

**Cost Analysis of Magnetically Controlled Growing Rods Compared with Traditional  
Growing Rods for Early Onset Scoliosis in the United States: An Integrated Healthcare  
Delivery System Perspective**

**TECHNICAL APPENDIX**

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**Costing Analysis of Procedures**

The unit costs used to estimate the total costs to the US integrated healthcare delivery system are provided in this appendix, including all DRG, CPT and APC costs, as well as x-ray, intraoperative neurophysiological monitoring, and anesthesia. The cumulative costs presented in Figure 1 of the main manuscript are calculated based on total costs in Table 3 of the main manuscript plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript. Because bundled DRG payments include the TGR device cost, for MCGR hospital inpatient procedures, the TGR device costs were subtracted from the DRG payment and the MCGR device costs were added to account for the difference in device cost.

The x-ray payment amount includes both the facility (\$90.89) and provider (\$24.00) components for CPT code 72010 (X-ray spine, entire, survey, anteroposterior and lateral, routine).

Intraoperative neurophysiological monitoring CPT 95940 (Continuous intraoperative neurophysiology monitoring in the operating room, one on one monitoring requiring personal attendance) was assumed for 90% of all invasive procedures, as per clinical advice. The national provider payment amount for intraoperative neurophysiological monitoring was \$32.60 for each 15 minutes. In the model, we assume 125 minutes in total is required for each invasive procedure, as per the multi-center EOS database.<sup>1</sup> The facility component for intraoperative neurophysiological monitoring is reflected in the bundled payment amount for the surgery.

We have assumed the same duration for anesthesia (125 minutes) as for intraoperative neurophysiological monitoring. The anesthesia provider fee amount (physician payment) was calculated as the sum of the base units and time units multiplied by a conversion factor (CF), where the payer mix (private insurance/Medicaid) was used to derive a weighted cost of \$45.25 (private insurance: \$67.94; Medicaid: \$22.6765).<sup>2,3</sup> The calculation reflected 10 base units for anesthesia code 00620 (Procedures on thoracic spine and cord; not otherwise specified) and 8.33 15-minute time units, assuming the patient was under anesthesia for 125 minutes.<sup>4</sup> A sensitivity analysis was performed assuming 13 base units. The facility component for anesthesia is reflected in the bundled payment amount for the surgery.

For TGR lengthening (Table A-2), the model incorporated the unlisted miscellaneous surgery code 22899, whereby the reinsertion code 22849 (\$1,336.19) was the reference procedure and was valued at 50% of the payment amount (\$668.10) given that the TGR procedure is a

lengthening and not a reinsertion. Reference procedure and payment percent was determined by a Growing Spine Study Group (GSSG) meeting consensus (Newport Beach, CA, January 19, 2006). This group of pediatric spine surgeons agreed that using this code was the most logical alternative to trying to create a new CPT for a procedure that has low volume.

For MCGR lengthening (which takes 5 to 10 minutes), the model incorporated the unlisted code 22899, indicating that the CPT code 95971 (electronic analysis [reprogramming] of implanted neurostimulator pulse generator system) was the reference procedure and was valued at \$60.90 in the physician office (Table A-2). The reference procedure was determined by clinical advisors and a certified spinal coder. Of note, there is no facility component for MCGR lengthenings performed in the physician office.

**Table A- 1** Insertion<sup>a</sup>

<b>TGR Insertion</b>	<b>Unit Cost (2015 USD) (sensitivity analysis)</b>
Arthrodesis, posterior, for spinal deformity, up to 6 vertebral segments (CPT code 22800)	\$1,393
Posterior segmental instrumentation, 3 to 6 vertebral segments (CPT code +22842)	\$787
Spinal Fusion Except Cervical W Spinal Curvature/Malignancy/Infection Or 9+ Fusions WO CC/MCC (DRG 458)	\$31,241
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>b</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)

<b>Calculated Cost to Hospital<sup>c</sup></b>	<b>\$34,555</b>
<b>MCGR Insertion</b>	
Arthrodesis, posterior, for spinal deformity, up to 6 vertebral segments (CPT code 22800)	\$1,393
Posterior segmental instrumentation, 3 to 6 vertebral segments (CPT code +22842)	\$787
Spinal Fusion Except Cervical W Spinal Curvature/Malignancy/Infection Or 9+ Fusions WO CC/MCC (DRG 458)	\$31,241
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring <sup>b</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Cost to Hospital<sup>c</sup></b>	<b>\$64,579</b>

**Notes:** <sup>a</sup>The cumulative costs presented in Figure 1 of the main manuscript are calculated based on the total costs in Table 3 (which have been derived from the unit costs presented in tables in this Technical Appendix) plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript.

