

1 **SUPPLEMENTAL MATERIAL**

2 Supplemental Table 1. ICD9 and ICD10 Codes

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A. Codes used to define hospitalizations with mitral valve interventions

Mitral Valve **ICD9 Procedure Codes**

Replacement 3523, 3524

ICD10 Procedure Codes

02RG08Z, 02RG0KZ, 02RG38Z, 02RG3KZ, 02RG48Z, 02RG4KZ,
02RG0JZ, 02RG3JZ, 02RG4JZ

Mitral Valve **ICD9 Procedure Codes**

Repair 3512, 3533

ICD10 Procedure Codes

02QG0ZZ, 02QG3ZZ, 02QG4ZZ, 027G04Z, 027G0DZ, 027G0ZZ,
027G34Z, 027G3DZ, 027G3ZZ, 027G44Z, 027G4DZ, 027G4ZZ,
02NG0ZZ, 02NG3ZZ, 02NG4ZZ, 02VG0ZZ, 02VG3ZZ, 02VG4ZZ,
02UG0JZ, 02UG4JZ

MitraClip **ICD9 Procedure Codes**

3597

ICD10 Procedure Codes

02UG3JZ

A. Codes used to define mitral valve etiology

Rheumatic Heart Disease ICD9 Diagnosis Codes
394, 3940, 3941, 3942, 3949, 396, 3960, 3961, 3962, 3963, 3968, 3969,
3940, 3942, 3960, 3961

ICD10 Diagnosis Codes
I051, I052, I058, I059, I080, I081, I083, I088, I089

Endocarditis (exclusion criteria) ICD9 Diagnosis Codes
421, 4210, 4211, 4219, 4249, 42490, 42491, 42499, 11281, 07422

ICD10 Diagnosis Codes
I330, I39, I339, I38, B376, B3321

Mitral Regurgitation ICD9 Diagnosis Codes
3941, 3942, 3949, 3962, 3963, 3968, 4240, 7466

ICD10 Diagnosis Codes
I051, I052, I080, I081, I083, I088, I340, Q233

Mitral Stenosis (exclusion criteria) ICD9 Diagnosis Codes
3940, 3960, 3961, 7465

ICD10 Diagnosis Codes
I050, I342, Q232

B. Codes used to define concomitant procedures

CABG

ICD9 Procedure Codes

4148, 3610, 3611, 3612, 3613, 3614, 3615, 3616, 3617, 3619, 0066,
1755, 3601, 3602, 3603, 3604, 3605, 3606, 3607, 3608, 3609

ICD10 Procedure Codes

0212083, 0212088, 0212089, 021208C, 021208F, 021208W, 0212093,
0212098, 0212099, 021209C, 021209F, 021209W, 02120A3, 02120A8,
02120A9, 02120AC, 02120AF, 02120AW, 02120J3, 02120J8, 02120J9,
02120JC, 02120JF, 02120JW, 02120K3, 02120K8, 02120K9, 02120KC,
02120KF, 02120KW, 02120Z3, 02120Z8, 02120Z9, 02120ZC,
02120ZF, 0213083, 0213088, 0213089, 021308C, 021308F, 021308W,
0213093, 0213098, 0213099, 021309C, 021309F, 021309W, 02130A3,
02130A8, 02130A9, 02130AC, 02130AF, 02130AW, 02130J3, 02130J8,
02130J9, 02130JC, 02130JF, 02130JW, 02130K3, 02130K8, 02130K9,
02130KC, 02130KF, 02130KW, 02130Z3, 02130Z8, 02130Z9,
02130ZC, 02130ZF, 0211083, 0211088, 0211089, 021108C, 021108F,
021108W, 0211089, 0211098, 0211099, 021109C, 021109F, 021109W,
02110A3, 02110A8, 02110A9, 02110AC, 02110AF, 02110AW,
02110J3, 02110J8, 02110J9, 02110JC, 02110JF, 02110JW, 02110K3,
02110K8, 02110K9, 02110KC, 02110KF, 02110KW, 02110Z3,
02110Z8, 02110Z9, 02110ZC, 02110ZF, 0210083, 0210088, 0210089,

