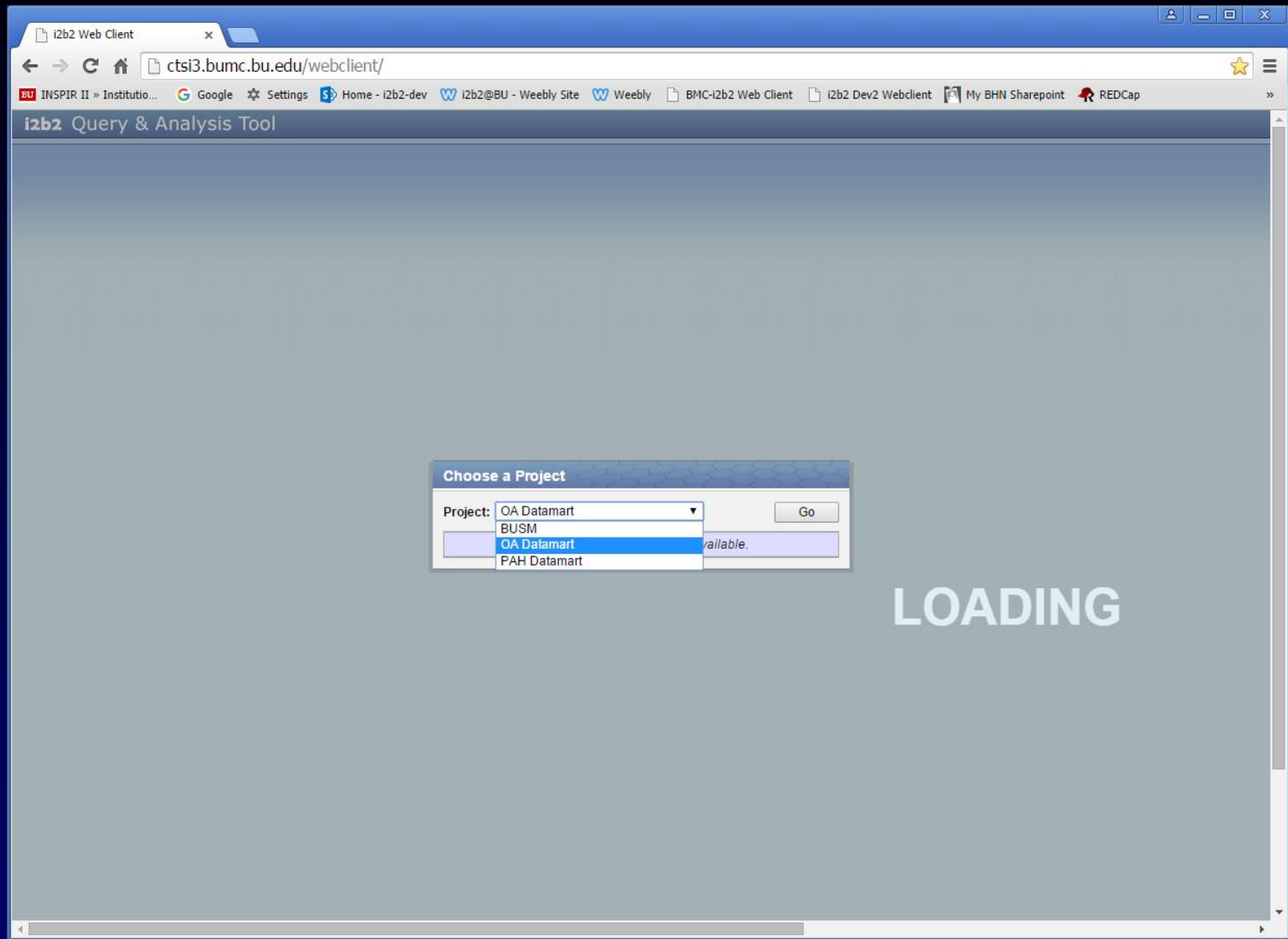


MySCILHS Telephony

- Leverage experience with data-driven telephony to support IVR REDCAP
 - “self-service questionnaires”
 - Local and cloud-based options
 - TTS (Susan) and ASR
 - Staff make contact and obtain consent
- Majority of call via IVR
 - Scalable
 - IRB- and patient-friendly

