**The Johns Hopkins Overuse Index**

**Instructions for Constructions with Claims Data**

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­­­The documentation included in this document is specified for used with administrative claims data. We recommend using no less than one year of data. The code enclosed is SAS.

**Step 1.** Construct the six files listed in the document entitled “Overuse data construction specification”. The file names and variable names should be constructed exactly as specified so that the SAS code in steps 2 and 3 can be run directly.

**Step 2.** Apply the first set of SAS code entitled “Procedure Codes” to create the components necessary for identifying potentially overused events.

**Step 3**. Apply the second set of SAS code entitled “JHOI Construction” to create the index. The regional indicator we used was Hospital Referral Region in developing the JHOI. The code can accommodated any regional indicator. The coefficient associated with the regional variable, which is generated from running the model, is the JHOI for that region.

For background reading, we recommend our published manuscripts describing the Johns Hopkins Overuse Index and its construction and validation.

Segal JB, Nassery N, Chang HY, Chang E, Chan K, Bridges JF. An index for measuring overuse of health care resources with Medicare claims. *Med Care*. 2015 Mar;53(3):230-6.

Segal JB, Bridges JF, Chang HY, Chang E, Nassery N, Weiner J, Chan KS. [Identifying possible indicators of systematic overuse of health care procedures with claims data.](http://www-ncbi-nlm-nih-gov.ezp.welch.jhmi.edu/pubmed/24374418) *Med Care.* 2014 Feb;52(2):157-63.

Chan KS, Chang E, Nassery N, Chang HY, Segal JB. The state of overuse measurement: a critical review. *Med Care Res Rev*. 2013 Oct;70(5):473-96.

Nassery N, Segal JB, Chang E, Bridges JF. Systematic overuse of healthcare services: a conceptual model. *Appl Health Econ Health Policy.* 2015 Feb;13(1):1-6.

**STEP 1. Overuse data construction specification**

**Patient**

File name: patient

Description: patient-level information

Unit: one record per patient

Variables and Definitions:

bene\_id: unique patient ID

sex: 'F' or 'M'

date\_death: date of death (in SAS format)

death: a binary indicator of death in the observation period

date\_birth: date of birth (in SAS format)

Age: a continuous variable

Age\_group: a categorical variable

Region: a categorical variable showing where the individual lives

*Researchers can decide what to use, such as HRR*

Race: a categorical variable

Morbidity: a categorical variable showing the morbidity of an individual

**Claims**

File name: claims

Description: claims-level information

Unit: one record per claims

Variables and Definitions:

bene\_id: unique patient ID

clm\_id: unique claims ID

place\_of\_service: IP, OP, ER

date\_from: the date when the claims start (in SAS format)

date\_end: the date when the claims end (in SAS format)

**Proc**

File name: proc

Description: procedure code-level information

Unit: one record per procedure code per claims

Variables and Definitions:

bene\_id: unique patient ID

clm\_id: unique claims ID

place\_of\_service: IP, OP, ER

date\_from: the date associated with the procedure code (in SAS format)

HCPCS: Five-digit HCPCS or CPT code / Character variable

HCPCS\_Num: Five-digit HCPCS or CPT code / Numeric variable

(Some HCPCS codes would be missing because those codes contain a letter such as C. This would not impact the results of the analyses.)

**ICD**

File name: icd

Description: icd code-level information

Unit: one record per icd code per claims

Variables and Definitions:

bene\_id: unique patient ID

clm\_id: unique claims ID

place\_of\_service: IP, OP, ER

date\_from: the date associated with the ICD code (in SAS format)

position: position of the ICD code in a claims / 1, 2, 3, etc.

ICD: icd code

**ICD\_Proc**

File name: icd\_proc

Description: icd procedure code-level information

Unit: one record per icd procedure code per claims

Variables and Definitions:

bene\_id: unique patient ID

clm\_id: unique claims ID

date\_from: the date associated with the ICD procedure code (in SAS format)

PROC: icd procedure code

**DRG**

File name: drg

Description: drg-level information

Unit: one record per drg per claims

Variables and Definitions:

bene\_id: unique patient ID

clm\_id: unique claims ID

date\_from: the date associated with the drg code (in SAS format)

DRG: drg

**Step 2. Procedure Codes**

\*\* Procedure Code (file name: proc) \*\*;

**Data** proc; set proc;

if HCPCS in ("99281" "99282" "99283" "99284" "99285") then er\_visit=**1**; /\* pop 1 \*/

if HCPCS in ("93350" "93351" "C8928" "C8930") then stress\_echocardiography=**1**; /\*pop 1\*/

if HCPCS in ("22533" "22534" "22558" "22630" "0275T" "63005" "63012" "63017" "63030" "63035" "63042" "63047" "63200" "63267" "63272" "63173" "63185" "63190" "63191") then laminectomy=**1**; /\*pop 10\*/

if HCPCS in ("58150" "58152" "58180" "58200" "52810" "58260" "58262" "58263" "58267" "58270" "58275" "58280" "58285" "58290" "58291" "58292" "59293" "59294" "58541" "58542" "58543" "58544" "58548" "58550" "58552" "58553" "58554" "58570" "58571" "58572" "58573") then hysterectomy=**1**; /\*pop 11\*/

if HCPCS in ("31575" "31476" "31577" "31578" "31579") then fiberoptic\_laryngoscopy=**1**; /\*pop 20\*/

if HCPCS in ("31231" "31233" "31235") then diagnostic\_endoscopy=**1**; /\*pop 21\*/

if HCPCS in ("99281" "99282" "99283" "99284" "99285") then er\_visit=**1**; /\* pop 24/26 \*/

if HCPCS in ("80162") then digoxin=**1**; /\*pop 26\*/

if HCPCS in ("3650F" "95812" "95813" "95816" "95819" "95822" "95827") then EEG=**1**; /\*pop 27\*/

if HCPCS in ("86677") then h\_pylori\_test=**1**; /\*pop 32\*/

if HCPCS in ("70551" "70552" "70553") then MRI\_brain=**1**; /\*pop 34\*/

if HCPCS in ("78811" "78812" "78813" "78814" "78815" "78816" "72192" "72193" "72194" "3269F" "77074" "77075") then prostate\_scan=**1**; /\*pop 36\*/

if HCPCS in ("78811" "78812" "78813" "78814" "78815" "78816") then pet\_scan=**1**; /\*pop 36\*/