021008C, 021008F, 021008W, 0210093, 0210098, 0210099, 021009C,
021009F, 021009W, 02100A3, 02100A8, 02100A9, 02100AC,
02100AF, 02100AW, 02100J3, 02100J8, 02100J9, 02100JC, 02100JF,
02100JW, 02100K3, 02100K8, 02100K9, 02100KC, 02100KF,
02100KW, 02100Z3, 02100Z8, 02100Z9, 02100ZC, 02100ZF, 0212344,
02123D4, 0212444, 0212483, 0212488, 0212489, 021248C, 021248F,
021248W, 0212493, 0212498, 0212499, 021249C, 021249F, 021249W,
02124A3, 02124A8, 02124A9, 02124AC, 02124AF, 02124AW,
02124J3, 02124J8, 02124J9, 02124JC, 02124JF, 02124JW, 02124K3,
02124K8, 02124K9, 02124KC, 02124KF, 02124KW, 02124Z3,
02124Z8, 02124Z9, 02124ZC, 02124ZF, 0213344, 02133D4, 0213444,
0213483, 0213488, 0213489, 021348C, 021348F, 021348W, 0213493,
0213498, 0213499, 021349C, 021349F, 021349W, 02134A3, 02134A8,
02134A9, 02134AC, 02134AF, 02134AW, 02134D4, 02134J3, 02134J8,
02134J9, 02134JC, 02134JF, 02134JW, 02134K3, 02134K8, 02134K9,
02134KC, 02134KF, 02134KW, 02134Z3, 02134Z8, 02134Z9,
02134ZC, 02134ZF, 0211344, 02113D4, 0211444, 0211483, 0211488,
0211489, 021148C, 021148F, 021148W, 0211493, 0211498, 0211499,
021149C, 021149F, 021149W, 02114A3, 02114A8, 02114A9,
02114AC, 02114AF, 02114AW, 02114D4, 02114J3, 02114J8, 02114J9,
02114JC, 02114JF, 02114JW, 02114K3, 02114K8, 02114K9, 02114KC,
02114KF, 02114KW, 02114Z3, 02114Z8, 02114Z9, 02114ZC,

02114ZF, 0210344, 02103D4, 0210444, 0210483, 0210488, 0210489,
021048C, 021048F, 021048W, 0210493, 0210498, 0210499, 021049C,
021049F, 021049W, 02104A3, 02104A8, 02104A9, 02104AC,
02104AF, 02104AW, 02104D4, 02104J3, 02104J3, 02104J8, 02104J9,
02104JC, 02104JF, 02104JW, 02104K3, 02104K3, 02104K8, 02104K9,
02104KC, 02104KF, 02104KW, 02104Z3, 02104Z8, 02104Z9,
02104ZC, 02104ZF

Aortic Valve
Replacement

ICD9 Procedure Codes
3521, 3522, 3505, 3506

ICD10 Procedure Codes

02RF0, 02RF07, 02RF07Z, 02RF08, 02RF08Z, 02RF0J, 02RF0JZ,
02RF0K, 02RF0KZ, 02RF3, 02RF37, 02RF37H, 02RF37Z, 02RF38,
02RF38H, 02RF38Z, 02RF3J, 02RF3JH, 02RF3JZ, 02RF3K, 02RF3KH,
02RF3KZ, 02RF4, 02RF47, 02RF47Z, 02RF48, 02RF48Z, 02RF4J,
02RF4JZ, 02RF4K, 02RF4KZ

