How to Make Ends Meet: A Risk Assessment for Pseudarthrosis and Cost-Benefit Analysis of BMP-2 in Adult Spinal Deformity Surgery

Tyler Kade Williamson, Peter Gust Passias[1], Djani Robertson, Jamshaid Mir, Pooja R Dave, Peter Sergeyevich Tretiakov[2], Stephane Owusu-Sarpong[2], Jordan Lebovic[3], Shaleen Vira[4]
[1]NY Spine Institute / NYU Medical Center-Hjd, [2]NYU Langone Orthopedic Hospital, [3]NYU Orthopedics, [4]University of Texas Southwestern Medical Center

INTRODUCTION:
Bone Morphogenetic Protein-2 (BMP-2) has not shown superior benefit in terms of overall cost-effectiveness after implementation during adult spinal deformity (ASD) surgery. However, it has yet to be determined whether certain patient populations obtain cost-utility from use of BMP-2. The purpose of this study is to generate a score to determine usage of BMP-2 and correlate with rates of pseudarthrosis.
METHODS:
ASD patients with BL and 2-year(2Y) data included. BMP-2 kit size and cost: small – 4.2 mg ($21,800), medium – 8.4 mg ($23,667), large – 12 mg ($25,617). Published methods converted ODI to SF-6D. QALYs utilized a 3% discount rate for residual decline. Cost was calculated using a national insurance database and assessed for Complications and Comorbidities and Major Complications and Comorbidities according to CMS.gov definitions. Binary logistic regression analyses determined significant predictors for development of pseudarthrosis. Established weights were generated for predictive variables via back-step logistic regression for a risk score to predict development of pseudarthrosis. Risk score was then validated via Receiver Operating Characteristic (ROC) curve method analysis. Categories via conditional inference tree (CIT) analysis-derived thresholds were tested for cost-utility of BMP-2 usage. Marginalized means for utility gained and Cost per QALY were calculated within each risk score category, controlling for age, history of prior fusion, and baseline deformity and disability.
RESULTS:
Included: 387 ASD patients. Of 387, 64% received BMP-2 (1% small, 4% medium, 59% large). There were 17 (4.4%) of patients that developed pseudarthrosis by two years, 9 (2.3%) of which underwent reoperation. BMP-2 use, regardless of kit size, did not significantly lower pseudarthrosis rates overall (OR: 0.4, [0.2-1.04]). A predictive risk score for development of pseudarthrosis was formed by the following preoperative variables: age, frailty, history of diabetes, osteoporosis, depression, ASA grade, and baseline L4-S1 and T1PA. Via ROC method, this predictive risk score generated an AUC of 0.87. Following CIT machine learning, thresholds for the BMP Risk Score were derived: >5 No Risk (NoR), 3-5 Low Risk (LowR), 2-3 Moderate Risk (ModR), and <2 High Risk (HighR). The rates of pseudarthrosis for each category were: NoR – 0%; LowR - 1.6%; ModR – 9.3%; HighR – 24.3%. When assessing BMP-2 use and its cost-utility within each group, patients receiving BMP-2 had similar QALYs to those that did not receive BMP-2 (0.163 vs. 0.171, p=.65). BMP-2 usage had significantly worse cost-utility in both NoR and LowR cohorts (both p<.05). In ModR patients, BMP-2 usage had equivocal cost-utility ($680,532.35 vs. $580,380.21, p=.14). In the HighR cohort, the cost-utility difference narrowed even further (BMP-2 use: $743,155.21 vs. $719,628.79, p=.82).
DISCUSSION AND CONCLUSION:
Our study shows BMP-2 has equivocal cost-utility within those at moderate and high risk for developing pseudarthrosis within two years following spinal deformity correction. The generated predictive score can better aid spine surgeons assess risk and enhance justification for the use of BMP-2 during surgical intervention for adult spinal deformity.

Table 3. Cost-Utility of BMP-2 Usage within Pseudarthrosis Risk Categories

Cost-Utility Metric	No BMP-2 Use	BMP-2 Use	p-value
Low-Risk			
Utility Gained	0.088	0.084	.653
Cost	$95,296.07	$116,875.99	.001
Cost per QALY	$561,227.24	$716,126.92	<.001
Moderate-Risk			
Utility Gained	0.088	0.084	.653
Cost	$98,825.02	$110,955.97	.284
Cost per QALY	$580,380.21	$680,532.35	.140
High-Risk			
Utility Gained	0.088	0.084	.653
Cost	$122,917.53	$121,166.18	.917
Cost per QALY	$719,628.79	$743,155.21	.816