Predictors of difference in reimbursement rate between Maryland All Payer Model and Medicare Severity-Diagnosis Related Group model in Adult Spine Deformity Surgery

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INTRODUCTION: Maryland All Payer Model (MAPM) has been shown to provide higher hospital reimbursements compared to the Medicare Severity-Diagnosis Related Group (MS-DRG) model in adult spine deformity (ASD) Surgery. This study seeks to identify the variables that lead to differences between the two reimbursement models and to determine whether the MAPM more accurately accounts for case complexity, inpatient complications, and length of stay (LOS) compared to the MS-DRG system

METHODS: ASD patients undergoing surgical correction enrolled in a prospective multicenter study were analyzed. MS-DRG reimbursements were calculated using the Centers for Medicare & Medicaid Services (CMS) Pricer tool, while MAPM reimbursements were obtained from a single institution in the state of Maryland**.** Two separate regression models were developed to compare the predictiveness of operative factors for reimbursement under the two models. To identify which predictors, lead to differences in reimbursement between the two models, a third regression model incorporating interaction terms between model type and each predictor was constructed.

RESULTS: A total of 638 patients were identified. 552 patients were in MS-DRG group while 86 patients were in the MAPM group. Patients under the MAPM model had a higher median (IQR) reimbursement $112,444 (98,000-125,448) compared to the MS-DRG model patients $59,230(49,317-70,032) (p=<0.0001). MS-DRG model explained 28.83% of the variance in reimbursement (Adjusted R^2 = 0.2698). In contrast, the Maryland All-Payer Model accounted for 51.62% of the variance (Adjusted R^2 = 0.4288). The interaction terms model identified that Bone Morphogenic Protein (BMP) use(p=0.037), Demineralized Bone Matrix (DBM) use(p=0.028), LOS (p<0.0001) and number of screws(p=0.003) significantly increased reimbursement under the MAPM model compared to the MS-DRG while complications requiring moderate interventions significantly decreased reimbursement under the MAPM model(p=0.001).

DISCUSSION AND CONCLUSION: Surgical complexity, inpatient complications and LOS explained a greater portion of reimbursement under the MAPM. Key factors such as BMP, DBM, LOS, and number of screws as predictors of increased reimbursements under MAPM compared to the MS-DRG system. Additionally, complications requiring moderate interventions were associated with reduced reimbursements under MAPM. MAPM accounts for surgical complexity more accurately than the MS-DRG model.

Table 1: Demographics

Variable	MS-DRG (n=552)	MAPM (n=86)	P-value
Age (years)	49.01 ± 15.17	42.51 ± 14.37	0.1521
Edmonton Frailty score	3.06 ± 2.40	3.19 ± 2.06	0.6436
BMI (kg/m²)	27.41 ± 5.62	28.70 ± 5.49	**0.0175**
Variable	**MS-DRG (n=552)**	**MAPM (n=86)**	**P-value**
Gender	Male : 169 (30.65%)	Male : 28 (32.56%)	0.717
	Female : 383 (69.38%)	Female : 58 (67.44%)	
Revision Surgery	No : 340 (61.59%)	No : 32 (37.21%)	**<0.0001**
	Yes : 212 (38.41%)	Yes : 54 (62.79%)	

Values are expressed as the mean ± SD, or as the count, with the percentage in parentheses. MS-DRG = Medicare Severity-Diagnosis Related Group; MAPM = Maryland All-Payer Model; BMI = Body Mass Index

Table 2: Operative Variables

Variable	MS-DRG (n=552)	MAPM (n=86)	P-value
Number of Levels Fused	12.26 ± 4.04	11.93 ± 4.41	0.532
EBL (ml)	1345.85 ± 1054.42	1508.44 ± 927.50	**0.0014**
Operative Time (minutes)	409.11 ± 152.83	473.18 ± 89.10	**0.0004**
Length of Stay (days)	7.45 ± 5.21	7.67 ± 3.38	0.1864
Number of screws	20.02 ± 28.51	18.18 ± 21	**0.0383**
Surgical ICU Stay (days)	2.21 ± 3.16	1.79 ± 1.81	**0.0484**
Variable	**MS-DRG (n=552)**	**MAPM (n=86)**	**P-value**
Three Column Osteotomy = No	484 (78.99%)	64 (69.44%)	**0.017**
Three Column Osteotomy = Yes	128 (21.01%)	28 (32.54%)	
Interbody Fusion =No	200 (36.13%)	34 (39.53%)	0.534
Interbody Fusion =Yes	352 (63.57%)	52 (60.47%)	
Allograft use =No	82 (15.84%)	82 (95.32%)	**<0.001**
Allograft use =Yes	469 (84.60%)	4 (4.65%)	
BMP use =No	137 (24.82%)	8 (9.30%)	**<0.001**
BMP use =Yes	415 (75.18%)	80 (93.02%)	
DBM use =No	421 (74.64%)	3 (3.16%)	**<0.001**
DBM use =Yes	143 (25.36%)	92 (96.84%)	

Values are expressed as the mean ± SD, or as the count, with the percentage in parentheses. MS-DRG = Medicare Severity-Diagnosis Related Group; MAPM = Maryland All-Payer Model; BMP = Bone Morphogenetic Protein; DBM = Demineralized bone matrix.

