COMMONWEALTH OF MASSACHUSETTS
HEALTH POLICY COMMISSION

TECHNICAL APPENDIX 9
PROVIDER ORGANIZATION PERFORMANCE VARIATION

ADDENDUM TO 2023 COST TRENDS REPORT

Contents

1 Summary

This appendix describes the Health Policy Commission's (HPC) approach to examining Provider Organization Performance Variation in the 2023 Cost Trends Report Chartpack.

2 Unadjusted total medical expenditures (TME) per member per year and average annual TME growth from 2019 to 2021

2.1 Data

For the exhibit **"Unadjusted total medical expenditures (TME) per member per year from 2015 to 2021 and average annual TME growth from 2016 to 2019, by provider organization"**, the HPC used the Center for Health Information and Analysis' (CHIA) Annual Report Alternative Payment Methods (APM) Databook from 2023 (for calendar years 2019-2021), 2022 (for calendar years 2018-2020), 2021 (for calendar years 2017-2019), 2019 (for calendar years 2016-2018), and 2018 (for calendar years 2015-2017).

2.2 Analysis

CHIA's 2018 through 2021 Annual Report APM Databooks report unadjusted total medical expenditures (TME). To calculate unadjusted TME per member per year, the HPC examined all commercial payers except for Tufts Public Plan and BMC Health Net. The HPC excluded non-full commercial claims and pediatric physician practices. The HPC restricted this analysis to the nine largest provider groups, identified by calculating the average member months for each provider group for 2019, 2020, and 2021. HPC took the average unadjusted TME for each provider group, weighted by member months, by provider group and year across all versions of the Annual Report APM Databook.

To standardize across CHIA Annual Report Databook years, the HPC calculated the growth rates between the first two years of data in each version of the Annual Report Databooks with the exception of the 2023 Databook, where the growth rate was calculated for the final two years of data (calendar years 2020 and 2021). For each provider group, the HPC used data for calendar years 2019 through 2021 from the 2023 Annual Report Databook and used the growth rates for prior years to calculate the unadjusted TME for calendar years 2015 to 2018.

3 Patient Attribution Methodology

3.1 Data

The HPC used the 2021 Registration of Provider Organizations (RPO) and the 2021 IQVIA, Inc Office Based and Hospital Based Providers (IQVIA, Inc) dataset to identify providers and create a "Provider File." The HPC then used the CHIA All-Payer Claims Database v2021 (APCD) to attribute patients observed in the APCD to provider organizations in Massachusetts in 2021. The HPC's APCD has data from six commercial payers in the state: Blue Cross Blue Shield of

Massachusetts, Tufts Health Plan, Harvard Pilgrim Health Care, Mass General Brigham Health Plan (formerly AllWays), Health New England, and Anthem (including Unicare, a GIC offering).

3.2 Provider File

These steps describe the creation of the provider file used in the provider attribution methodology. As described below, the member attribution process requires a file of all providers and their National Provider Identifiers (NPIs), as well as a list of only the primary care providers (PCPs) and their NPIs.

Overall provider file:
To create the overall provider file, the HPC combined 2021 RPO data with 2021 IQVIA, Inc data. After excluding any providers missing NPIs and removing duplicate entries of providers who may appear in both files, the final provider file includes 52,218 providers, 27,468 from RPO and 24,750 from IQVIA, Inc.

Primary care provider file:
The HPC defined primary care providers from this list as follows. For the providers in RPO, the HPC included all providers who self-report that they practice as a primary care provider, a pediatrician, or both. The HPC identified PCPs from the IQVIA, Inc file by using these self-reported specialties: Family practitioner, General practitioner, Internal medicine, Pediatrician, Internal Medicine & Pediatrics. The PCP file also includes Nurse Practitioners from IQVIA, Inc (NPs are not included in the RPO data) who self-reported a primary care specialty.

The final PCP file includes 9,007 PCPs.

3.3 Attribution Methodology

These steps describe the attribution methodology that relies on the primary care provider file created in 2.2 above.

Individuals with a payer-reported PCP in the member eligibility file:
There are 1,668,048 unique members in the HPC's 2021 commercial analytic file of the APCD. The member eligibility file enables assignment of 83.2% (1,388,486) of members who have an identifiable PCP in their record.

Step-wise PCP assignment using the medical claim file and pharmacy claim file:
The remaining unassigned members were then linked to their medical claims to identify primary providers of well visits, sick visits, and most frequent prescriber in the pharmacy claim file. Well visits are defined as any claims with the following procedure codes: G0438,

G0439, V2020, V2030, V7000, V7030, V7050, V7060, V7080, V7090, 99381-99387, 99391-99397, 99401-99404, 99411-99412, 99420, 99429, 99432, 99461. Sick visits are defined as any claims with the following procedure codes: 99201-99205, 99211-99215. Claims that were identified as either well or sick visits were limited to sites of service where patients would be expected to see a PCP [excluding 01 (pharmacy), 17 (retail clinic), 20 (urgent care), 21 (inpatient hospital), 23 (emergency department), 41 (ambulance), 42 (air ambulance), 51 (inpatient psychiatric facility), 52 (psychiatric facility, partial hospitalization), 53 (community mental health), 55 (residential SUD treatment), 56 (psychiatric residential treatment), 57 (non-residential SUD facility), 62 (outpatient rehab facility), 65 (end stage renal disease facility), 81 (independent lab)]. If a member was not linked to a PCP through a well visit, or sick visit, we then reviewed their pharmacy claims to determine if there was a primary prescriber.

In total, there are 1,388,486 individuals attributed to a provider organization in 2021. For the Chartpack, the HPC then restricted analyses to the 14 (non-specialty) provider organizations with at least 11,000 attributed commercial members. This resulted in a patient population of 1,210,257 attributed members in 2021.