Tricuspid Valve
Replacement

ICD9 Procedure Codes
3527, 3528

ICD10 Procedure Codes

02RJ07Z, 02RJ08Z, 02RJ0JZ, 02RJ0KZ

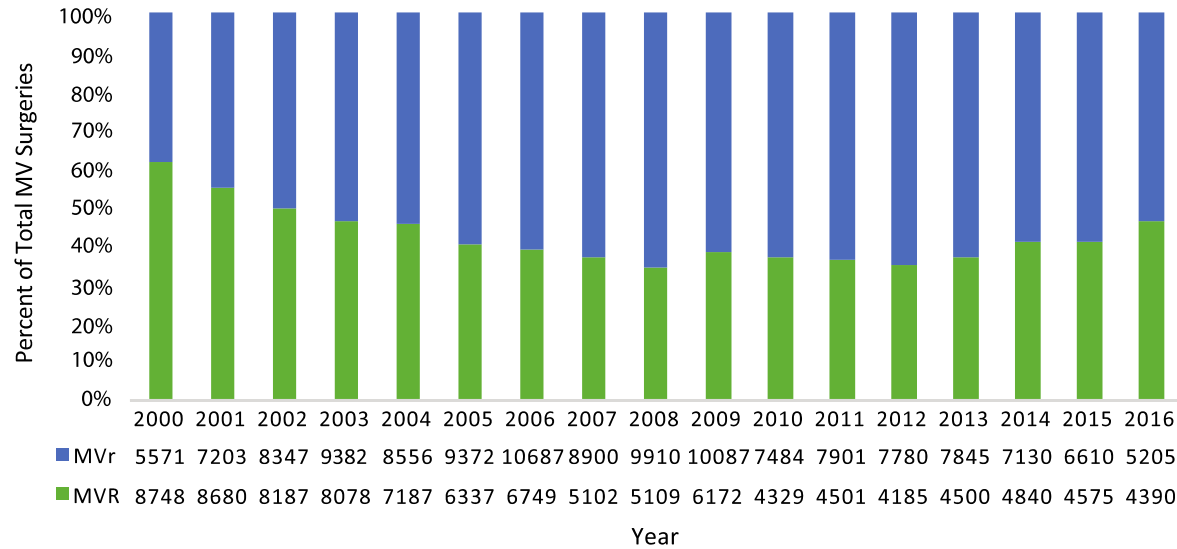
Procedures on the	ICD9 Procedure Codes
Aorta	3804, 3814, 3834, 3844, 3845, 3864

ICD10 Procedure Codes

025W, 025W0, 025W0Z, 025W0ZZ, 025W3, 025W3Z, 025W3ZZ,
025W4, 025W4Z, 025W4ZZ, 025X, 025X0, 025X0Z, 025X0ZZ, 025X3,
025X3Z, 025X3ZZ, 025X4, 025X4Z, 025X4ZZ, 027W, 027W0,
027W04, 027W04Z, 027W0D, 027W0DZ, 027W0Z, 027W0ZZ, 027W3,
027W34, 027W34Z, 027W3D, 027W3DZ, 027W3Z, 027W3ZZ, 027W4,
027W44, 027W44Z, 027W4D, 027W4DZ, 027W4Z, 027W4ZZ, 027X,
027X0, 027X04, 027X04Z, 027X0D, 027X0DZ, 027X0Z, 027X0ZZ,
027X3, 027X34, 027X34Z, 027X3D, 027X3DZ, 027X3Z, 027X3ZZ,
027X4, 027X44, 027X44Z, 027X4D, 027X4DZ, 027X4Z, 027X4ZZ,
02BW, 02BW0, 02BW0Z, 02BW0ZX, 02BW0ZZ, 02BW3, 02BW3Z,
02BW3ZX, 02BW3ZZ, 02BW4, 02BW4Z, 02BW4ZX, 02BW4ZZ,
02BX, 02BX0, 02BX0Z, 02BX0ZX, 02BX0ZZ, 02BX3, 02BX3Z,
02BX3ZX, 02BX3ZZ, 02BX4, 02BX4Z, 02BX4ZX, 02BX4ZZ, 02CW,
02CW0, 02CW0Z, 02CW0ZZ, 02CW3, 02CW3Z, 02CW3ZZ, 02CW4,
02CW4Z, 02CW4ZZ, 02CX, 02CX0, 02CX0Z, 02CX0ZZ, 02CX3,
02CX3Z, 02CX3ZZ, 02CX4, 02CX4Z, 02CX4ZZ, 02QW, 02QW0,
02QW0Z, 02QW0ZZ, 02QW3, 02QW3Z, 02QW3ZZ, 02QW4,
02QW4Z, 02QW4ZZ, 02QX, 02QX0, 02QX0Z, 02QX0ZZ, 02QX3,

