A Quality Improvement Program to Reduce Unnecessary Referrals for Adolescent Scoliosis

abstract

OBJECTIVE: Adolescent idiopathic scoliosis (AIS) is a relatively common reason for referral to orthopedic surgery, but most referred patients do not require bracing or surgery. We developed a quality improvement (QI) program within the Pediatric Physicians’ Organization at Children’s, an independent practice association affiliated with Boston Children’s Hospital, to reduce unnecessary specialty referrals for AIS.

METHODS: The QI program consisted of physician education, decision support tools available at the point of care, and longitudinal feedback of data on physician referrals for AIS. Referral patterns in the 2-year postintervention period were tracked and compared with those of the 2-year preintervention period. Clinical characteristics of referred patients were compared through claims analysis and chart review.

RESULTS: Initial visits to orthopedic surgery for AIS declined from 5.1 to 4.1 per 1000 adolescents per year, a reduction of 20.4% (P = .01). Process control chart analysis showed a rapid change in referral patterns after the initiation of the program which was sustained over the 2-year postintervention period and demonstrated that 66 initial and 131 total AIS specialty visits were avoided as a result of the program.

CONCLUSIONS: A QI program consisting of physician education, decision support available at the point of care, and longitudinal data feedback led to a sustained reduction in unnecessary referrals for AIS. This program can serve as a model for other programs that seek to shift the locus of care from specialists to primary care providers. Pediatrics 2013;131:e912–e920

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KEY WORDS scoliosis, quality improvement

ABBREVIATIONS

AIS—adolescent idiopathic scoliosis
CPT—Current Procedural Terminology
CUSUM—cumulative sum
PCP—primary care provider
PPOC—Pediatric Physicians’ Organization at Children's
QI—quality improvement

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Adolescent idiopathic scoliosis (AIS), defined as a lateral curvature of the spine of >10° with no pathologic cause identified, is a common condition affecting 1% to 3% of adolescents.1−5 In an analysis of referral patterns within the Pediatric Physicians’ Organization at Children’s (PPOC), an independent practice association affiliated with Boston Children’s Hospital, we found scoliosis to be a common reason for referral to orthopedic surgery, accounting for 6.5% of all referrals to that specialty.6 Yet, evidence of the need for referral to orthopedic surgery, accounting for 6.5% of all referrals to that specialty, is lacking. In natural history studies, only a small proportion of curves <20° progress significantly.7 And although the effectiveness of bracing for moderate and severe curves is hotly debated,8 it is generally not recommended for adolescents with idiopathic curves <25°.9 Consistent with these data, we found within our own network that <5% of patients referred to orthopedic surgery for AIS were treated with bracing and <1% underwent surgery. Based on our baseline data, we reasoned that primary care providers (PCPs), armed with appropriate training, could successfully manage substantially more AIS cases in the primary care setting. Thus, we designed a quality improvement (QI) program to reduce unnecessary referrals to orthopedic surgery for AIS and planned to measure 3 relevant outcomes before and after our intervention: (1) the rates of new and total visits to orthopedic surgery for AIS; (2) the proportion of children seen by orthopedic surgery for AIS treated with bracing and surgery within 30 days and within 6 months after the initial visit; and (3) the clinical characteristics of a newly referred AIS patient.

METHODS
The PPOC is an independent practice association of 72 privately owned pediatric practices affiliated with Boston Children’s Hospital that cares for an estimated 300,000 children in eastern Massachusetts. The PPOC, in conjunction with the Department of Orthopedic Surgery at Boston Children’s Hospital, developed a program to assist PCPs in managing AIS in the primary care setting. The program consisted of 3 principal elements: (1) physician education; (2) educational and decision support tools; and (3) longitudinal data reports informing physicians of their AIS referral patterns in comparison with their peers. Educational and decision support materials consisted of a decision support algorithm for the appropriate management of AIS in the primary care setting and reasons for referral to specialist (Fig 1), a clinician fact sheet, and a patient/parent informational handout. These materials were embedded in the network’s electronic medical record and could be readily accessed at the point of care. An in-person didactic educational session was conducted at the outset of the program; a recording of the session was available for clinicians who were unable to attend the live session. A follow-up didactic session was offered by recorded webinar 1 year into the program. Data reports were sent to each PPOC practice at the beginning of the program and ∼1 year later which included each physician’s and practice’s AIS referral rates compared with their peers and a listing of each AIS patient referred.