4 Study population

For the subsequent analyses, the study population is broadly defined as commercial members who were attributed to a provider organization with at least 11,000 attributed members. The HPC reports on the 14 largest provider organizations as they exist in the most current data years available. Then the study population is further limited to adults who are at least 18 years old with continuous enrollment (12 months of insurance coverage). Additional study population inclusion and exclusion criteria apply for analyses on categorical spending (4.2), HOPD (4.6), and low value care (4.7) and are detailed below.

For all analyses reported as a rate of an event per 1,000 attributed commercial members (ED utilization and inpatient utilization), the final underlying data on the commercial member population reflection by provider organization is below.

Provider organization	2021 Attributed commercial adults
Acton	7,347
Atrius	85,088
Baystate	57,607
BILH	148,141
BMC	24,750
MGB	191,164
Reliant	25,730

Signature	8,146
South Shore	16,966
South Coast	11,589
Steward	81,486
UMass	51,104
Wellforce	77,209
Total	786,327

5 Analyses

5.1 Emergency Department Utilization

Emergency department (ED) visits were identified in the 2021 commercial medical claims using procedure codes (CPT) that indicate a professional service was delivered in the emergency department (99281-99285), and any outpatient facility claim lines using the Health Care Cost Institute's methodology, indicating that a claim line is from a facility claim originating from an ED.[1]

An ED encounter was established as an ED visit for the same member on the same date of service. Claims with a populated admitting diagnosis, indicating that an ED visit turned into a hospital admission, were excluded from subsequent analyses.

A predominant diagnosis across all relevant claim lines for each ED encounter was established by using the diagnosis code that was most commonly populated for each ED encounter. If there was a tie, a diagnosis that matched the "patched" Billings algorithm (see details below) to identify potentially avoidable ED visits was prioritized to ensure classification of the visit. If all or no diagnosis codes had a match with this algorithm, then a random selection was done to identify a single diagnosis code to represent all claim lines of the encounter.

Overall Emergency Department Utilization

Overall ED utilization is defined as the sum of all ED visits for all attributed members of a particular provider organization that are included in the study population defined in Section 3. The rate of overall ED utilization is reported as an adjusted rate of ED visits per 1,000 attributed patients for comparability across different provider organizations that vary in the size of their attributed patient populations and to control for patient characteristics that may vary across provider organizations. The adjusted rate is established through a multivariable regression analysis controlling for patient-level and community-level variables (see more below).

[1] For more information on Health Care Cost Institute's methodology to identify types of outpatient facility claims please see: https://healthcostinstitute.org/images/pdfs/HCCI_2018_Methodology_public_v1.pdf.

Potentially Avoidable Emergency Department Utilization

The Billings algorithm is based on work by the NYU Center for Health and Public Service Research. In Billings et al. (1993)[1], the researchers, along with a panel of ED and primary care physicians, develop the following classification for ED visits:

- Non-emergent: The patient's initial complaint, presenting symptoms, vital signs, medical history, and age indicated that immediate medical care was not required within 12 hours;
- Emergent/Primary Care Treatable: Based on information in the record, treatment was required within 12 hours, but care could have been provided effectively and safely in a primary care setting. The complaint did not require continuous observation, and no procedures were performed or resources used that are not available in a primary care setting (e.g., CAT scan or certain lab tests);
- Emergent - ED Care Needed - Preventable/Avoidable: Emergency department care was required based on the complaint or procedures performed/resources used, but the emergent nature of the condition was potentially preventable/avoidable if timely and effective ambulatory care had been received during the episode of illness (e.g., the flare-ups of asthma, diabetes, congestive heart failure, etc.); and
- Emergent - ED Care Needed - Not Preventable/Avoidable: Emergency department care was required and ambulatory care treatment could not have prevented the condition (e.g., trauma, appendicitis, myocardial infarction, etc.).

Potentially avoidable ED visits are based on the "patched" Billings algorithm, which updates the original crosswalk (ICD-9) to ICD-10 and accounts for any periodic coding changes. See Johnston et al. (2017) for more information.[2] To improve classification rate, diagnosis codes unclassified by the “patched” Billings algorithm were sequentially truncated and shortened codes were re-classified using the same algorithm.

For the purposes of reporting, the rate of potentially avoidable emergency department utilization is a weighted sum of the non-emergent and emergent/primary care treatable category values reported as a rate per 1,000 attributed patients adjusted for patient-level and community-level variables.

Mental Health-Related Emergency Department Utilization

Mental health-related ED utilization is defined as the sum of all mental health-related ED visits for all attributed members of a particular provider organization that are included in the study population defined in Section 3. Mental health-related ED utilization is reported as an adjusted rate of ED visits per 1,000 attributed patients for comparability across different provider organizations that vary in the size of their attributed patient populations and to control for patient characteristics that may vary across provider organizations. The adjusted rate is established through a multivariable regression analysis controlling for patient-level and community-level variables (see more below).

Mental health-related ED visits are identified using Clinical Classifications Software (CCS) diagnostic classifications for mental health based on the most frequently used primary diagnosis for an ED encounter.[2]

5.2 Unadjusted Medical Spending Per Member Per Year By Category And Provider Organization

In addition to restricting the patient population of analysis to commercially-insured adults who are at least 18 years old with continuous enrollment (12 months of insurance coverage) in the 14 largest provider organizations, a further exclusion was added for categorical spending analysis to ensure individuals had continuous prescription enrollment (12 months of prescription insurance coverage). This patient population distribution by provider organization is listed below. This was done to ensure that only those who were eligible and covered for prescription insurance were included in the calculations for categorical per member per year spending.

Provider organization	2021 Attributed commercially-insured adults
Acton	6,290
Atrius	63,045
Baystate	41,471
BILH	103,820
BMC	19,707
MGB	153,842
Reliant	22,248
Signature	6,035
South Shore	12,896
Southcoast	8,384
Steward	58,797
UMass	40,405
Wellforce	56,141
Total	593,081

To calculate per member per year spending for each of the five categories (inpatient, outpatient, professional, other, and prescription spending), total spending by provider organization was calculated for each category. Then the provider total for each category was divided by the number of individuals in each provider patient population.