if HCPCS in ("3272F" "3273F") then prostate\_risk=**1**; /\*pop 36\*/

if HCPCS in ("97012" "97140" "E0830") then traction=**1**; /\*pop 37\*/

if HCPCS in ("93880") then carotid\_ultrasound=**1**; /\*pop 41\*/

if HCPCS in ("3100F") then carotid\_image=**1**; /\*pop 41\*/

if HCPCS in ("71010" "71020") then radiology=**1**; /\*pop 43\*/

if HCPCS\_num >= **100** AND HCPCS\_num <= **2101** then anesthesia=**1**; /\*pop 43\*/

if HCPCS in ("82378" "86300") then tumor\_marker=**1**; /\*pop 45\*/

if HCPCS in ("82701" "82784" "82785" "82787" "86005") then allergy\_test46=**1**; /\*pop 46\*/

if HCPCS in ("70486" "70487" "70488") then sinus\_ct=**1**; /\*pop 47\*/

if HCPCS in ("72148" "72149" "72158") then lumbar\_mri=**1**; /\*pop 49\*/

if HCPCS in ("97110" "97112" "97113" "97124" "97140" "98940" "98941" "98942" "98943") then therapies=**1**; /\*pop 49\*/

if HCPCS in ("99201" "99202" "99203" "99204" "99205" "99211" "99212" "99213" "99214" "99215" "99241" "99242" "99243"

"99244" "99245" "99341" "99342" "99343" "99344" "99345" "99347" "99348" "99349" "99350" "99354" "99355" "99356" "99357"

"99385" "99386" "99387" "99395" "99396" "99397" "99401" "99402" "99403" "99404" "99455" "99456" "99499") then evaluations=**1**; /\*pop 49\*/

if HCPCS in ("22899") then lumbar\_surgery=**1**; /\*pop 49\*/

if HCPCS\_num >= **22010** AND HCPCS\_num <= **22865** then lumbar\_surgery=**1**; /\*pop 49\*/

if HCPCS in ("71250" "71260" "71270") then thorax\_ct=**1**; /\*pop 50\*/

if HCPCS in ("71270") then thorax\_contrast=**1**; /\*pop 50\*/

if HCPCS in ("74150" "74160" "74170") then abdomen\_ct=**1**; /\*pop 51\*/

if HCPCS in ("74170") then abdomen\_contrast=**1**; /\*pop 51\*/

**run**;

\*\* ICD (file name: icd) \*\*;

**Data** icd; set icd;

icd4=substr(icd, **1**, **4**); icd3=substr(icd, **1**, **3**); icd\_5=substr(icd, **5**, **1**);

if icd in ("4111" "41181" "41189") then acs=**1**; /\*pop 1\*/

if icd3 in ("410") then acs=**1**; /\*pop 1\*/

if position in ("1" "2") and icd in ("4111 " "41181 " "41189 ") then acs\_ip\_12=**1**; /\*pop 1\*/

if position in ("1" "2") and icd3 in ("410") then acs\_ip\_12=**1**; /\*pop 1\*/

if icd in ("7221" "7222" "7223" "7225" "7226" "7227" "7228" "7229" "72270" "72272" "72273" "72280" "72282" "72283" "72290" "72292" "72293") then herniated\_disc=**1**; /\*pop 10\*/

if icd in ("3550" "3557" "3558" "3559" "7243" "7244" "7292") then mononeuritis=**1**; /\*pop 10\*/

if icd3 in ("179" "180" "182" "183" "184") then malignancy=**1**; /\*pop 11\*/

if icd3 in ("461" "473") and icd\_5="" then sinusitis=**1**; /\*pop 19 20 21\*/

if icd in ("4280" "4281" "4289") then CHF=**1**; /\*pop 26\*/

if icd4 in ("4282" "4283" "4284") then CHF=**1**; /\*pop 26\*/

if icd4 in ("4273") then AF\_flutter=**1**; /\*pop 26\*/

if icd in ("7802" "9921") then syncope\_heat=**1**; /\*pop 27\*/

if icd in ("33701") then syncope\_carotid\_sinus=**1**; /\*pop 27\*/

if icd in ("95901") then traumatic\_brain\_injury=**1**; /\*pop 34\*/

if icd4 in ("8540" "8541") then traumatic\_brain\_injury=**1**; /\*pop 34\*/

if icd3 in ("850" "851" "852" "853") then traumatic\_brain\_injury=**1**; /\*pop 34\*/

if icd3 in ("185") or icd in ("2334") then prostate\_ca=**1**; /\*pop 36\*/

if icd in ("7213" "72190" "72210" "72252" "7226" "72293" "72402" "7242" "7243" "7245" "7246" "72470" "72471" "72479" "7385"

"7393" "7394" "8460" "8461" "8462" "8463" "8468" "8469" "8472") then low\_back\_pain=**1**; /\*pop 37 & pop 49\*/

if icd in ("7859" "7842" "36234" "4359" "43310" "34290" "7802" "7813" "4370") then pop\_41=**1**; /\*pop 41\*/

if icd3 in ("466" "480" "481" "482" "483" "484" "485" "486" "487" "488" "490" "491" "492" "493" "494" "495" "496" "500" "501" "502" "503" "504" "505" "506" "507" "508" "510" "511" "512" "513" "514" "515" "516" "517" "518" "519") then pop\_43=**1**; /\*pop 43\*/

if icd in ("1740" "1741" "1742" "1743" "1744" "1745" "1746" "1748" "1749") then breast\_cancer=**1**; /\*pop 45\*/

if icd in ("4770" "4771" "4772" "4778" "4779" "49302" "49390" "49392" "7080" "9953") then allergy=**1**; /\*pop 46\*/

if icd in ("4610" "4611" "4612" "4613" "4618" "4619") then acute\_sinusitis=1; /\*pop 47\*/

if icd in ("4730" "4731" "4732" "4733" "4738" "4739") then chronic\_sinusitis=1; /\*pop 47\*/

if icd in ("34460" "34461" "7292" "2793") then pop49=**1**; /\*pop 49\*/

if icd in ("92611" "92612") then trauma=**1**; /\*pop 49\*/

if icd in ("3249" "3241") then intraspinal\_abcess=**1**; /\*pop 49\*/

if icd3 in ("140" "141" "142" "143" "144" "145" "146" "147" "148" "149" "150" "151" "152" "153" "154" "155" "156" "157"

"158" "159" "160" "161" "162" "163" "164" "165" "166" "167" "168" "169" "170" "171" "172" "173" "174" "175" "176" "177"

"178" "179" "180" "181" "182" "183" "184" "185" "186" "187" "188" "189" "190" "191" "192" "193" "194" "195" "196" "197"