To evaluate the program, we planned 3 complimentary types of analysis: (1) a traditional pre- and postintervention analysis of the rates of new and total visits to orthopedic surgery for AIS and the rates of bracing and surgery among children 10 to 18 years of age by using medical claims data; (2) a process control chart analysis of visit rates by the use of medical claims data; and (3) a chart review of a subset of cases to analyze clinical data regarding the severity of referred cases and the appropriateness of referral.

For the claims analyses, we analyzed paid medical claims from 2 large not-for-profit insurers in Massachusetts for new (Current Procedural Terminology [CPT] codes 99201–99205 and 99241–99245) and return (CPT codes 99211–99215) visits to orthopedic surgery for AIS (International Classification of Diseases, Ninth Revision codes 737.30 and 737.9) and for scoliosis radiographs (CPT codes 72069 and 72090) among patients 10 to 18 years of age at the time of the visit over a 2-year preintervention period (July 1, 2007 to June 30, 2009) and a 2-year postintervention period (July 1, 2009 to June 30, 2011). The rates of new AIS visits to orthopedic surgery, all AIS visits to orthopedic surgery, and scoliosis radiographs were compared between the pre- and postintervention periods by using a 2-sample t test. To assess change and sustainability over time, monthly referral rates were analyzed by using statistical process control charting methodology. U-charts for new and total visits were created by using the monthly rates from July 2007 through June 2009 to set the centerline and upper and lower control limits (±3 SDs). Postintervention monthly visit rates were analyzed for the identification of special cause points as outlined by standard statistical process control rules.9 When a special cause was found, we recalculated control limits by using the special cause point and subsequent 11 monthly points. Cumulative sum (CUSUM) charts were constructed to show the cumulative change in AIS visits to orthopedic surgery during the postintervention period in comparison with what would have been expected had rates remained unchanged from the preintervention period.

To assess the rates of bracing and surgery, we analyzed paid medical claims among patients with a new visit.
**Decision Support Algorithm for Adolescent Scoliosis**

Ages 10 to 18 Years

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**Inspect**

- **From the back**
  - Is pelvis level?
  - Is waist symmetrical?
  - Are shoulders leveled?
  - Adam forward bending test

- **From the side**
  - Excessive lordosis?
  - Excessive kyphosis?

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**Asymmetry on Exam**

Measure with scoliometer at the horizon

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**Scoliometer <7°**

Follow-Up

- In 6 - 12 months based on growth potential

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**Scoliometer ≥7°**

Evaluate Further

- Obtain standing PA scoliosis x-ray From C7 to iliac crest
- Must request Cobb Angle in x-ray order
- Follow-up based on Cobb Angle

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**Growth Potential**

<table>
<thead>
<tr>
<th>Follow-Up Based on Cobb Angle (assuming no red flags are present)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 - 14°</td>
</tr>
<tr>
<td>Age 10 or older but Prepubertal</td>
</tr>
<tr>
<td>Pubertal Premenarcheal girl or Boy age 12-14</td>
</tr>
<tr>
<td>Postmenarcheal girl or Boy age 15-16</td>
</tr>
<tr>
<td>Skeletally Mature (2y postmenarche or age 17-18)</td>
</tr>
</tbody>
</table>

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**Red Flags**

- Pain
- Double Curves
- Neurofibromatosis
- Connective Tissue Disorders
- Left Curve
- Neurologic Abnormalities
- Foot Deformity
- Leg Length Discrepancy

**Higher Risk of Progression**

- Girls
- During growth spurt
- Double curves
- More severe curves

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Sign of near completion of growth = gained <1cm in height in 6 months

**X-ray progression = increase in Cobb Angle of 5 degrees or more**

April 2009

By Dr. M. Timothy Hresko, Department of Orthopaedic Surgery, Children's Hospital Boston and Dr. Wanessa Risko in collaboration with PPOC members

**Figure 1**

Decision support algorithm for the management of AIS. Hx, medical history.
to orthopedic surgery for AIS during the study period for evidence of bracing (CPT codes L1200, L1300, L0450, L0452, L0454, L0456, L0458, L0460, L0462, L0464, L0466, L0468, L0470, L0472, L0480, L0482, L0484, L0486, L0488, L0490, L0491, L0492, L1000, L1001, L1005, and L1310) and scoliosis surgery (CPT codes 22800–22819 and 22840–22847) within 30 days and within 6 months of the initial orthopedic surgery visit. Frequencies of bracing and surgery in the pre-versus postintervention period were compared by $\chi^2$ analysis.