IVR Strengths

- Conversational
 - Bidirectional
 - Speech-based
- Accessible
 - Ubiquitous technology
 - Available everywhere
 - Lower literacy requirements
- Adaptive



i2b2 Web Client

cts3.bumc.bu.edu/webclient/

INSPIR II » Institutio...GoogleSettingsHome - i2b2-devi2b2@BU - Weebly SiteWeeblyBMC-i2b2 Web Clienti2b2 Dev2 WebclientMy BHN SharepointREDCap

i2b2 Query & Analysis ToolProject: OA DatamartUser: Bill AdamsFind Patients | Analysis Tools | Message Log | Help | Change Password | Logout

Navigate TermsFind

PCORI SCILHS Surveys

OA 1.1.2

PAH 1.1.2

PCORnet Demographics

PCORnet Diagnoses

PCORnet Encounters

PCORnet Enrollment

PCORnet Labs (v2)

PCORnet Medication (v3)

PCORnet Procedures

PCORnet Vital Signs

Workplace

Previous QueriesFind

OA 1.1.2@09:08:34 [9-29-2015] [biadams]

OA 1.1.2@08:52:27 [9-29-2015] [biadams]

OA 1.1.2@08:50:44 [9-29-2015] [biadams]

OA 1.1.2@08:47:22 [9-29-2015] [biadams]

OA 1.1.2@08:43:51 [9-29-2015] [biadams]

OA 1.1.2@08:43:34 [9-29-2015] [biadams]

Query Tool

Query Name: OA 1.1.2@09:08:34

Temporal Constraint: Treat all groups independently

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently			Treat Independently			Treat Independently		
OA 1.1.2								

one or more of theseANDdrop a term on here

Run QueryClearPrint Query1 GroupNew Group

Show Query StatusGraph Results

Number of patients

22

For Query "OA 1.1.2@09:08:34"

i2b2 Web Client

cts3.bumc.bu.edu/webclient/

INSPIR II » Instituto...GoogleSettingsHome - i2b2-devi2b2@BU - Weebly SiteWeeblyBMC-i2b2 Web Clienti2b2 Dev2 WebclientMy BHN SharepointREDCap

i2b2 Query & Analysis ToolProject: OA DatamartUser: Bill AdamsFind Patients | Analysis Tools | Message Log | Help | Change Password | Logout

Navigate TermsFind

PCOR! SCILHS Surveys

OA 1.1.2

PAH 1.1.2

PCORnet Demographics

PCORnet Diagnoses

PCORnet Encounters

PCORnet Enrollment

PCORnet Labs (v2)

PCORnet Medication (v3)

PCORnet Procedures

PCORnet Vital Signs

Workplace

Previous QueriesFind

OA 1.1.2@09:17:55 [9-29-2015] [biadams]

OA 1.1.2@09:08:34 [9-29-2015] [biadams]

OA 1.1.2@08:52:27 [9-29-2015] [biadams]

OA 1.1.2@08:50:44 [9-29-2015] [biadams]

OA 1.1.2@08:47:22 [9-29-2015] [biadams]

OA 1.1.2@08:43:51 [9-29-2015] [biadams]

Query Tool

Query Name: OA 1.1.2@09:17:55

Temporal Constraint: Treat all groups independently

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently			Treat Independently			Treat Independently		
OA 1.1.2								

one or more of theseANDdrop a term on here

Run QueryClearPrint Query

1 Group

New Group

Show Query StatusGraph Results

Number of patients

23

For Query "OA 1.1.2@09:17:55"

Conclusions

- Powerful tool for exploratory analyses
- “Rapid”, distributed queries are feasible and informative
- The outcomes evaluated are not improving nor are racial gaps narrowing
- Multi-variate approach particularly promising/important (strata enhancement work ongoing)

Word of caution...