"198" "199" "200" "201" "202" "203" "204" "205" "206" "207" "208" "230" "231" "232" "233" "234" "235" "236" "237" "238"

"239" "042" "043" "044") then pop49=**1**; /\*pop 49\*/

if icd3 in ("800" "801" "802" "803" "804" "805" "806" "807" "808" "809" "810" "811" "812" "813" "814" "815" "816" "817"

"818" "819" "820" "821" "822" "823" "824" "825" "826" "827" "828" "829" "830" "831" "832" "833" "834" "835" "836" "837"

"838" "839" "850" "851" "852" "853" "854" "860" "861" "862" "863" "864" "865" "866" "867" "868" "869" "905" "906" "907"

"908" "909" "929" "952" "958" "959") then trauma=**1**; /\*pop 49\*/

if icd4 in ("3040" "3041" "3042" "3044" "3054" "3055" "3056" "3057") then pop49=**1**; /\*pop 49\*/

if icd in ("5939" "1200" "59970" "59971" "59972" "2512" "2510" "2508" "2703" "2559" "1550" "1551" "1552" "1570" "1571" "1572"

"1573" "1574" "1578" "1579" "1890" "2115" "2116" "2117" "2230") then pop51=**1**; /\*pop 51\*/

if icd3 in ("194" "277" "237") then pop51=**1**; /\*pop 51\*/

if icd3 in ("180") then cervical\_cancer=**1**; /\*Cervical Cancer\*/

if icd3 in ("180") and position='1' then cervical\_cancer=**1**; /\*Cervical Cancer\*/

if icd3 in ("185") and position='1' then prostate\_cancer=**1**; /\*Prostate Cancer\*/

**run**;

**Data** icd\_proc; set icd\_proc;

if proc in ("8051" "8106" "8107" "8108" "8467" "8465") then spinal\_fusion=**1**; /\*pop 10\*/

if proc in ("683" "6831" "6839" "684" "6841" "6849" "685" "6851" "6859" "686" "6861" "6869" "687" "6871" "6879" "689") then hysterectomy=**1**; /\*pop 11\*/

if proc in ("8914") then EEG=**1**; /\*pop 27\*/

**run**;

**Data** drg; set drg;

if drg in ("281" "282" "283" "284" "285" "286" "287") then do; acs=**1**; acs\_drg=**1**; end; /\*pop 1\*/

if drg in ("459" "460") then spinal\_fusion=**1**; /\*pop 10\*/

if drg in ("734" "735" "736" "737" "738" "739" "740" "741" "754" "755" "756") then malignancy=**1**; /\*pop 11\*/

**run**;

**Step 3. Johns Hopkins Overuse Index Construction**

/\*\*\* Pop 01 \*\*\*/

/\* Denominator - Individuals with a code for emergency visit\* with any of the ICD-9 diagnoses OR individuals with a hospitalization

with DRGs as listed, or primary or secondary diagnosis code during hospitalization for any of the ICD-9 diagnoses\*/

\*\* ACS in ER \*;

\*\* ER Visit \*\*;

**Data** clm\_er; set claims; where er\_visit=**1** OR er\_pos=**1**; keep clm\_id bene\_id date\_from; **run**;

**Data** proc\_er; set proc; where er\_visit=**1** OR er\_pos=**1**; keep clm\_id bene\_id; **run**;

**Data** er\_visit; set clm\_er proc\_er; **run**; **proc** **sort** nodupkey; by clm\_id bene\_id date\_from; **run**;

\*\* ACS \*\*;

**Data** icd\_acs; set icd; where acs=**1**; keep clm\_id bene\_id acs; **run**;

**proc** **sort** nodupkey; by clm\_id bene\_id acs; **run**;

**Data** icd\_er\_acs; merge icd\_acs (in=a) er\_visit (in=b); by clm\_id bene\_id; if a=**1** and b=**1**; keep clm\_id bene\_id date\_from acs; **run**;

\*\* ACS in DRG \*\*;

**Data** drg\_acs; set drg; where acs=**1**; keep clm\_id bene\_id acs date\_from; **run**;

**proc** **sort** nodupkey; by clm\_id bene\_id acs; **run**;

\*\* ACS in IP in 1st/2nd position \*;

\*\* IP Visit \*\*;

**Data** ip\_visit; set claims; where ip\_visit=**1**; keep clm\_id bene\_id date\_from; **run**; **proc** **sort** nodupkey; by clm\_id bene\_id; **run**;

\*\* ACS in 1st/2nd position \*\*;

**Data** icd\_acs\_12; set icd; where acs=**1** and position in (**1** **2**); keep clm\_id bene\_id acs; **run**;

**proc** **sort** nodupkey; by clm\_id bene\_id acs; **run**;

**Data** icd\_ip\_acs; merge icd\_acs\_12 (in=a) ip\_visit (in=b); by clm\_id bene\_id; if a=**1** and b=**1**; keep clm\_id bene\_id acs date\_from; **run**;

\*\* All ACS Combined: per beneficiary per date of service\*\*;

**Data** acs; set icd\_er\_acs drg\_acs icd\_ip\_acs; length pop\_01\_de **3**; pop\_01\_de=**1**; **run**; **proc** **sort** nodupkey; by clm\_id bene\_id acs; **run**;

**Data** pop\_01\_de; set acs; length pop\_01\_de **3**; pop\_01\_de=**1**; keep bene\_id pop\_01\_de; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - Individuals with CPT codes as listed or HCPCS codes as listed for echocardiography \*/

**Data** pop\_01\_nu; set proc; where stress\_echocardiography=**1**; length pop\_01\_nu **3**; pop\_01\_nu=**1**; keep bene\_id pop\_01\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 01 merge \*/

**Data** pop\_01; merge pop\_01\_de (in=a) pop\_01\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_01; set pop\_01; pop\_num="01"; if pop\_01\_nu=**.** then pop\_01\_nu=**0**; if pop\_01\_de=**.** then pop\_01\_de=**0**; **run**;

/\*\*\* Pop 10 \*\*\*/

/\* Denominator - Everyone MINUS those with a clear indication (radicular symptoms--symptoms clearly of herniated disc-radicular pain)\*/

\* Herniated Disc \*;

**Data** icd\_herniated\_disc; set icd; where herniated\_disc=**1**; keep clm\_id bene\_id herniated\_disc; **run**;

**proc** **sort** nodupkey; by clm\_id bene\_id; **run**;

\* Mononeuritis: Exclude mononueritis if occur 2 times with 30 days \*;

**Data** icd\_mononeuritis; set icd; where mononeuritis=**1**; keep clm\_id bene\_id mononeuritis date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_from; **run**;