02QX3Z, 02QX3ZZ, 02QX4, 02QX4Z, 02QX4ZZ, 02RW, 02RW0,
02RW07, 02RW07Z, 02RW08, 02RW08Z, 02RW0JZ, 02RW0K,
02RW0KZ, 02RW4, 02RW47, 02RW47Z, 02RW48, 02RW48Z,
02RW4J, 02RW4JZ, 02RW4K, 02RW4KZ, 02RX, 02RX0, 02RX07,
02RX07Z, 02RX08, 02RX08Z, 02RX0J, 02RX0JZ, 02RX0K,
02RX0KZ, 02RX4, 02RX47, 02RX47Z, 02RX48, 02RX48Z, 02RX4J,
02RX4JZ, 02RX4K, 02RX4KZ, 02UW, 02UW0, 02UW07, 02UW07Z,
02UW08, 02UW08Z, 02UW0JZ, 02UW0K, 02UW0KZ, 02UW3,
02UW3, 02UW37Z, 02UW38, 02UW38Z, 02UW3J, 02UW3JZ,
02UW3K, 02UW3KZ, 02UW4, 02UW47, 02UW47Z, 02UW48,
02UW48Z, 02UW4J, 02UW4JZ, 02UW4K, 02UW4KZ, 02UX, 02UX0,
02UX07, 02UX07Z, 02UX08, 02UX08Z, 02UX0J, 02UX0JZ, 02UX0K,
02UX0KZ, 02UX3, 02UX37, 02UX37Z, 02UX38, 02UX38Z, 02UX3J,
02UX3JZ, 02UX3K, 02UX3KZ, 02UX4, 02UX47, 02UX47Z, 02UX48,
02UX48Z, 02UX4J, 02UX4JZ, 02UX4K, 02UX4KZ'

6 **Supplemental Figure 1.** Distribution of Mitral Valve Interventions from 2000-2016 in Patients with Concomitant CABG



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8 MVR as a proportion of total MV surgeries with concomitant CABG decreased an average 6.6% per year from 2000-2008 (P<0.001),
9 but after 2008 it increased an average 2.9% per year (P=0.004). MVr increased from 2000-2007 (APC=13.8 from 2000-2002, P=0.03;
10 APC=4.8 from 2003-2007, P=0.01), after which it decreased but not reaching statistical significance (APC=-0.1 from 2008-2013,
11 P=0.9; APC=-4.8 from 2014-2016, P=0.1).
12 MVR = mitral valve replacement; MVr = mitral valve repair; CABG = coronary artery bypass surgery

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22 **Supplemental Table 2.** Confirmatory Analysis of Trends in In-hospital Mortality by Mitral Valve Intervention. Odds ratios were
 23 estimated by fitting multilevel regression model for complex survey data and adjusting for patient age, gender, type of admission and
 24 comorbidities.
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	Odds Ratio	95 % CL
MVR	0.95	0.95-0.96
MV Repair	0.93	0.92-0.94
MitraClip	0.82	0.56-1.19
Isolated MVR	0.92	0.90-0.94
Isolated MV Repair	0.94	0.93-0.94
Any Mitral Intervention	0.94	0.93-0.94

26 We observed the decrease in the odds of in-hospital mortality for mitral valve interventions by 6 percent per years from 2000 to 2016.
 27 Similar trends were observed for isolated mitral valve repair and for isolated mitral valve replacement.
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32 **Supplemental Table 3.** Regional Variation in Trends and Usage of Mitral Valve Procedures
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	Northeast	Midwest	South	West	P-value (between regions)
Isolated MVR					
APC	-2.2**	-0.7 ⁺	-6.8***	-1.3*	<0.001
Rate, %	43	40	44	41	<0.001
Isolated MVr					
APC	3.4***	5.1**	3.0***	3.2***	<0.001
Rate, %	49	51	45	45	<0.001
Isolated MitraClip					
APC	79.5*	80.2*	81.7*	88.7*	0.15
Rate, %	8	9	10	14	<0.001

34 *** P<0.001, ** P<0.01, *P<0.5, + P≥0.5 for trends within regions

35 Rate by interventions for each region is shown for 2016

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37 Significant regional variations exist in the usage of mitral valve interventions. All regions had an increase in the prevalence of MVR,
38 the greatest occurring in the Midwest; while all but the Midwest had a decrease in the prevalence of MVR (Supplemental Table 3).
39 Mitraclip showed substantial growth in all regions, but the proportion of MitraClip interventions was still a relatively small percentage
40 of all MV procedures in 2016 (8% in Northeast and 14% of Midwest).

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