Table 3: Multivariate linear regression models of reimbursement under MS-DRG and MAPM

Variable	MS-DRG Coefficient (Std. Err.)	MS-DRG P-Value	MAPM Coefficient (Std. Err.)	MAPM P-Value
Age (years)	1.0 (0.1) [0.9 - 1.1]	0.9	1.0 (0.1) [0.9 - 1.1]	0.9
Medicaid	-4107.11 (2775.44)	0.138	2976.28 (1872.81)	0.024
Mother's compensation	-4108.20 (8750.18)	0.639		
Allograft use	2317.55 (1278.7)	0.021	12410.88 (8783.94)	0.089
BMP use	-2692.87 (1608.68)	**0.023**	11178.83 (8231.81)	0.179
DBM use	-1000.42 (1000.42)	0.319	14000.12 (9000.12)	0.119
Complications requiring moderate intervention	8782.18 (2865.47)	**0.002**	-10054.71 (7204.22)	0.123
Complications requiring severe intervention	7865.78 (3182.14)	**0.014**	6325.08 (1380.38)	0.777
Operative Time	0.75 (0.38)	**0.045**	38.81 (48.48)	0.48
Length of Stay	441.77 (135.81)	**0.001**	2894.78 (585.62)	**<0.0001**
Number of screws	1785.08 (608.81)	**0.002**	3514.36 (1487.05)	**<0.0001**
Three column osteotomy	5526.86 (1897.75)	**0.004**	2892.20 (1487.05)	0.124
Surgical ICU Stay	1555.37 (1031.51)	**0.014**	-3108.31 (1887.18)	0.098
Source	**MS-DRG**	**MAPM**		
Adjusted R^2	0.2698	0.4288		
Variance Explained	28.83%	51.62%		

Std. Err. = standard error; MS-DRG = Medicare Severity-Diagnosis Related Group; MAPM = Maryland All-Payer Model; BMP = Bone Morphogenetic Protein; DBM = Demineralized bone matrix; R^2 = coefficient of determination

Table 4: Multivariate linear regression model of reimbursement with interaction terms

Variable	Coefficient	P-Value	95% Confidence Interval
Medicaid Group	-4108.20	0.121	[-9134.23 - 1145.18]
Medicaid	-4107.11	0.138	[-9514.11 - 1299.89]
BMP use	-4310.88	**0.007**	[-7497.74 - -1124.02]
DBM use	-1727.80	**0.002**	[-4100.873 - -1024.24]
Complications requiring moderate intervention	8782.18	**0.002**	[3206.166 - 14358.2]
Complications requiring severe intervention	8092.42	**0.001**	[3206.166 - 14978.67]
Interaction with Allograft use (MAPM)	11500.06	0.17	[-4868.445 - 17868.44]
Interaction with BMP use (MAPM)	16002.11	**0.037**	[1031.8867 - 31129.33]
Interaction with DBM use (MAPM)	12330.90	**0.038**	[-3012.706 - 28705.05]
Interaction with Complications requiring moderate intervention (MAPM)	-10054.71	**0.001**	[-16000.19 - -4109.23]
Interaction with Complications requiring severe intervention (MAPM)	-2022.66	0.471	[-10010.51 - 5965.85]
Operative Time	41.09	**0.033**	[4.040543 - 10.0245]
Length of Stay	1181.71	**0.002**	[-1181.0105 - 3581.531]
Number of screws	1881.87	**<0.0003**	[-1881.782 - 5763.027]
Three column osteotomy	2892.20	0.124	[-1487.05 - 6271.45]
Surgical ICU Stay	3108.31	0.098	[-1887.18 - 7103.82]
Interaction with Operative Time (MAPM)	11.71	0.707	[-0.80008 - 69.14988]
Interaction with Length of Stay (MAPM)	2317.55	**<0.0001**	[1005.851 - 3630.313]
Interaction with Number of screws (MAPM)	1731.88	**0.003**	[-631.7485 - 5730.539]
Interaction with Three Column Osteotomy (MAPM)	2892.20	0.124	[-1487.05 - 6271.45]
Interaction with Surgical ICU Stay (MAPM)	-3012.31	0.07	[-6242.141 - 1007.12]

MAPM = Maryland All-Payer Model; BMP = Bone Morphogenetic Protein; DBM = Demineralized bone matrix.