**Data** icd\_mononeuritis; set icd\_mononeuritis; by bene\_id date\_from;

date\_from\_pre = lag(date\_from);

if first.bene\_id then diff = **100**; if not first.bene\_id then diff = date\_from - date\_from\_pre;

if diff > **30** then delete; **run**;

**Data** exclusion; set icd\_herniated\_disc icd\_mononeuritis; keep bene\_id; **run**; **proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_10\_de; set patient; length pop\_10\_de **3**; pop\_10\_de=**1**; keep bene\_id pop\_10\_de; **run**;

**proc** **sort**; by bene\_id; **run**;

**Data** pop\_10\_de; merge pop\_10\_de (in=d) exclusion (in=e); by bene\_id; if d=**1** and e=**0**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - Laminectomy or spinal fusion \*/

**Data** proc\_laminectomy; set proc; where laminectomy=**1**; keep bene\_id; **run**;

**Data** icd\_proc\_laminectomy; set icd\_proc; where laminectomy=**1**; keep bene\_id; **run**;

**Data** drg\_laminectomy; set drg; where laminectomy=**1**; keep bene\_id; **run**;

**Data** pop\_10\_nu; set proc\_laminectomy icd\_proc\_laminectomy drg\_laminectomy; length pop\_10\_nu **3**; pop\_10\_nu=**1**;

keep bene\_id pop\_10\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 10 merge \*/

**Data** pop\_10; merge pop\_10\_de (in=a) pop\_10\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_10; set pop\_10; pop\_num="10"; if pop\_10\_nu=**.** then pop\_10\_nu=**0**; if pop\_10\_de=**.** then pop\_10\_de=**0**; **run**;

/\*\*\* Pop 11 \*\*\*/

/\* Denominator - all women minus those with a malignancy diagnosis (ICD9 and DRG)\*/

**Data** icd\_malignancy; set icd; where malignancy=**1**; keep bene\_id; **run**;

**Data** drg\_malignancy; set drg; where malignancy=**1**; keep bene\_id; **run**;

**Data** malignancy; set icd\_malignancy drg\_malignancy; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** female; set patient; where sex="F"; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_11\_de; merge female (in=d) malignancy (in=e); by bene\_id; if d=**1** and e=**0**; length pop\_11\_de **3**; pop\_11\_de=**1**;

keep bene\_id pop\_11\_de; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - anyone with hysterectomy (not specified for malignancy) \*/

**Data** proc\_hysterectomy; set proc; where hysterectomy=**1**; keep bene\_id; **run**;

**Data** icd\_proc\_hysterectomy; set icd\_proc; where hysterectomy=**1**; keep bene\_id; **run**;

**Data** pop\_11\_nu; set proc\_hysterectomy icd\_proc\_hysterectomy; length pop\_11\_nu **3**; pop\_11\_nu=**1**; keep bene\_id pop\_11\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 11 merge \*/

**Data** pop\_11; merge pop\_11\_de (in=a) pop\_11\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_11; set pop\_11; pop\_num="11"; if pop\_11\_nu=**.** then pop\_11\_nu=**0**; if pop\_11\_de=**.** then pop\_11\_de=**0**; **run**;

/\*\*\* Pop 20 \*\*\*/

/\* Denominator - Individual with a diagnosis of sinusitis (acute or chronic) –inpatient or outpatient\*/

**Data** pop\_20\_de; set icd; where sinusitis=**1**; length pop\_20\_de **3**; pop\_20\_de=**1**; keep bene\_id pop\_20\_de; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - Laryngoscopy WITH ICD-9 code indicating sinusitis on the same claim ID\*/

**data** proc\_fiberoptic\_laryngoscopy; set proc; where fiberoptic\_laryngoscopy=**1**; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** icd\_sinusitis; set icd; where sinusitis=**1**; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** pop\_20\_nu; merge proc\_fiberoptic\_laryngoscopy (in=a) icd\_sinusitis (in=b); by bene\_id clm\_id; if a=**1** and b=**1**; **run**;

**Data** pop\_20\_nu; set pop\_20\_nu; length pop\_20\_nu **3**; pop\_20\_nu=**1**; keep bene\_id pop\_20\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 20 merge \*/

**Data** pop\_20; merge pop\_20\_de (in=a) pop\_20\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_20; set pop\_20; pop\_num="20"; if pop\_20\_nu=**.** then pop\_20\_nu=**0**; if pop\_20\_de=**.** then pop\_20\_de=**0**; **run**;

/\*\*\* Pop 21 \*\*\*/

/\* Denominator - Individual with a diagnosis of sinusitis (acute or chronic) –inpatient or outpatient\*/

**Data** pop\_21\_de; set icd; where sinusitis=**1**; length pop\_21\_de **3**; pop\_21\_de=**1**; keep bene\_id pop\_21\_de; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - Nasal endoscopy WITH ICD-9 code indicating sinusitis on the same claim ID\*/

**Data** diagnostic\_endoscopy; set proc; where diagnostic\_endoscopy=**1**; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by clm\_id bene\_id; **run**;

**Data** sinusitis; set icd; where sinusitis=**1**; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by clm\_id bene\_id; **run**;

**Data** pop\_21\_nu; merge diagnostic\_endoscopy (in=a) sinusitis (in=b); by clm\_id bene\_id; if a=**1** and b=**1**;

length pop\_21\_nu **3**; pop\_21\_nu=**1**; keep bene\_id pop\_21\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 21 merge \*/

**Data** pop\_21; merge pop\_21\_de (in=a) pop\_21\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_21; set pop\_21; pop\_num="21"; if pop\_21\_nu=**.** then pop\_21\_nu=**0**; if pop\_21\_de=**.** then pop\_21\_de=**0**; **run**;

/\*\*\* Pop 24 \*\*\*/

/\* Denominator - Individuals with death during our observation period \*/

**Data** pop\_24\_de; set patient; where death=**1**; length pop\_24\_de **3**; pop\_24\_de=**1**; keep pop\_24\_de bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - More than 2 visits with location code or CPT code indicating ED use within 30 days before death\*/

**Data** er\_proc; set proc; where er\_visit=**1** OR er\_pos=**1**;; date\_er=date\_from; keep bene\_id date\_er; **run**;

**Data** er\_claims; set claims; where er\_visit=**1** OR er\_pos=**1**; date\_er=date\_from; keep bene\_id date\_er; **run**;

**Data** er; set er\_proc er\_claims; **run**;

**proc** **sort** nodupkey; by bene\_id date\_er; **run**;

**Data** death; set patient; keep bene\_id date\_death; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** c; merge death (in=a) er (in=b); by bene\_id; if a=**1** and b=**1**; **run**;