2 Clinical Classifications Software Refined (CCSR)for ICD-10-CM Diagnoses. Healthcare Cost and Utilization Project (HCUP). February 2023. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/toolssoftware/ccsr/dxccsr.jsp

5.3 CT and MRI Utilization Measures

For an analysis of adjusted CT and MRI rates by provider organization attributed member groups, the HPC first restricted medical claims where the patient population of analysis was commercially-insured adults who are at least 18 years old with continuous enrollment (12 months of insurance coverage) at one of the fourteen largest provider organizations in the state. Then on a claim line level, all CT and MRI services were identified using the following codes from BETOS subcategory classifications.

CT: 74177 70450 71260 71250 74176 71275 70486 72125 70496 70491 70498 74178 73700 74174 72131 75574 73200 70480 74170 74160 72192 70487 72193 72128 75572 74175 75571 74150 70490 75635 73701 72132 70481 70470 70492 72129 70460 73201 71270 74261 73706 76380 73206 72126 0042T 75573 72191 72194 74262 70488 70482 76497 73702 G0288 72127 73202 72133 D0367 72275 72130 72295 0555T 0558T 0561T 0562T 72240 72255 72265 72270 72285 77078 G0297 Q9982 Q9983

MRI: 70553 73721 72148 73221 74183 70551 77049 72141 72197 70544 72156 72158 73718 72157 72146 70543 72195 73222 73720 74181 75561 70549 73722 73218 73220 73723 70547 73223 71552 71555 75565 70548 70546 77047 74185 74712 72142 71550 75557 77048 70336 70552 70540 72147 72198 72149 73725 70545 76498 74182 76391 70554 77084 75563 77046 72196 C8937 C8908 70542 72159 73719 70555 73219 73225 71551 74713 70559 C8911 C8902 C8906 0159T 70557 70558 75559 77058 77059 C8900 C8901 C8903 C8904 C8905 C8907 C8909 C8910 C8912 C8913 C8914 C8918 C8919 C8920 C8931 C8932 C8933 C8934 C8935 C8936

After identifying the claim line numbers, the HPC collapsed the analysis level from the claim line level to the encounter level, collapsing on the same unique member identifier, same date, and same procedure code. Then the results were collapsed to an individual level with the attributed members and adjusted for patient-level and community-level variables.

5.4 Average Imaging spending per attributed member per year by provider organization, 2021

To calculate per member per year spending for each of the four categories (MRI, CT, X-Ray, and Ultrasound) using BETOS classification codes, total spending calculated for each category by provider, then the provider total for each category was divided by the number of individuals in each provider patient population.

The X-Ray and Ultrasound services were identified using the following codes:

X-Ray: 77067 77063 71046 73630 71045 73030 92250 77065 77080 73610 73562 73130 73564 73502 G0279 72100 Q9967 73110 77066 73560 73140 74018 73080 72040 72050 72110 73590 71101 72170 74019 72070 92285 73565 58340 73660 73090 73000 70355 73060 91200 73620 76098 73523 74246 73552 73600 72202 73070 73522 74740 72220 73650 72072 74420 74230 73100 71100 74220 Q9966 76376 73120 72082 77081 72020 73503 73501 72052 92235 76377 74240 23350 73521 70220 77077 70360 77073 70030 38792 D0330 92611 91110 Q9965 76000 72114 27093 D0274 72190 73020 77085 70160 74022 36224 73010 36226 71111 72120 73040 92286 72200 51600 Q9957 73525 74270 72081 71120 70250 Q9968 74455 76080 77075 36247 70200 74430 92242 73050 70150 72080 74210 49424 74300 36227 74250 75710 74021 70330 70110 77071 75726 36223 25246 71110 75774 75820 Q0092 75625 70260 74450 77072 D0220 70210 71047 70350 37252 51610 72083 70320 75898 Q9956 72074 R0070 36245 36248 73551 36246 47531 75716 36005 71048 74485 72084 50431 73115 71130 D0272 75736 27369 62284 Q9960 36215 92614 92612 75893 36010 36598 49465 75825 D0210 36140 36225 75630 70140 75822 73615 Q9954 38790 70120 15860 27095 74400 75831 24220 70100 76499 Q9958 62304 20501 36251 70370 74280 36253 75705 36217 70300 73580 92240 Q9963 R0075 70328 75827 36200 75803 36228 36252 75889 74425 36216 75801 75870 36218 62305 75885 50430 50690 75743 75833 75891 76102 78265 73085 75860 77074 G0278 62290 62302 70190 70240 74190 75807 77053 91111 92613 47532 70130 75741 D0270 Q9961 19030 70310 75887 78266 92616 36221 62303 70170 70371 74251 75605 75842 76496 77054 77086 92230 92287 0126T 0174T 0355T 21116 27370 36100 36120 36160 36222 36254 38200 42550 50394 50684 51605 54230 55300 62291 68850 70010 70015 70134 70332 70373 70380 70390 71010 71015 71020 71021 71022 71023 71030 71034 71035 72010 72069 72090 73092 73500 73510 73520 73530 73540 73550 73592 74000 74010 74020 74235 74241 74245 74247 74249 74260 74290 74291 74301 74305 74320 74410 74415 74440 74445 74470 74475 74480 74710 74742 74775 75600 75658 75731 75733 75746 75756 75791 75805 75809 75810 75840 75872 75880 76001 76010 76100 76101 76120 76125 76977 77051 77052 77055 77056 77057 77076 77082 92615 92617 D0240 D0250 D0277 G0106 G0120 G0130 G0202 G0204 G0206 Q9951 Q9953 Q9955 Q9959 Q9962 Q9964