To analyze patient-level clinical parameters, we conducted structured chart reviews of all new AIS visits to orthopedic surgery for patients insured by 1 of 2 insurers who participated in the project. Notes of the initial orthopedic surgery visit were extracted from the medical record, blinded, and reviewed independently by 2 pediatric orthopedic surgeons (1 the primary reviewer and 1 secondary) and 1 PCP by using a standardized data collection form. For each element of data extracted, if the primary orthopedic surgery reviewer and the PCP reviewer agreed, that value was used. If there was a disagreement between the 2 principal reviewers, then the value from the secondary orthopedic surgery reviewer was used to break the tie. Frequencies were compared by using $\chi^2$ analysis. Median Cobb angles and scoliometer readings in the pre-versus postintervention period were compared by using the Wilcoxon rank sum test. We applied our decision support algorithm to each reviewed case to determine if the patient could potentially have been managed in the primary care setting by assessing whether the case met all of the following 3 criteria: (1) the initial orthopedic surgery visit revealed a scoliometer reading of $<7^\circ$ (or was missing); (2) the Cobb angle on spine radiograph was of $<15^\circ$ (or not done); and (3) no “red flags” for nonidiopathic scoliosis or associated systemic diseases as specified in the algorithm were noted (Fig 1).

This work met our institution’s definition of QI work and was therefore exempt from institutional review board review.

**RESULTS**

**Program Participation**

Of the 72 PPOC practices, 45 (62.5%) sent 1 or more physicians to the initial session; overall, 70 of the 186 PPOC physicians (37.6%) attended the initial session. There was a trend toward higher attendance by practices with higher AIS specialty visit rates. Fourteen of the 17 practices (82.4%) in the highest quartile of AIS referral rates had at least 1 physician attend the initial didactic session, compared with 11 of 17 (64.7%) for those in the third quartile, 9 of 18 (50.0%) for those in the second quartile, and 9 of 18 (50.0%) for those on the lowest quartile ($P$ for trend = .03).

**Rates and Characteristics of AIS Visits to Orthopedic Surgery**

The studied cohort consisted of a monthly mean of 30,539 patients 10 to 18 years of age. In the 2-year preintervention period, there were 315 initial visits to orthopedic surgery for AIS, yielding a rate of 5.11 visits per 1000 adolescents per year. Two hundred eight (66.0%) of the patients were female, and the median age was 13.0 years. In the 2-year postintervention period, there were 246 initial AIS visits to orthopedic surgery, for a rate of 4.07 visits per 1000 adolescents per year; a decline of 20.4% ($P$ = .01). In the postintervention period, 163 (63.8%) of the patients were female and the median age was 13.3 years. In the preintervention period, there were 1243 total visits (initial visits plus follow-up visits) to orthopedic surgery for AIS, a rate of 20.2 total AIS visits per 1000 adolescents per year, compared with 1093 total AIS visits in the postintervention period, a rate of 18.1 visits per 1000 adolescents per year, a decline of 10.4% ($P$ = .06). During the same period of time, initial visits to all specialists combined within our network rose 4.0%, whereas all visits (initial plus follow-up) rose 12.4%. For visits to orthopedic surgery for any condition, initial visits rose 10.2%, and all visits rose 12.9%. In terms of scoliosis radiographs, they increased from 20.2 per 1000 adolescents per year in the preintervention period to 22.8 in the postintervention period, an increase of 13.2% ($P$ = .05).