**Data** c; set c; where date\_er>=date\_death-**30**; length n\_num **3**; n\_num=**1**; **run**;

**proc** **summary** Data=c; by bene\_id; output out=d sum(n\_num)=n\_num; **run**;

**Data** pop\_24\_nu; set d; where n\_num>=**2**; length pop\_24\_nu **3**; pop\_24\_nu=**1**; keep bene\_id pop\_24\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 24 merge \*/

**Data** pop\_24; merge pop\_24\_de (in=a) pop\_24\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_24; set pop\_24; pop\_num="24"; if pop\_24\_nu=**.** then pop\_24\_nu=**0**; if pop\_24\_de=**.** then pop\_24\_de=**0**; **run**;

/\*\*\* Pop 26 \*\*\*/

/\* Denominator - All patients with CHF (will include atrial fibrillation patients as well)\*/

**Data** pop\_26\_de; set icd; where CHF=**1** or AF\_flutter=**1**; length pop\_26\_de **3**; pop\_26\_de=**1**; keep pop\_26\_de bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - Any measure of digoxin with no hospitalizations or ER visits during that year.\*/

**Data** digoxin; set proc; where digoxin=**1**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Hospitalization & ER \*/

**Data** ip\_er\_clm; set claims; where place \_of\_service in ('IP' 'ER') or er\_visit=**1**; keep bene\_id; **run**;

**Data** er\_proc; set proc; where er\_visit=**1** OR er\_pos=**1**;; keep bene\_id; **run**;

**Data** ip\_er; set ip\_er\_clm er\_proc; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_26\_nu; merge digoxin (in=a) ip\_er (in=b); by bene\_id; if a=**1** and b=**0**; length pop\_26\_nu **3**; pop\_26\_nu=**1**; keep pop\_26\_nu bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 26 merge \*/

**Data** pop\_26; merge pop\_26\_de (in=a) pop\_26\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_26; set pop\_26; pop\_num="26"; if pop\_26\_nu=**.** then pop\_26\_nu=**0**; if pop\_26\_de=**.** then pop\_26\_de=**0**; **run**;

/\*\*\* Pop 27 \*\*\*/

/\* Denominator - Individuals with an outpatient visit with diagnosis of syncope or hospitalization for syncope\*/

**Data** pop\_27\_de; set icd; where syncope\_heat=**1** or syncope\_carotid\_sinus=**1**; length pop\_27\_de **3**; pop\_27\_de=**1**; keep pop\_27\_de bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - EEG on the same claim as diagnosis of syncope or at any time during the hospitalization with a code for syncope\*/

/\* EGG not in ICD Procedure Outpatient \*/

**Data** egg\_ip; set icd\_proc; where eeg=**1** and place\_of\_service='IP'; date\_egg=date\_from; keep bene\_id clm\_id date\_egg; **run**;

**Data** egg\_op; set proc; where eeg=**1** and place\_of\_service='OP'; date\_egg=date\_from; keep bene\_id clm\_id date\_egg; **run**;

**Data** egg; set egg\_ip egg\_op; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id date\_egg; **run**;

**Data** a1; set icd; where syncope\_heat=**1** or syncope\_carotid\_sinus=**1**; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** b1; set egg; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** c1; merge a1 (in=a) b1 (in=b); by bene\_id clm\_id; if a=**1** and b=**1**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** a2; set icd; where (syncope\_heat=**1** or syncope\_carotid\_sinus=**1**) and place\_of\_service='IP';

syncope\_start=date\_from; syncope\_end=date\_end; keep bene\_id syncope\_start syncope\_end; **run**;

**proc** **sort** nodupkey; by bene\_id syncope\_start syncope\_end; **run**;

**Data** b2; set egg; keep bene\_id date\_egg; **run**;

**proc** **sort** nodupkey; by bene\_id date\_egg; **run**;

**proc** **sql**; create table c2 as select \* from a a2, b b2 where a.bene\_id=b.bene\_id; **quit**;

**Data** c2; set c2; where date\_egg>=syncope\_start and date\_egg<=syncope\_end; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_27\_nu; set c1 c2; length pop\_27\_nu **3**; pop\_27\_nu=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 27 merge \*/

**Data** pop\_27; merge pop\_27\_de (in=a) pop\_27\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_27; set pop\_27; pop\_num="27"; if pop\_27\_nu=**.** then pop\_27\_nu=**0**; if pop\_27\_de=**.** then pop\_27\_de=**0**; **run**;

/\*\*\* Pop 32 \*\*\*/

/\* Denominator - Whole population \*/

**Data** pop\_32\_de; set patient; length pop\_32\_de **3**; pop\_32\_de=**1**; keep pop\_32\_de bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - Any code indicating testing for H. pylori\*/

**Data** pop\_32\_nu; set proc; where h\_pylori\_test=**1**; length pop\_32\_nu **3**; pop\_32\_nu=**1**; keep pop\_32\_nu bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 32 merge \*/

**Data** pop\_32; merge pop\_32\_de (in=a) pop\_32\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_32; set pop\_32; pop\_num="32"; if pop\_32\_nu=**.** then pop\_32\_nu=**0**; if pop\_32\_de=**.** then pop\_32\_de=**0**; **run**;

/\*\*\* Pop 34 \*\*\*/

/\* Denominator - Patients with traumatic brain injury\*/

**Data** pop\_34\_de; set icd; where traumatic\_brain\_injury=**1**; keep pop\_34\_de bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - MRI on the same claim as diagnosis if outpatient or during hospitalization if inpatient\*/

**Data** mri; set proc; where MRI\_brain=**1**; date\_mri=date\_from; **run**;

**Data** a1; set icd; where traumatic\_brain\_injury=**1**; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** b1; set mri; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** c1; merge a1 (in=a) b1 (in=b); by bene\_id clm\_id; if a=**1** and b=**1**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** a2; set icd; where traumatic\_brain\_injury=**1** and place\_of\_service='IP';

brain\_start=date\_from; brain\_end=date\_end; keep bene\_id brain\_start brain\_end; **run**;

**proc** **sort** nodupkey; by bene\_id brain\_start brain\_end; **run**;

**Data** b2; set mri; keep bene\_id date\_mri; **run**;

**proc** **sort** nodupkey; by bene\_id date\_mri; **run**;

**proc** **sql**; create table c2 as select \* from a a2, b b2 where a.bene\_id=b.bene\_id; **quit**;

**Data** c2; set c2; where date\_mri>=brain\_start and date\_mri<=brain\_end; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_34\_nu; set c1 c2; length pop\_34\_nu **3**; pop\_34\_nu=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 34 merge \*/