Ultrasound: 76830 76642 93306 76856 76816 76536 76819 76705 93971 76817 76700 76770 76801 51798 76813 76815 76811 76805 76870 76775 76882 76857 93975 93325 93970 76820 93880 92136 76514 93320 93351 93308 76831 93976 76641 76872 93321 93350 76827 76825 76512 76818 76821 76706 93923 93312 76604 93303 93922 76881 93926 93978 76981 93925 93924 76802 76519 76776 76828 93980 76812 93886 76814 C8929 76513 93313 93979 76826 93352 93882 93314 93892 93931 93307 93888 76810 93304 76516 93315 93930 C8930 37253 93317 76506 93981 76982 76510 93890 93355 C8928 93316 76800 76885 C8924 76511 93318 76873 93998 93893 76886 76978 C8923 0346T 0399T 0439T 0508T 37250 37251 75945 75946 76529 76645 76970 76979 76983 93895 93965 93982 C8921 C8922 C8925 C8926 C8927 C9457 C9744 G0389

Provider organization	2021 Attributed commercially-insured adults
Acton	6,290
Atrius	63,045
Baystate	41,471
BILH	103,820
BMC	19,707
MGB	153,842
Reliant	22,248
Signature	6,035
South Shore	12,896
Southcoast	8,384
Steward	58,797
UMass	40,405
Wellforce	56,141
Total	593,081

5.5 HOPD

The HPC conducted an analysis of Hospital Outpatient Department (HOPD) utilization by provider organization attributed patient groups. This analysis used a smaller patient population based on services received. The HPC selected 458 common professional and outpatient laboratory procedure codes that often took place at HOPD service locations. In order to be considered a "cross-over" procedure (procedures taking place in both the HOPD and office), at least 20% of all encounters had to take place in a HOPD and at least 20% of all encounters had to take place in an office. The 458 codes are the final numbers of relevant procedure codes.

HOPD procedure codes: 10005 10140 10160 11042 11043 11104 11105 11403 11404 11406 11420 11421 11422 11423 11441 11442 11981 12001 12034 12041 12042 12051 12052 13101 14040 14060 16020 17311 17312 17313 20552 20553 20606 20610 26055 27093 27096 29065 29075 29125 29130 29405 29515 29580 29581 31231 31237 31575 31579 36415 36475 37765 41010 46221 46600 51600 51700 51701 51720 51728 51729 51741 51784 51797 52000 52310 54235 55250 55700 56605 57452 57455 57456 57522 58100 58340 58555 58558 59025 59820 59841 62321 62323 64405 64450 64479 64483 64484 64490 64491 64492 64493 64494 64495 64612 64615 64616 64633 64634 64635 64636 64642 65855 66761 66821 67028 67145 67228 67840 69220 69801 70160 70220 70360 70544 70551 70553 71046 71100 71101 72040 72050 72052 72070 72072 72100 72110 72114 72141 72146 72148 72156 72157 72158 72170 72195 72202 72220 73000 73010 73020 73030 73060 73070 73080 73090 73100 73110 73120 73130 73140 73218 73221 73501 73502 73503 73521 73522 73523 73552 73560 73562 73564 73565 73590 73600 73610 73620 73630 73650 73660 73718 73720 73721 73722 74018 74019 74170 74176 74183 74740 76377 76512 76519 76536 76641 76700 76706 76770 76775 76801 76802

76805 76811 76813 76815 76816 76817 76818 76819 76820 76830 76856 76857 76870 76872 76881 76885 77002 77063 77067 77080 77081 77085 77417 78452 80050 80061 80307 81002 81015 82040 82043 82274 82310 82465 82565 82570 82670 82747 82947 82948 82962 83002 83013 83014 83036 83655 83718 83721 83921 84132 84144 84153 84270 84295 84436 84466 84681 84702 84703 85004 85014 85041 85379 85651 86308 86593 86663 86666 86703 86705 86708 86803 87081 87101 87147 87177 87209 87210 87255 87430 87480 87481 87491 87510 87511 87591 87625 87640 87660 87661 87798 87801 87808 88112 88175 88305 88312 88344 89055 89261 89310 89320 89322 90473 90670 90675 90716 90734 90746 90853 90970 91065 91110 91200 92025 92060 92134 92235 92285 92504 92522 92523 92524 92526 92537 92540 92550 92553 92555 92556 92557 92567 92579 92582 93225 93227 93228 93270 93272 93280 93282 93283 93284 93288 93294 93295 93296 93297 93298 93303 93306 93308 93320 93325 93351 93880 93922 93923 93925 93926 93970 93971 93978 94010 94060 94375 94621 94664 94729 94760 95018 95816 95874 95885 95886 95908 95909 95910 95911 95912 95913 95992 96112 96116 96372 96374 96401 97018 97113 97116 97161 97162 97163 97165 97166 97167 97168 97597 97760 97763 97802 97803 97804 98926 99204 99205 99211 99212 99215 99241 99242 99244 99245 99403 A9500 A9502 A9552 A9575 G0008 G0009 G0010 G0108 G0180 G0250 G0279 G0328 G0480 G0481 J0129 J0178 J0561 J0585 J0897 J1100 J1200 J1580 J1745 J1756 J1885 J2182 J2323 J2357 J2778 J2785 J2795 J2920 J2930 J3262 J3490 J7030 J7040 J7050 J9035 J9250 J9312 L1830 L3670 L3808 L3913 L4350 Q0091 Q9966 S0119 S9443 S9485 V5264

After establishing the 458 procedure codes, only encounters (same person, same day, same procedure) with those codes were kept for the analysis, and all other codes and individuals without any of those specific 458 procedure code encounters were removed from the analysis. The patient population size remaining for this analysis is listed in the table below.

Provider organization	2021 Attributed commercially-insured adults
Acton	7,347
Atrius	85,088
Baystate	57,607
BILH	148,141
BMC	24,750
MGB	191,164
Reliant	25,730
Signature	8,146
South Shore	16,966
Southcoast	11,589
Steward	81,486
UMass	51,104
Wellforce	77,209
Total	786,327

5.6 Low Value Care

Identifying a Low Value Service

The measures generally adhere to the following logic:

- Measure exclusions: Remove all claims for patients that have at the time of the procedure, or in their claims history, have had any diagnosis code for which the procedure in question may be indicated.