<sup>b</sup>Intraoperative neurophysiological monitoring assumed in 90% of cases.

<sup>c</sup>Device cost included and reported in Table A- 8.

**Abbreviations:** CPT, current procedural terminology; DRG, diagnosis-related group; MCGR, magnetically controlled growing rod; TGR, traditional growing rod; USD, United States Dollars; WO CC/MCC, without complications/comorbidities or major complications/comorbidities.

**Table A- 2 Lengthening<sup>a</sup>**

<b>TGR Lengthening Outpatient</b>	<b>Unit Cost (2015 USD) (sensitivity analysis)</b>
Unlisted CPT code 22899 <sup>b</sup>	\$668
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Surgery APC 0050 (facility)	\$2,576

Intraoperative neurophysiological monitoring (CPT code 95940) <sup>c</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Sub-Total Cost</b>	<b>\$4,378</b>
<b>TGR Lengthening Inpatient Short Stay</b>	
Unlisted CPT code 22899 <sup>b</sup>	\$668
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Surgery APC 0050 (facility)	\$2,576
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>c</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Sub-Total Cost</b>	<b>\$4,378</b>
<b>TGR Lengthening Inpatient Standard Ward</b>	
Unlisted CPT code 22899 <sup>b</sup>	\$668
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,201
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>c</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Sub-Total Cost</b>	<b>\$12,003</b>
<b>TGR Lengthening Inpatient ICU</b>	
Unlisted CPT code 22899 <sup>b</sup>	\$668
Pediatric intensivist (CPT 99253)	\$116
Other Musculoskeletal System and Connective Tissue OR Procedure W CC (DRG 516)	\$12,259
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT	\$115

code 72010)	
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>c</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Sub-Total Cost</b>	<b>\$14,177</b>
<b>Weighted Total Cost of TGR Lengthening</b>	<b>\$6,327</b>
<b>MCGR Lengthening Physician Office</b>	
Unlisted CPT code 22899 <sup>d</sup>	\$61
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
<b>Calculated Total Cost</b>	<b>\$176</b>

**Notes:** <sup>a</sup>The cumulative costs presented in Figure 1 of the main manuscript are calculated based on the total costs in Table 3 (which have been derived from the unit costs presented in tables in this Technical Appendix) plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript.

<sup>b</sup> Reinsertion code 22849 (\$1,336.19) as the reference procedure valued at 50%.

<sup>c</sup>Intraoperative neurophysiological monitoring assumed in 90% of cases.

<sup>d</sup>CPT code 95971 (electronic analysis [reprogramming] of implanted neurostimulator pulse generator system) as the reference procedure.

**Abbreviations:** APC, ambulatory payment classification; CPT, current procedural terminology; DRG, diagnosis-related group; ICU, intensive care unit; MCGR, magnetically controlled growing rod; TGR, traditional growing rod; USD, United States Dollars; W CC, with complications or comorbidities; WO CC/MCC, without complications/comorbidities or major complications/comorbidities.

**Table A- 3 Exchange<sup>a</sup>**

<b>TGR Exchange</b>	<b>Unit Cost (2015 USD) (sensitivity analysis)</b>
Reinsertion of spinal fixation device (CPT code 22849)	\$1,336
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,201
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>b</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>c</sup></b>	<b>\$12,672</b>
<b>MCGR Exchange</b>	
Reinsertion of spinal fixation device (CPT code 22849)	\$1,336
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,202
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>b</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>c</sup></b>	<b>\$42,696</b>

**Notes:** <sup>a</sup>The cumulative costs presented in Figure 1 of the main manuscript are calculated based on the total costs in Table 3 (which have been derived from the unit costs presented in tables in this Technical Appendix) plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript.

<sup>b</sup>Intraoperative neurophysiological monitoring assumed in 90% of cases.

<sup>c</sup>Device cost included and reported in Table A- 8.

**Abbreviations:** CPT, current procedural terminology; DRG, diagnosis-related group; MCGR, magnetically controlled growing rod; TGR, traditional growing rod; USD, United States Dollars; WO CC/MCC, without complications/comorbidities or major complications/comorbidities.