**Data** pop\_34; merge pop\_34\_de (in=a) pop\_34\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_34; set pop\_34; pop\_num="34"; if pop\_34\_nu=**.** then pop\_34\_nu=**0**; if pop\_34\_de=**.** then pop\_34\_de=**0**; **run**;

/\*\*\* Pop 36 \*\*\*/

/\* Denominator - Men with low risk for prostate CA\*/

**Data** prostate; set icd; where prostate\_ca=**1**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** risk; set proc; where prostate\_risk=**1**;; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_36\_de; merge prostate (in=a) risk (in=b); by bene\_id; if a=**1** and b=**0**; length pop\_36\_de **3**; pop\_36\_de=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator – PET, CT or radionuclide bone scan AFTER diagnosis \*/

**Data** scan; set proc; where prostate\_scan=**1**; date\_scan=date\_from; keep bene\_id date\_scan; **run**;

**proc** **sort** nodupkey; by bene\_id date\_scan; **run**;

**Data** prostate; set icd; where prostate\_ca=**1**; date\_cancer=date\_from; keep bene\_id date\_cancer; **run**;

**proc** **sort** nodupkey; by bene\_id date\_cancer; **run**;

**proc** **sql**; create table pop\_36\_nu as select \* from a scan, b prostate where a.bene\_id=b.bene\_id; **quit**;

**Data** pop\_36\_nu; set pop\_36\_nu; where date\_scan>=date\_cancer; length pop\_36\_nu **3**; pop\_36\_nu=**1**; keep bene\_id pop\_36\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 36 merge \*/

**Data** pop\_36; merge pop\_36\_de (in=a) pop\_36\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_36; set pop\_36; pop\_num="36"; if pop\_36\_nu=**.** then pop\_36\_nu=**0**; if pop\_36\_de=**.** then pop\_36\_de=**0**; **run**;

/\*\*\* Pop 37 \*\*\*/

/\* Denominator - Low back pain diagnosis\*/

**Data** pop\_37\_de; set icd; where back\_pain=**1**; length pop\_37\_de **3**; pop\_37\_de=**1**; keep bene\_id pop\_37\_de; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - Traction with diagnosis of low back pain\*/

**Data** pop\_37\_nu; set proc; where traction=**1**; length pop\_37\_nu **3**; pop\_37\_nu=**1**; keep bene\_id pop\_37\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 37 merge \*/

**Data** pop\_37; merge pop\_37\_de (in=a) pop\_37\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_37; set pop\_37; pop\_num="37"; if pop\_37\_nu=**.** then pop\_37\_nu=**0**; if pop\_37\_de=**.** then pop\_37\_de=**0**; **run**;

/\*\*\* Pop 41 \*\*\*/

/\* Denominator - all minus those with a specific diagnosis\*/

**Data** a; set icd; where pop\_41=**1**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** b; set patient; length pop\_41\_de **3**; pop\_41\_de=**1**; keep bene\_id pop\_41\_de; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_41\_de; merge a (in=a) b (in=b); by bene\_id; if a=**0** and b=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* Numerator - Screening for asymptomatic artery stenosis (CPT 93880 or 3100F, ONLY IN outpatient setting (not ER))\*/

**Data** pop\_41\_nu; set proc; where carotid\_ultrasound=**1** or carotid\_image=**1**; **run**;

**Data** pop\_41\_nu; set pop\_41\_nu; if er\_visit=**1** or er\_pos=**1** or place\_of\_service='ER' then delete; length pop\_41\_nu **3**; pop\_41\_nu=**1**; keep bene\_id pop\_41\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 41 merge \*/

**Data** pop\_41; merge pop\_41\_de (in=a) pop\_41\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_41; set pop\_41; pop\_num="41"; if pop\_41\_nu=**.** then pop\_41\_nu=**0**; if pop\_41\_de=**.** then pop\_41\_de=**0**; **run**;

/\*\*\* Pop 43 \*\*\*/

/\* Denominator - All with anesthesia code excluding certain diagnoses\*/

**Data** a; set icd; where pop\_43=**1**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** b; set proc; where anesthesia=**1**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_43\_de; merge a (in=a) b (in=b); by bene\_id; if a=**0** and b=**1**; length pop\_43\_de **3**; pop\_43\_de=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_43\_de; **run**;

/\* Numerator - Chest radiography 30 days before anesthesia\*/

**Data** radiology; set proc; where radiology=**1**; date\_radiology=date\_from; keep bene\_id date\_radiology; **run**;

**proc** **sort** nodupkey; by bene\_id date\_radiology; **run**;

**Data** b; set proc; where anesthesia=**1**; date\_anes=date\_from; keep bene\_id date\_anes; **run**;

**proc** **sort** nodupkey; by bene\_id date\_anes; **run**;

**proc** **sql**; create table c as select \* from a radiology, b b where a.bene\_id=b.bene\_id; **quit**;

**Data** pop\_43\_nu; set c; where date\_anes-date\_radiology>=**0** and date\_anes-date\_radiology<=**30**; **run**;

**Data** pop\_43\_nu; set pop\_43\_nu; length pop\_43\_nu **3**; pop\_43\_nu=**1**; keep bene\_id pop\_43\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 43 merge \*/

**Data** pop\_43; merge pop\_43\_de (in=a) pop\_43\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_43; set pop\_43; pop\_num="43"; if pop\_43\_nu=**.** then pop\_43\_nu=**0**; if pop\_43\_de=**.** then pop\_43\_de=**0**; **run**;

/\*\*\* Pop 45 \*\*\*/

/\* Denominator - Women with breast cancer diagnosis\*/

**Data** cancer; set icd; where breast\_cancer=**1**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** female; set patient; where sex='F'; length pop\_45\_de **3**; pop\_45\_de=**1**; keep bene\_id pop\_45\_de; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_45\_de; **run**;

**Data** pop\_45\_de; merge cancer (in=a) female (in=b); by bene\_id; if a=**1** and b=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_45\_de; **run**;

/\* Numerator - Tumor marker studies\*/

**Data** pop\_45\_nu; set proc; where tumor\_marker=**1**; length pop\_45\_nu **3**; pop\_45\_nu=**1**; keep bene\_id pop\_45\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 45 merge \*/

**Data** pop\_45; merge pop\_45\_de (in=a) pop\_45\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_45; set pop\_45; pop\_num="45"; if pop\_45\_nu=**.** then pop\_45\_nu=**0**; if pop\_45\_de=**.** then pop\_45\_de=**0**; **run**;