- Identify the eligible population (denominator): Use ICD-10 codes and/or CPT codes to capture all encounters. Encounters were defined as unique patient on a unique date.

- Identify low value care (LVC) service (numerator): Identify all encounters that include a claim for the procedure code that is of low value for the eligible population.

The HPC took a conservative approach in implementing the existing measures. For example, only the first screening identified in a patient's claim history was labeled as being low value. If that patient received more than one non-indicated screening test, all subsequent tests were considered monitoring, not screening, based on clinical opinion.

Analysis Timeframe

The HPC measured low value services that occurred in 2021 claims data. Claims from 2020 were included as a "look-back period" to determine whether members should be included in the eligible population. For example, if a patient received a hypothyroidism diagnosis in July 2020 and subsequently received a T3 test in August 2020 and March 2021, only the March 2019 T3 test was included in the calculation of low value use and spending for the purpose of reporting on LVC in 2021.

Low Value Care Spending

After identifying the low value encounters, the HPC calculated spending by only including spending on the specific claim line attached to the LVC service. Some claim amounts (e.g., $0) were determined to be not representative of the actual cost because these services were likely paid under a global payment, capitated encounter records, or secondary payments where another carrier covers a portion of the reimbursement. Claims with these amounts were counted in total spending by imputing the median spending for the specific procedure code in the eligible population.

As previously mentioned, these LVC spending estimates only include the 15 services that were used in the study and do not represent all low value services. Spending includes insurer and enrollee payments for covered medical services.

Spending on a PMPY basis for the last Chartpack exhibit was calculated by finding the total spending among the 15 LVC services and then divided by the attributed population for each provider organization. Unlike the medical spending and most of the other analyses, the only restrictions on this attributed population size by provider organization is that individuals are over 18 years of age and they are attributed to one of the largest 14 provider organizations in the state. There is no restriction on having 12 months of coverage for this analysis.

Measure Source and Specification for LVC

Screening		
T3 screening for patients with hypothyroidism	Schwartz AL, Jena AB, Zaslavsky AM, McWilliams JM. Analysis of Physician Variation in Provision of Low-Value Services. JAMA Intern Med. 2019 Jan 1;179(1):16-25.	**Eligible population:** CCW codes (ICD-10) for acquired hypothyroidism **Exclusions:** None **Numerator:** Total or free T3 test. CPT: 84480 84481
Stress testing for patients with an established diagnosis of ischemic heart disease or angina	Schwartz AL, Landon BE, Elshaug AG, Chernew ME, McWilliams JM. Measuring low-value care in Medicare. JAMA Intern Med. 2014 Jul;174(7):1067-76.	**Eligible population:** CCW codes (ICD-10) for ischemic heart disease **Exclusions:** None **Numerator:** Cardiac stress testing. CPT: 93015 93016 93017 93018 93350 93351 78451 78452 78453 78454 78460 78461 78464 78465 78472 78473 78481 78483 78491 78492
Vitamin D screening for patient without chronic conditions	Mafi JN, Russell K, Bortz BA, Dachary M, Hazel WA Jr, Fendrick AM. Low-Cost, High-Volume Health Services Contribute The Most To Unnecessary Health Spending. Health Aff (Millwood). 2017 Oct 1;36(10):1701-1704. Colla CH, Morden NE, Sequist TD, Schpero WL,	**Eligible population:** All patients **Exclusions:** Members who had 25-Ohvitamin D screening and diagnosis of chronic conditions within 1 year on or prior to the testing. ICD-10: E550 E559 E643 M83 N18 K7200 E8411 E8419 E848 E849 K50 K51 K520 Z9884 K7030 K740 K7460 K7469

	Rosenthal MB. Choosing wisely: prevalence and correlates of low-value health care services in the United States. J Gen Intern Med. 2015 Feb;30(2):221-8.	K743 K744 K745 E8351 E8352 E673 E678 Q780 Q782 M3210 M3390 M889 Z79891 Z79899 G737 L400 L401 L402 L403 L404 L4050 L4051 L4052 L4053 L4054 L4055 L4056 L4057 L4058 L4059 L408 L409 E210 E211 E212 E213 E214 E215 Z7951 Z7952 K900 K901 K902 K903 K904 K9089 K909 K7201 K762 K7031 K702 K741 K742 K7689 K760 K7581 K7291 K7211 K7041 K7111 K7290 K912 N251 E209 E200 E208 E892 M833 E840 E662 E672 E68 L419 L410 L411 L418 L413 L414 L415 L945 M899 M949 M859 M32 M33 M360 M88 M81 M80 Members who had 25-Ohvitamin D screening and diagnosis of risk factors within 90 days on or prior to the testing. ICD-10: D86 A15 A17 A18 A19 B39 B38 J63 C81 C82 C83 E440 E83 G40 C84 C85 C86 C96 C88 C91 Members who had 25-Ohvitamin D screening and diagnosis of pregnancy and obesity on the day of the testing. ICD-10: O02 O03 O69 O04 O07 Z33 O08 A34 O20 O44 O45 O46 O67 O10 O11 O13 O16 O14 O15 O21