**Table A- 4** Complete Revision<sup>a</sup>

<b>TGR Complete Revision</b>	<b>Unit Cost (2015 USD) (sensitivity analysis)</b>
Reinsertion of spinal fixation device (CPT code 22849)	\$1,336
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,201
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>b</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>c</sup></b>	<b>\$12,672</b>
<b>MCGR Complete Revision</b>	
Reinsertion of spinal fixation device (CPT code 22849)	\$1,336
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,201
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>b</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>c</sup></b>	<b>\$42,696</b>

**Notes:** <sup>a</sup>The cumulative costs presented in Figure 1 of the main manuscript are calculated based on the total costs in Table 3 (which have been derived from the unit costs presented in tables in this Technical Appendix) plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript.

<sup>b</sup>Intraoperative neurophysiological monitoring assumed in 90% of cases.

<sup>c</sup>Device cost included and reported in Table A- 8.

**Abbreviations:** CPT, current procedural terminology; DRG, diagnosis-related group; MCGR, magnetically controlled growing rod; TGR, traditional growing rod; USD, United States Dollars; WO CC/MCC, without complications/comorbidities or major complications/comorbidities.

**Table A- 5** Partial Revision<sup>a</sup>

<b>TGR Partial Revision</b>	<b>Unit Cost (2015 USD) (sensitivity analysis)</b>
Reinsertion of spinal fixation device (CPT code 22849)	\$1,336
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,201
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>b</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>c</sup></b>	<b>\$11,475</b>
<b>MCGR Partial Revision</b>	
Reinsertion of spinal fixation device (CPT code 22849)	\$1,336
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,201
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>b</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>c</sup></b>	<b>\$41,500</b>

**Notes:** <sup>a</sup>The cumulative costs presented in Figure 1 of the main manuscript are calculated based on the total costs in Table 3 (which have been derived from the unit costs presented in tables in this Technical Appendix) plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript.

<sup>b</sup>Intraoperative neurophysiological monitoring assumed in 90% of cases.

<sup>c</sup>Device cost included and reported in Table A- 8.

**Abbreviations:** CPT, current procedural terminology; DRG, diagnosis-related group; MCGR, magnetically controlled growing rod; TGR, traditional growing rod; USD, United States Dollars; WO CC/MCC, without complications/comorbidities or major complications/comorbidities.

**Table A- 6 Deep Infection<sup>a</sup>**

<b>TGR Deep Infection</b>	<b>Unit Cost (2015 USD) (sensitivity analysis)</b>
Reinsertion of spinal fixation device (CPT Code 22849)	\$1,336
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,202
IV Clindamycin 4 weeks	\$0.00 <sup>b</sup>
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>c</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>d</sup></b>	<b>\$12,672</b>
<b>MCGR Deep Infection<sup>d</sup></b>	
Reinsertion of spinal fixation device (CPT Code 22849)	\$1,336
Other musculoskeletal system and connective tissue or procedure WO CC/MCC (DRG 517)	\$10,202
IV Clindamycin 4 weeks	\$0.00 <sup>b</sup>
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940) <sup>c</sup>	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>d</sup></b>	<b>\$43,557</b>

**Notes:** <sup>a</sup>The cumulative costs presented in Figure 1 of the main manuscript are calculated based on the total costs in Table 3 (which have been derived from the unit costs presented in tables in this Technical Appendix) plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript.

<sup>b</sup>Reflected in DRG 517 (\$224).

<sup>c</sup>Intraoperative neurophysiological monitoring assumed in 90% of cases.

<sup>d</sup>Device cost included and reported in Table A- 8.

**Abbreviations:** CPT, current procedural terminology; DRG, diagnosis-related group; IV, intravenous; MCGR, magnetically controlled growing rod; TGR, traditional growing rod; USD, United States Dollars; WO CC/MCC, without complications/comorbidities or major complications/comorbidities.

**Table A- 7 Removal and Final Fusion<sup>a</sup>**

<b>TGR Removal and Final Fusion</b>	<b>Unit Cost (2015 USD) (sensitivity analysis)</b>
Arthrodesis, posterior, for spinal deformity, up to 6 vertebral segments (CPT code 22800) (weight = 5%)	\$1,393
Arthrodesis, posterior, for spinal deformity, 7 to 12 vertebral segments (CPT code 22802) (weight = 75%)	\$2,154
Arthrodesis, posterior, for spinal deformity, 13 or more vertebral segments (CPT code 22804) (weight = 20%)	\$2,479
Posterior segmental instrumentation, 3 to 6 vertebral segments (CPT code +22842) (weight = 5%)	\$787
Posterior segmental instrumentation, 7 to 12 vertebral segments (CPT code +22843) (weight = 75%)	\$837
Posterior segmental instrumentation, 13 or more vertebral segments (CPT code +22844) (weight = 20%)	\$1,007
Osteotomy of spine, posterior or posterolateral approach, 1 vertebral segment, thoracic (CPT code 22212) (weight = 50%)	\$1,508
Osteotomy of spine, posterior or posterolateral approach, 1 vertebral segment, lumbar (CPT code 22214) (weight = 50%)	\$1,519
Osteotomy of spine, posterior or posterolateral approach, each additional vertebral segment (CPT code +22216) (weight = 200%)	\$374
Spinal Fusion Except Cervical W Spinal Curvature/Malignancy/Infection or 9+ Fusions WO CC/MCC (DRG 458) (weight = 24%)	\$31,241
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code	\$115