/\*\*\* Pop 46 \*\*\*/

/\* Denominator – Individuals with allergy diagnosis (477.0, 477.1, 477.2, 477.8, 477.9, 493.0, 493.02, 493.9, 493.90, 493.92, 708.0, 995.3)\*/

**Data** pop\_46\_de; set icd; where allergy=**1**; length pop\_46\_de **3**; pop\_46\_de=**1**; keep bene\_id pop\_46\_de; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_46\_de; **run**;

/\* Numerator - Use of CPT 82701, 82784, 82785, 82787, 86005 on the same claim as a code for diagnoses in the denominator column \*/

**Data** a; set proc; where allergy\_test46=**1**; keep clm\_id bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** b; set icd; where allergy=**1**; keep bene\_id clm\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** pop\_46\_nu; merge a (in=a) b (in=b); by bene\_id clm\_id; if a=**1** and b=**1**; length pop\_46\_nu **3**; pop\_46\_nu=**1**; keep bene\_id pop\_46\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 46 merge \*/

**Data** pop\_46; merge pop\_46\_de (in=a) pop\_46\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_46; set pop\_46; pop\_num="46"; if pop\_46\_nu=**.** then pop\_46\_nu=**0**; if pop\_46\_de=**.** then pop\_46\_de=**0**; **run**;

/\*\*\* Pop 47 \*\*\*/

/\* Denominator – 461.0, 461.1, 461.2, 461.3, 461.8, 461.9 AND NO code in the preceding 3 months for any of these AND NO code in the preceding 3 months for 473.0, 473.1, 473.2, 473.3, 473.8, 473.9\*/

**Data** acute\_sinusitis; set icd; where acute\_sinusitis=**1**; rename date\_from=date\_service; keep bene\_id date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_service; **run**;

**Data** sinusitis; set icd; where chronic\_sinusitis=**1** OR acute\_sinusitis=**1**; keep bene\_id date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_from; **run**;

\*\*\* Left join merge \*\*\*;

**proc** **sql**; create table c as select \* from a acute\_sinusitis left join b sinusitis on a.bene\_id=b.bene\_id; **quit**;

**Data** d; set c; where date\_from < date\_service <= date\_from+**92**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_47\_de; merge acute\_sinusitis (in=a) d (in=b); by bene\_id; if a=**1** and b=**0**; **run**;

**Data** pop\_47\_de; set pop\_47\_de; length pop\_47\_de **3**; pop\_47\_de=**1**; keep bene\_id pop\_47\_de; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_47\_de; **run**;

/\* Numerator - Any occurrence of sinus CT (CPT 70486, 70487, 70488) in the 3 months preceding the diagnosis of acute sinusitis \*/

**Data** acute\_sinusitis; set icd; where acute\_sinusitis=**1**; keep bene\_id date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_from; **run**;

**Data** sinus\_ct; set icd; where sinus\_ct=**1**; rename date\_from=date\_sinus\_ct; keep bene\_id date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_sinus\_ct; **run**;

\*\*\* many-to-many merge \*\*\*;

**proc** **sql**; create table c as select \* from a acute\_sinusitis, b sinus\_ct where a.bene\_id=b.bene\_id; **quit**;

**Data** c; set c; where date\_sinus\_ct < date\_from <= date\_sinus\_ct+**92**; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_47\_nu; merge pop\_47\_de (in=a) c; by bene\_id; if a=**1**; length pop\_47\_nu **3**; pop\_47\_nu=**1**; keep bene\_id pop\_47\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 47 merge \*/

**Data** pop\_47; merge pop\_47\_de (in=a) pop\_47\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_47; set pop\_47; pop\_num="47"; if pop\_47\_nu=**.** then pop\_47\_nu=**0**; if pop\_47\_de=**.** then pop\_47\_de=**0**; **run**;

/\*\*\* Pop 49 \*\*\*/

/\* Denominator – MRI of the lumbar spine studies with a diagnosis of low back pain on the imaging claim.

CPT=72148, or 72149, or 72158 AND ICD-9: 721.3, 721.90, 722.10, 722.52, 722.6, 722.93, 724.02, 724.2 , 724.3, 724.5, 724.6, 724.70, 724.71, 724.79, 738.5, 739.3, 739.4, 846.0, 846.1, 846.2, 846.3, 846.8, 846.9 , 847.2 "

Excluded from the denominator - CPT codes: 22010-22865 and 22899 in 90 days preceding MRI; ICD-9 codes: 140-208, 230-234, 235-239, 304.0X, 304.1X, 304.2X, 304.4X, 305.4X, 305.5X, 305.6X, 305.7X, 344.60, 344.61, 729.2, 042-044, 279.3 in preceding 365 days; 800-839, 850-854, 860-869, 905-909, 926.11, 926.12, 929, 952, 958-959 in preceding 45 days; 324.9, 324.1 on same claim ID as MRI of the lumbar spine\*/

**Data** a; set proc; where lumbar\_mri=**1**; rename date\_from=date\_mri; keep bene\_id clm\_id date\_mri; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id date\_mri; **run**;

**Data** b; set icd; where back\_pain=**1**; keep bene\_id clm\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** c; merge a (in=a) b (in=b); by clm\_id bene\_id; if a=**1** and b=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id date\_mri clm\_id; **run**;

\*Exclusions / Date;

**Data** lumbar\_surgery; set proc; where lumbar\_surgery=**1**; rename date\_from=date\_lumbar\_surgery; keep bene\_id date\_lumbar\_surgery; **run**;

**proc** **sort** nodupkey; by bene\_id date\_lumbar\_surgery; **run**;

**Data** pop49; set ICD; where pop49=**1**; rename date\_from=date\_pop49; keep bene\_id date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_pop49; **run**;

**Data** trauma; set proc; where trauma=**1**; rename date\_from=date\_trauma; keep bene\_id date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_trauma; **run**;

**data** dates; set lumbar\_surgery pop49 trauma; **run**;

\*\*\* Left join merge \*\*\*;

**proc** **sql**; create table d as select \* from c c left join dates d on c.bene\_id=d.bene\_id; **quit**;

**Data** e; set d; where date\_lumbar\_surgery<=date\_mri<=date\_lumbar\_surgery+**90** OR date\_pop49<=date\_mri<=date\_pop49+**365** OR date\_trauma<=date\_mri<=date\_trauma+**45**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** f; merge c (in=a) e (in=b); by bene\_id; if a=**1** and b=**0**; **run**;

\*Exclusions / same claims;

**Data** intraspinal\_abcess; set icd; where intraspinal\_abcess=**1**; keep bene\_id clm\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**proc** **sort** data=c nodupkey; by bene\_id clm\_id; **run**;

**Data** g; merge c (in=c) intraspinal\_abcess (in=f); by bene\_id clm\_id; if c=**1** and f=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** h; merge f (in=f) g (in=g); by bene\_id date\_mri; if f=**1** and g=**0**; **run**;

**Data** pop\_49\_de; set h; length pop\_49\_de **3**; pop\_49\_de=**1**; keep bene\_id pop\_49\_de; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_49\_de; **run**;

/\* Numerator – MRI of the lumbar spine studies with a diagnosis of low back pain (from the denominator) without the patient having claims-based evidence of prior antecedent conservative therapy.