		O90 O33 O30 O36 O09 O71 Z32 O68 O60 O23 O9A O31 O35 O76 O72 Z36 O77 O47 O99 O25 O32 O40 O62 O73 E66 O00 O48 O29 O34 O64 O41 O63 O74 Z68 O12 O98 O75 O66 O42 O43 O82 O01 O26 O24 O80 O65 O61 O70 Z34 P50 Members who had 25-Ohvitamin D screening and diagnosis of falls and non-traumatic fracture within 1 year on or prior to the testing. ICD-10: Z9181 Z87311 Z87310 Members who had 1, 25-(OH)2-vitamin D screening and diagnosis of inherited or acquired disorders of vitamin D and phosphate metabolism within 90 days on or prior to the testing. ICD-10: D86 A15 A17 A18 A19 B39 B38 J63 C81 C82 C83 E44 E83 C84 C85 C86 C96 C88 C91 M83 N18 **Numerator:** Vitamin D test. CPT: 82306 82652
Preoperative Testing		
Preoperative EKG, chest X-ray, and pulmonary function testing	Mafi JN, Russell K, Bortz BA, Dachary M, Hazel WA Jr, Fendrick AM. Low-Cost, High-Volume Health Services Contribute The Most To Unnecessary Health Spending. Health Aff (Millwood). 2017 Oct 1;36(10):1701-1704.	**Eligible population:** All members 2 years and older with a low-risk surgery. BETOS: P1 P3D P4A P4C P5C P5D P8A P8G CPT: 19120 19125 47562 47563 49560 58558 **Exclusions:** • Members with an evaluation and

		management visit for emergency care, observation, or urgent care on or within one day prior to the pre-operative testing. CPT: 99217 99218 99219 99220 99224 99225 99226 99281 99282 99283 99284 99285 • Members with pre-operative testing that is not 30 days prior to surgery. • Members with a diagnosis of cardiovascular risk factors within 90 days prior to pre-operative testing. ICD-10: Z136 • Members with signs and symptoms of cardiovascular and cardiopulmonary disease within 30 days prior to pre-operative testing. ICD-10: R071 R060 R002 • Members with a diagnosis of underlying pulmonary disease within 90 days prior to pre-operative testing. ICD-10: I26 I27 I28 **Numerator:** Pre-operative test. CPT: 71045 71046 71047 71048 71100 71101

		71111 71120 71130 93229 96417 96418 96419 96421
Baseline labs in patients without significant systemic disease undergoing low-risk surgery	Mafi JN, Russell K, Bortz BA, Dachary M, Hazel WA Jr, Fendrick AM. Low-Cost, High-Volume Health Services Contribute The Most To Unnecessary Health Spending. Health Aff (Millwood). 2017 Oct 1;36(10):1701-1704.	**Eligible population:** Patients without significant systemic disease undergoing low-risk surgery. BETOS: P1x P3D P4A P4B P4C P5C P5D P8A P8G. CPT: 19120 19125 47562 47563 49560 58558 **Exclusions:** All services where the low risk surgery falls on or 1 day after the E&M visit for emergency care, observation or urgent care visit. CPT: 99217 99219 99226 99284 99218 99220 99281 99285 99224 99282 99225 99283 5160 4590 7620 9810 4500 4520 All electrolyte testing laboratory related services. CPT: 82374 82435 80051 82435 80047 80053 84132 80048 84295 80050 All services with a diagnosis of endocrine, liver or renal disorders. ICD-10: E08 E09 E10 E11 E13 E16 E20 E21 E22 E23 E24 E25 E26 E27 E28 E29 E30 E31 E32 E34 E35 E89 K70 K71 K72 K73 K74 K75 K76 K77 K80 K81 K82 K83 K87 K91 M3214 M3215 M3504 N00 N01

		N02 N03 N04 N05 N06 N07 N08 N11 N14 N15 N16 N17 N18 N19 N25 N26 N27 CBC testing related services and a diagnosis of anemia or history suggestive of recent blood loss in the last 6 months prior to the CBC testing. CPT: 85014 85018 G0306 85025 G0307 85027 85032. ICD-10: C966 D5* D6* D71* D72* D73* D74* D75* D761 D762 D763 I8501 I880 I881 I882 I883 I884 I885 I886 I887 I888 I889 K270 K272 K920 K921 K922 R58 Z832 Coagulation testing related services in those with a diagnosis of coagulation disorders up to 2 years prior to the coagulation testing event or on anticoagulant medications 3 months prior to the coagulation testing. CPT: 85002 85611 85049 85730 85055 85732 85610. ICD-10: D65-D69.9 **Numerator:** Laboratory tests. CPT: 80047 80048 80050 80051 80053 81000 81001 81002 81003 81005 81007 81020 81050 81099 82040 82247 82310 82330 82374 82435 82565 82947 82948 82950 82953 84075 84132 84155 84295 84450 84460 85002 85014 85018 85025 85027 85032 85049 85055 85610 85611 85730

		85732 95250 95251 G0306 G0307
Procedures		
Outpatient epidural, facet, or trigger point injections for lower back pain	Schwartz AL, Jena AB, Zaslavsky AM, McWilliams JM. Analysis of Physician Variation in Provision of Low-Value Services. JAMA Intern Med. 2019 Jan 1;179(1):16-25.	**Eligible population:** Patients with low back pain. ICD-10: M47817 M47819 M5126 M519 M5136 M5134 M961 M961 M4647 M4800 M4806 M4806 M545 M5489 M4327 M533 M532X8 M533 M4300 M9983 M9903 M9904 Q762 S338XXA S336XXA S338XXA S338XXA S338XXA S339XXA S335XXA M5127 M5137 M5135 M5186 M549 M4328 M4310 M9984 M5136 M5187 M532X7 M5137 M533 I256 I25700 I25701 I25708 I25709 I25710 I25711 I25718 I25719 I25720 I25721 I25728 I25729 I25730 I25731 I25738 I25739 I25750 I25751 I25758 I25759 I25760 I25761 I25768 I25769 I25790 I25791 I25798 I25799 I25810 I25811 I25812 I2582 I2583 I2584 I2589 I259 I2101 I2102 I2109 I2111 I2119 I2121 I2129 I213 I214 I219 I21A1 I21A9 I220 I221 I222 I228 I229