Figure 2 shows trends in new AIS visits to orthopedic surgery by month through the pre- and postintervention periods. The U-chart of the monthly rates of new AIS visits (Fig 2A) showed a special cause effect that began in July of 2009, the first of 9 consecutive points below the centerline calculated from the baseline period. The CUSUM chart (Fig 2B) shows that 66 fewer initial visits to orthopedic surgery occurred in the 2-year postintervention period in comparison with what would have been expected based on the preintervention rate. Trends for total AIS visits (new visits plus follow-up visits) to orthopedic surgery are shown in Fig 3. The U-chart of monthly rates (Fig 3A) showed a special cause effect in October of 2009 with a single monthly rate >3 SDs below the center line. A CUSUM analysis for all AIS visits to orthopedic surgery demonstrated 131 fewer visits than would have been predicted from preintervention rates (Fig 3B).

To assess the severity of AIS cases referred to orthopedic surgery, we analyzed the proportion of cases receiving bracing and surgery within 30 days and within 6 months after the initial visit (Table 1). The proportion receiving a scoliosis brace within 30 days of the initial referral visit increased significantly from 4.4% in the preintervention period to 9.3% postintervention ($P$ = .02).
FIGURE 2
U-chart (A) and CUSUM chart (B) of initial visits to orthopedic surgery for AIS.

upper control limit (+3 SD)
center line
lower control limit (-3SD)
initial didactic session
initial report of AIS
referral rates to pediatrics
follow-up didactic session
follow-up report of AIS
referral rates to pediatrics

Rate from baseline period normalized to 0
Cumulative number of initial AIS visits to orthopedic surgery relative to pre-intervention period

FIGURE 3
U-chart (A) and CUSUM chart (B) of total visits to orthopedic surgery for AIS.
the proportion receiving a brace within 6 months also increased from 8.9% to 13.4%, but this change was not statistically significant (P = .09). The proportion of referred adolescents undergoing scoliosis surgery within 30 days and within 6 months of the initial visit did not change significantly, and the number of surgeries was small (8/561 children, 1.4%).

**Chart Review**

We compared clinical parameters at the initial AIS visit to orthopedic surgery by chart review for a subset of subjects insured by 1 of the 2 insurance companies that participated in the project. The median scoliometer reading by the orthopedic surgeon did not change, although a reading was reported for only 54 of 92 patients (58.7%). The median Cobb angle increased slightly from 12° to 14° for patients having a spine radiograph and from 9° to 11° for all patients, assuming those who did not have a spine radiograph had Cobb angles of <10°, although these small changes were not statistically significant (P = .1 for both; Fig 4). Immediate bracing was recommended for 3 of 56 patients (5.4%) in the preintervention period versus 5 of 36 (13.9%) patients in the postintervention period (P = .2), and no patients were recommended to have immediate surgery. Based on the parameters of our decision support algorithm, we calculated that 29 of 56 patients (51.8%) could have been managed in the primary care setting in the preintervention period versus 14 of 36 (38.9%) in the postintervention period (P = .2).

**TABLE 1** Proportion of Adolescents Referred to Orthopedic Surgery for AIS Receiving a Scoliosis Brace or Scoliosis Surgery Within 30 Days and Within 6 Months of the Initial Visit

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Preintervention Period (n = 315)</th>
<th>Postintervention Period (n = 246)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>Brace</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 30 d</td>
<td>14 (4.4)</td>
<td>23 (9.3)</td>
<td>.02</td>
</tr>
<tr>
<td>Within 6 mo</td>
<td>28 (8.9)</td>
<td>33 (13.4)</td>
<td>.09</td>
</tr>
<tr>
<td>Surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 30 d</td>
<td>1 (0.3)</td>
<td>0 (0.0)</td>
<td>.4</td>
</tr>
<tr>
<td>Within 6 mo</td>
<td>6 (1.9)</td>
<td>2 (0.8)</td>
<td>.3</td>
</tr>
</tbody>
</table>

**FIGURE 4** Distribution of Cobb angles in preintervention and postintervention periods.
DISCUSSION
The rising cost of US health care represents a substantial societal challenge, especially because the quality of US health care is not measurably better than that of other industrialized countries with substantially lower costs.\(^{10–12}\)

One aspect of the US system that has been blamed for the gap between cost and outcomes is the focus on specialty care over primary care. Specialty utilization in the United States is higher than that of other countries,\(^{13,14}\) and evidence demonstrates that effective primary care reduces the need for specialty care.\(^{15}\)

One potential strategy for maintaining or enhancing quality while controlling cost is to shift the locus of care from specialists to PCPs when feasible. Such an approach may be especially appealing to accountable care organizations accepting financial risk for the cost of care.\(^{16}\)

Also, in areas where pediatric subspecialty care is scarce, shifting care to the primary care setting when appropriate may reduce waiting times for specialty care and better use the skills of the specialist for patients who can truly benefit from them.