CPT=72148, or 72149, or 72158 with no codes for 97110, 97112, 97113, 97124, 97140, 98940, 98941,98942,98943 in the 60 days preceding the MRI of the lumbar spine AND no codes for 99201-99205,99211 -99215,99241-99245, 99341-99345,99347-99350,99354-99357,99385-99387,99395-99397 , 99401-99404,99455-99456,99499 between 28 and 60 days preceding the MRI of the lumbar spine\*/

**Data** therapies; set proc; where therapies=**1**; rename date\_from=date\_therapies; keep bene\_id date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_therapies; **run**;

**Data** evaluations; set proc; where evaluations=**1**; rename date\_from=date\_evaluations; keep bene\_id date\_from; **run**;

**proc** **sort** nodupkey; by bene\_id date\_evaluations; **run**;

**data** therapies\_evals; set therapies evaluations; **run**;

**proc** **sort**; by bene\_id; **run**;

\*\*\* Left join merge \*\*\*;

**proc** **sql**; create table d as select \* from c c left join a therapies\_evals on c.bene\_id=a.bene\_id; **quit**;

**Data** d; set d; where date\_therapies<=date\_mri<=date\_therapies+**60** OR date\_evals+**28**<=date\_mri<=date\_evals+**60**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**data** e; set pop\_49\_de; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_49\_nu; merge d (in=d) e (in=c); by bene\_id; if c=**1** and d=**0**;

length pop\_49\_nu **3**; pop\_49\_nu=**1**; keep bene\_id pop\_49\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

/\* POP 49 merge \*/

**Data** pop\_49; merge pop\_49\_de (in=a) pop\_49\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_49; set pop\_49; pop\_num="49"; if pop\_49\_nu=**.** then pop\_49\_nu=**0**; if pop\_49\_de=**.** then pop\_49\_de=**0**; **run**;

/\*\*\* Pop 50 \*\*\*/

/\* Denominator – The number of thorax CT studies with and without contrast (“combined studies”). CPT 71250, 71260, 71270\*/

**Data** pop\_50\_de; set proc; where thorax\_ct=**1**; length pop\_50\_de **3**; pop\_50\_de=**1**; keep bene\_id pop\_50\_de; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_50\_de; **run**;

/\* Numerator – The number of thorax CT studies performed (with contrast, without contrast or both with and without contrast). CPT 71270\*/

**Data** pop\_50\_nu; set proc; where thorax\_contrast=**1**; length pop\_50\_nu **3**; pop\_50\_nu=**1**; keep bene\_id pop\_50\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_50\_nu; **run**;

/\* POP 50 merge \*/

**Data** pop\_50; merge pop\_50\_de (in=a) pop\_50\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_50; set pop\_50; pop\_num="50"; if pop\_50\_nu=**.** then pop\_50\_nu=**0**; if pop\_50\_de=**.** then pop\_50\_de=**0**; **run**;

/\*\*\* Pop 51 \*\*\*/

/\* Denominator – The number of Abdomen CT studies performed (with contrast, without contrast or both with and without contrast). CPT 74150, 74160, 74170, Excluding some diagnoses if on the same claim ID\*/

**Data** abdomen\_ct; set proc; where abdomen\_ct=**1**; keep bene\_id clm\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** pop51; set icd; where pop51=**1**; keep bene\_id clm\_id; **run**;

**proc** **sort** nodupkey; by bene\_id clm\_id; **run**;

**Data** c; merge abdomen\_ct (in=a) pop51 (in=b); by bene\_id clm\_id; if a=**1** and b=**1**; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** d; set abdomen\_ct; keep bene\_id; **run**;

**proc** **sort** nodupkey; by bene\_id; **run**;

**Data** pop\_51\_de; merge d (in=d) c (in=c); by bene\_id; if d=**1** and c=**0**; length pop\_51\_de **3**; pop\_51\_de=**1**; keep bene\_id pop\_51\_de; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_51\_de; **run**;

/\* Numerator – The number of Abdomen CT studies with and without contrast (“combined studies”).

CPT 74170\*/

**Data** pop\_51\_nu; set proc; where abdomen\_contrast=**1**; length pop\_51\_nu **3**; pop\_51\_nu=**1**; keep bene\_id pop\_51\_nu; **run**;

**proc** **sort** nodupkey; by bene\_id pop\_51\_nu; **run**;

/\* POP 51 merge \*/

**Data** pop\_51; merge pop\_51\_de (in=a) pop\_51\_nu; by bene\_id; if a=**1**; **run**;

**Data** pop\_51; set pop\_51; pop\_num="51"; if pop\_51\_nu=**.** then pop\_51\_nu=**0**; if pop\_51\_de=**.** then pop\_51\_de=**0**; **run**;

/\*\* Build Model \*\*/

**Data** pop; set pop\_01 pop\_10 pop\_11 pop\_20 pop\_21 pop\_24 pop\_26 pop\_27 pop\_32 pop\_34 pop\_36 pop\_37 pop\_41 pop\_43 pop\_45

pop\_46 pop\_47 pop\_49 pop\_50 pop\_51; **run**;

**proc** **sort**; by bene\_id; **run**;

**Data** a; set patient; keep bene\_id region morbidity sex age\_group race; **run**;

**proc** **sort**; by bene\_id; **run**;

**Data** pop; merge pop (in=a) a; by bene\_id; if a=**1**; **run**;

\*\* Users can decide what covariates to be included and how they are included in the model \*\*;

\*\* The JHOI is the coefficient associated with the regional variable (variable name "estimate" from the file "jhoi") \*\*;

**proc** **surveyreg** Data=pop;

class pop\_num region morbidity sex age\_group race;

model pop = region morbidity sex age\_group race pop\_num/ noint solution;

ods output ParameterEstimates=jhoi;

**run**;