		Exclusions: Patients with radicular back pain. ICD-10: M4716 M4710 M519 M5106 M5430 M5414 M5107 M5415 M5416 M5417 J1438 **Numerator:** Spinal injections. CPT: 62311 64483 20552 20553 64493 64475
Imaging		
DEXA Screening for Osteoporosis	Mafi JN, Reid RO, Baseman LH, et al. Trends in low-value health service use and spending in the US Medicare fee-for-service program, 2014-2018. JAMA Netw Open. 2021;4(2):e2037328. doi:10.1001/jamanetworkopen.2020.37328	**Eligible population:** All women under 65 years of age and men 50-69 DEXA CPT: 77080, 77081, 77085, 77086 **Exclusions:** • Patients with a diagnosis of osteoporosis on the day of the DEXA or a far back in the claims (as possible) before the DEXA screening. • Osteoporosis ICD-10 diagnosis codes starting with: M80, M81, M83, M84, or M85. • Competing diagnosis or risk factor diagnosis before the DEXA scan as far as possible in the claims. o Diagnosis codes starting with: o Vertebral compression: M485 o Maladaptive syndrome diagnosis: K90

		○ rheumatoid arthritis diagnosis: M05 and M06 ○ Hyperthyroidism: E05 **Numerator**: Those who had a DEXA screening with an office visit 30 days prior to the DEXA screening
Brain Imaging Studies (CT or MRI) for Simple Syncope	Mafi JN, Reid RO, Baseman LH, et al. Trends in low-value health service use and spending in the US Medicare fee-for-service program, 2014-2018. JAMA Netw Open. 2021;4(2):e2037328. doi:10.1001/jamanetworkopen.2020.37328	**Eligible population:** All individuals 18 or older a diagnosis of syncope. • CT scan procedure codes: 70450 70460 70470. • MRI procedure codes: 70551 70552 70553 70554 70555 70557 70558 70559. • Syncope diagnosis codes starting with: "R55". **Exclusions:** • An inpatient admission within the time period from the diagnosis of syncope to the brain imaging. Inpatient site of service codes: 21 31 51 61. • A competing diagnosis (CVA, intracranial hemorrhage, brain tumors, etc.) ○ Intracranial Hemorrhage:

		diagnosis code starting with I62 ○ Stroke: diagnosis codes starting with I63 G459 I693 Z8673 • Head and neck tumor diagnosis within 1 year prior to imaging ○ Tumor diagnosis codes starting with: C71 D330 D331 D332 D333 C760 D234 D233 D3611 • Head injury withing 7 days prior to imaging ○ Diagnostic code starting with S0 • Members with a neurological deficit ○ Diagnosis codes starting with R298 R299 **Numerator**: Those with a brain imaging study (CT or MRI) within 30 days of the syncope diagnosis
Back Pain Imaging	Mafi JN, Reid RO, Baseman LH, et al. Trends in low-value health service use and spending in the US Medicare fee-for-service program, 2014-2018. JAMA Netw Open. 2021;4(2):e2037328. doi:10.1001/jamanetworkopen.2020.37328	**Eligible population:** All members 18+ years old with a low back pain diagnosis. ICD-10: M545 **Exclusions:** • Members with a diagnosis of low back pain within 180 days prior to imaging. CPT: 72020 72040 72050 72052 72070 72072 72074 7280

		72081 72082 72083 72084 72100 72110 72114 72120 72125 72126 72127 72128 72129 72130 72131 72132 72133 72141 72142 72146 72147 72148 72149 72156 72157 72158 72159 • Members with lumbar spine surgery within 90 days prior to imaging. CPT: All codes in the range 62263 and 63746 • Members with an inpatient admission within 6 weeks prior to imaging. ICD-10: non-missing admitting diagnosis • Members with a back MRI with neurological deficits diagnosis. ICD-10: R298 R299 CPT: 72148 72149 72156 72157 72158 • Members with a MRI and diagnosis of some other serious underlying conditions such as cancer or immunosuppression. ICD-10: All codes in the range C00 and C96 D8 Z796 • Members with a diagnosis requiring imaging within 90

		days of MRI (e.g., osteoporosis, trauma or infection, drug abuse). ICD-10: M81 M82 M83 M84 M85 S3 F1 • Members aged 70+ with a back X-ray/CT lumbar spine without MRI. CPT: 72100 72110 72114 72120 72131 72132 72133 • Members with an X-ray/CT lumbar spine without MRI and long-term steroid use. ICD-10: Z795 **Numerator**: Members with back imaging within 6 weeks prior to the back pain diagnosis
Heel Pain Imaging	Do LA, Koethe BC, Daly AT, Chambers JD, Ollendorf DA, Wong JB, et al. State-level variation in low-value care for commercially insured and Medicare Advantage populations. Health Aff (Millwood). 2022;41(9).	**Eligible population:** All members 18+ years old with a heel pain diagnosis. ICD-10: M25571 M25572 M25579 M722 M7967 **Exclusions:** • Members with a diagnosis of heel pain within 180 days prior to imaging. CPT: 73620 73630 73650 73718 73719 73720 76880 • Members with an inpatient admission within 6 weeks prior to imaging. ICD-10: non-missing admitting diagnosis

		• Members with a foot MRI with neurological deficits diagnosis. ICD-10: R298 R299 CPT: 73718 73719 73720 • Members with a MRI and diagnosis of some other serious underlying conditions such as cancer or immunosuppression. ICD-10: All codes in the range C00 and C96 D8 Z796 • Members with a diagnosis requiring imaging within 90 days of MRI (e.g., osteoporosis, trauma or infection, drug abuse). ICD-10: M81 M82 M83 M84 M85 S3 F1 • Members aged 70+ with a foot X-ray/CT without MRI. CPT: 73620 73630 73650 76881 • Members with an X-ray/CT without MRI and long-term steroid use. ICD-10: Z795 **Numerator**: Members with foot imaging within 6 weeks prior to the heel pain diagnosis
Prescription		