72010)	
Intraoperative neurophysiological monitoring (CPT code 95940)	\$272
Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>b</sup></b>	<b>\$35,967</b>
<b>MCGR Removal and Final Fusion</b>	
Arthrodesis, posterior, for spinal deformity, up to 6 vertebral segments (CPT code 22800) (weight = 5%)	\$1,393
Arthrodesis, posterior, for spinal deformity, 7 to 12 vertebral segments (CPT code 22802) (weight = 75%)	\$2,154
Arthrodesis, posterior, for spinal deformity, 13 or more vertebral segments (CPT code 22804) (weight = 20%)	\$2,479
Posterior segmental instrumentation, 3 to 6 vertebral segments (CPT code +22842) (weight = 5%)	\$787
Posterior segmental instrumentation, 7 to 12 vertebral segments (CPT code +22843) (weight = 75%)	\$837
Posterior segmental instrumentation, 13 or more vertebral segments (CPT code +22844) (weight = 20%)	\$1,007
Osteotomy of spine, posterior or posterolateral approach, 1 vertebral segment, thoracic (CPT code 22212) (weight = 50%)	\$1,508
Osteotomy of spine, posterior or posterolateral approach, 1 vertebral segment, lumbar (CPT code 22214) (weight = 50%)	\$1,519
Osteotomy of spine, posterior or posterolateral approach, each additional vertebral segment (CPT code +22216) (weight = 200%)	\$374
Spinal Fusion Except Cervical W Spinal Curvature/Malignancy/Infection Or 9+ Fusions WO CC/MCC (DRG 458) (weight = 24%)	\$31,241
X-ray spine, entire, survey, anteroposterior and lateral, routine (CPT code 72010)	\$115
Intraoperative neurophysiological monitoring (CPT code 95940)	\$272

## Magnetic vs. Traditional Growing Rod Cost Analysis

Anesthesia code 00620	\$774 (\$774–901)
<b>Calculated Total Cost<sup>b</sup></b>	<b>\$35,967</b>

**Note:** <sup>a</sup>The cumulative costs presented in Figure 1 of the main manuscript are calculated based on the total costs in Table 3 (which have been derived from the unit costs presented in tables in this Technical Appendix) plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript.

<sup>b</sup>Device cost included and reported in Table A- 8.

**Abbreviations:** CPT, current procedural terminology; DRG, diagnosis-related group; MCGR, magnetically controlled growing rod; TGR, traditional growing rod; USD, United States Dollars; WO CC/MCC, without complications/comorbidities or major complications/comorbidities.

**Table A- 8 TGR and MCGR Device Costs<sup>a</sup>**

<b>TGR Device</b>	<b>Unit Cost (2015 USD) (sensitivity analysis)</b>
Single Rod	\$750 (\$563–1,125)
Dual Rod	\$1,500
Single Pedicle Screw/Hook	\$7,804
Dual Pedicle Screw/Hook	\$10,405
Single Rod Set Screw	\$1,314
Dual Rod Set Screw	\$1,752
Wedding Band	\$625
Tandem Connector	\$1,250
Cross Link	\$650
<b>MCGR Device</b>	
Single Rod	\$17,500 (\$13,125–21,875)
Dual Rod	\$35,000
Single Pedicle Screw/Hook	\$7,804
Dual Pedicle Screw/Hook	\$10,405
Single Rod Set Screw	\$1,314
Dual Rod Set Screw	\$1,752
Cross Link	\$650

**Note:** <sup>a</sup>The cumulative costs presented in Figure 1 of the main manuscript are calculated based on the total costs in Table 3 (which have been derived from the unit costs presented in tables in this Technical Appendix) plus several model parameters, for instance, the clinical parameters and medical resource use percentages shown in Table 1 and Table 2 of the main manuscript.

**Abbreviations:** MCGR, magnetically controlled growing rod; TGR, traditional growing rod; USD, United States Dollars.

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