- Numerous opportunities for “epidemiologic malpractice”



- Lots of cheese
 - Plenty of holes...
-
- New ways of thinking and data management required (not always easy)
 - Lots of work to do with Epic

A Novel Approach

- Data is open - privacy is protected
- Focus is on measurement - not SQL
- Researchers can ask complex questions *themselves - quickly*
- CER, HSR, *and* QI supported by a common framework
- Analytic software is interoperable
- Logic is transparent *and* portable

Additional projects/activities

- BMC Cancer Registry Integration
- BP Normalization and Care
- VVV in BP, lipid, and Hgb1C
- Sickie Cell QI (children and adults)
- Sickie Cell BH
- Community-based smoking cessation
- Pneumonia rates in PCV vaccine era
- HPV vaccination
- Algorithms for Personalized Decision Making
- ePROS – psychotropic medication use in kids
- ePROS – on- off-label safety
- PCORI-CDRN (SCILHS)
- Tele-REDCAP
- Insurance switching
- Vital Village – geographic health effects

Future Plans

- Spread i2b2 web-client access to BUMC research community
- Expand functionality of Strata tab and query code to support multivariate, aggregate data generation
- Provide a web-based version of the HOME Cell

Coming soon...

i2b2 Query & Analysis Tool

Project: i2b2MHDR User: Bill Adams Find Patients | Analysis Tools | Message Log | Help | Logout

Navigate Terms Find Terms

- Admissions
- Clinical Ontologies
- Demographics
- Diagnoses
- Drug Products by VA Class
- GE Centricity
- GE Centricity New
- GIS
- Immunizations (Epic)
- Insurance by Payer
- Laboratory Tests - Essential
- Laboratory Tests - Reference (LOINC)
- LabsCommonName(Epic)
- Metathesaurus HCPCS Hierarchical Terms

Workplace

- aalegler
- adamsb
- alkapoor
- amgarg
- amhancha
- aufrakt
- biadams
- cabyrned
- CAFREUDE
- chshanahan
- cshanahan
- demann
- demo

Previous Queries

- Depression 2014 count [10-26-2015] [kebrady]
- Child HHS BaseQ-Primary Care [10-26-2015] [kebrady]
- HOME:Child HHS-ADD/ADHD Prevalence [10-26-2015] [kebrady]
- HOME:Child HHS-Schizophrenia Prevalence-Final [10-26-2015]
- HOME:Child HHS-Bipolar Disorder Prevalence-final [10-26-2015]


HOME Cell


Start Population:Denominator Outcome:Numerator Strata Display/Execute Data Graph

Health Outcome Monitoring and Evaluation(HOME) Plug-in

Drag-and-drop existing HOME query here

New Query




EXCEPTIONAL CARE. WITHOUT EXCEPTION.



[On-line resources](#)

Plugins

Detailed List View Category: ALL

-  **HOME Cell**
This plugin runs the HOME cell
-  **Demographics (1 Patient Set) - Simple Counts**
This plugin displays a demographic break-down of a Patient Set.

Massachusetts Health Disparities Repository (MHDR)

Clinical Data

Data:

- Demographic
- Insurances
- Services
- Medications
- Problems
- Labs
- Clinical Observations

Sites:

- Boston Medical Center
- Dorchester House MSC
- Codman Square HC
- Healthcare for the Homeless
- Greater Roslindale MDC
- Whittier Street HC
- Mattapan CHC
- South End CHC
- South Boston CHC
- Uphams Corner CHC

Staging Area

Functions:

- MPI linkage
- Data cleaning
- Standardization (LOINC, CPT, RxNorm, ICD9, SNOMED CT)

i2b2

Database

- People (1.4+ mil)
- Facts (1+ billion)
- Concepts

Tools

- Query Cell
- HOME Cell

BMC-i2b2

- BMC only
- Web accessible
- Aggregate data
- No additional IRB

MHDR

- BMC + CHCs
- RDP access (with SAS, STATA)
- HOME Cell and data extracts
- IRB approval required