Antibiotics for Upper Respiratory Infection and Ear Infection (acute otitis externa)	Mafi JN, Reid RO, Baseman LH, et al. Trends in low-value health service use and spending in the US Medicare fee-for-service program, 2014-2018. JAMA Netw Open. 2021;4(2):e2037328. doi:10.1001/jamanetworkopen.2020.37328	**Eligible Population**: Patients with upper respiratory or ear infection. Diagnosis codes beginning with the following indicated the condition. Viral infections: - Cold: "J00" - Acute sinusitis: "J01" - URI: "J06" - Flu: "J09-J011" - Viral pneumonia: "J12" - RSV: "B974" - Parainfluenza: "B348" - Adenovirus: "B340" - Coronavirus: "B342" - Enterovirus: "B341", "B9719" - Viral bronchitis: "J203-J207" - Viral bronchiolitis: "J210-J211" - Metapneumonia: "B9781" - Acute otitis externa: "H60" Bacterial infections: - Infectious and parasitic infections: "B95", "B96", "A", excluding stomach "A08", nervous system "A8", and fevers "A9" - Mastoiditis: "H70" - Strep: "J020", "J0300", "J0301", "J13" - Abscess: "J36, J85, L02, J390, L03" **Denominator Exclusions:** - HIV: "B20", immunocompromised conditions, and Malignant neoplasms: "C, D0-D4,

		D8" up to a year beforehand - Tympanostomy up to two years beforehand: "69631, 69632, 69635, 69636, 69637, 69641, 69642, 69644, 69643, 69645, 69646" - Bacterial infections 30 days before antibiotic prescriptions - Middle ear infections: "H65, H66, H67" 14 days before antibiotics **Numerator exclusions**: - Middle ear disease: "H65-H70" AND acute otitis "H605" externa within 30 days prior to the antibiotics prescription. - Malignant otitis externa "H602" 30 days prior to antibiotics prescription - Acute rhinosinusitis and sinusitis complications within 10 days prior: orbital complications "H05", intracranial complications "G93, I62", neurological deficit "R298, R299, H558", periorbital and orbital cellulitis and orbital abscess "L03213, H0501", and subperiosteal abscess "H7001" **Numerator**: all antibiotics prescribed within a 7-day interval to the original URI or otitis media diagnosis

Concurrent Antipsychotics	Mafi JN, Reid RO, Baseman LH, et al. Trends in low-value health service use and spending in the US Medicare fee-for-service program, 2014-2018. JAMA Netw Open. 2021;4(2):e2037328. doi:10.1001/jamanetworkopen.2020.37328	**Starting population**: all patients with an antipsychotic prescription **Exclusions**: A lithium prescription within 60 days prior to an antipsychotic prescription. Concurrent antipsychotics with an overlap of 30 days or fewer between prescriptions. **Numerator**: All other concurrent, overlapping antipsychotics
Concurrent Anticholinergics	Garber, Judith. Lown Institute. How to identify low-value prescribing practices. February 28, 2022. https://lowninstitute.org/how-to-identify-low-value-prescribing-practices/	**Starting population**: all patients with an anticholinergic prescription **Exclusions**: Concurrent anticholinergic with an overlap of 30 days or fewer between prescriptions. Two concurrent anticholinergics that are also BOTH antipsychotics. **Numerator**: All other concurrent, overlapping anticholinergics.
Chronic Benzodiazepines	Luijendijk, Hendrika J., Henning Tiemeier, Albert Hofman, Jan Heeringa, and Bruno H. Ch Stricker. "Determinants of chronic benzodiazepine use in the elderly: a longitudinal study." *British journal of clinical pharmacology* 65, no. 4 (2008): 593-599.	**Starting population**: All patients with a benzodiazepine prescription. **Exclusions**: Those with less than a 180 days supply in a year

		Numerator: All other users with a greater than 180 day supply in a year period
Gabapentinoids for Non-Neuropathic Pain	Garber, Judith. Lown Institute. How to identify low-value prescribing practices. February 28, 2022. https://lowninstitute.org/how-to-identify-low-value-prescribing-practices/	**Starting population**: All patients with a gabapentinoid prescription. **Exclusions**: Those with epilepsy "G40" or neuropathic pain: "G539, G546, E084, E08610, E094, E09610, E104, E114, E134, M471, M472, M480, M500, M501, M502, M510, M511, M512, M541, M543, M544, M5481, S14, S24, S34, G50, G51, S045, B022, G60, G9009, M792, G905, G56, G57, M146, G58, G59, G62, G63, A5043, A5215, B2701, B2711, B2781, B2791, B2684, G54, G55, E71522, G130, G652, G651, G462, H463, H4701, M3483, G379, G990, G61, M055." **Numerator**: All other prescriptions

6 Control variables

Adjusted rates are reported for all exhibits in this chart pack except for those pertaining to LVC (section 4.4). Adjusted rates take into account the potential differences across provider organizations in patient health status, age, sex, patient insurance type, and insurer type. Patient health status is based on risk score information processed by software called The Johns Hopkins ACG® System © 1990, 2017, Johns Hopkins University. All Rights Reserved.

In addition to these variables, the HPC linked community-level variables at the member zip code level, based on CHIA analysis of the 2019 American Community Survey. These variables include:

- Median family income
- Median home value
- Percent of employed persons ages 16 and over in white collar occupations
- Percent of households with dependents under age 18 headed by single parents
- Whether or not the population ages 25 and over with at least a high school education is over 80%
- Percent of population receiving food stamps/SNAP
- Percent of population who have lived in the same house in the past 12 months
- Percent of population ages 16 and over who are unemployed

A multivariable regression model was used to calculate adjusted rates. For each analysis, all independent variables were means-centered and reported adjusted rates were scaled per 1,000 attributed measures.

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[1] Billings, J., Zeitel, L., Lukomnik, J., Carey, T. S., Blank, A. E., & Newman, L. (1993). Impact of socioeconomic status on hospital use in New York City. *Health affairs*, *12*(1), 162-173.
[2] Johnston, K. J., Allen, L., Melanson, T. A., & Pitts, S. R. (2017). A "Patch" to the NYU emergency department visit algorithm. *Health services research*, *52*(4), 1264-1276.