Within our network of primary care pediatricians affiliated with a tertiary care pediatric hospital, we discovered an opportunity to shift care from the specialty arena to PCPs for the management of AIS. We believed this condition to be a feasible target, because, in our baseline analysis, we found AIS to be a common reason for referral to orthopedic care with only 5% of referred patients required bracing or surgery. The remainder were managed expectantly with follow-up examinations and spine radiographs, procedures that could be performed by PCPs.

We thus developed a QI initiative consisting of professional education, decision support materials available at the point of care, and longitudinal feedback of performance data, and demonstrated >20% reduction in initial orthopedic surgery visits for AIS during the 2-year follow-up period. It is unlikely that these observed changes were due to factors other than our program, because, during the same time period, visits to orthopedic surgery for all diagnoses and visits to all specialists increased substantially.

Our process control charting demonstrated that the reduction in AIS referrals began quickly after initiation of the program and was sustained throughout the 2-year postintervention period. It will be important to monitor the sustainability of this change over a longer period of time to assess the durability of our intervention. Because any given PCP sees relatively few patients with scoliosis, it is possible that skills gained through our program will wane over time. Alternatively, the continued availability of our decision support tools at the point of care may provide the guidance needed to sustain the reduction in unnecessary referrals achieved to date.

A somewhat surprising finding of our study was an overall increase in scoliosis radiographs in the postintervention period. This trend may be the result of our algorithm recommending that PCPs obtain radiographs as part of their evaluation to determine if a referral is necessary, and it is not clear whether this change reflects an increase in appropriate care that was not being delivered previously, or an overuse of radiographs, which may cause an unjustified increase in cost and radiation exposure. Further investigations will be necessary to clarify this point.

The obvious potential hazard of a program such as this one is the possibility of delayed referral for patients who could benefit from specialist consultation. To assess whether such delayed referral occurred within our program, we designed a counterbalancing analysis examining the rates of bracing and surgery within 30 days and within 6 months of initial orthopedic visit. We reasoned that if the AIS severity level of patients being referred increased appropriately, we would see an increased rate of bracing within the first 30 days after the initial orthopedic surgery visit; however, we felt that an increase in the need for surgery within 30 days of the initial visit would be a sign of possible delayed referrals. We did find an increased rate of immediate bracing (from ~4% to 9%), but we did not discover any patients requiring immediate surgery in the postintervention period, suggesting the lack of any substantially delayed referrals.

In our chart review examining clinical parameters of patients seen by orthopedic surgeons for AIS, we discovered some enlightening patterns. First, in the preintervention period, more than one-half of the patients seen by the specialists did not actually meet criteria for AIS, because they had Cobb angles of <10° or were not deemed severe enough by clinical examination to merit a spine radiograph. Such patients would properly be described as having spinal asymmetry rather than scoliosis and almost certainly could be followed adequately in the primary care setting. We suspect that this finding reflects a lack of education among PCPs in distinguishing true disease from variations of normal. We also wonder what effect school-based scoliosis screening may have on referrals to specialists. Despite the fact that the US Preventive Task Force has recommended against routine AIS screening,\(^{17}\) school-based screening is still required by law in Massachusetts.\(^{18}\)

The evidence for the value of such programs in improving scoliosis outcomes is mixed,\(^{5,19–22}\) as are the data on their cost-effectiveness.\(^{22–25}\) Our data do not allow us to determine if any patients were referred directly to orthopedic surgery from school-based screening programs without being
evaluated by their PCP, but such an analysis would be of value. Although our sample of chart reviews was small and therefore not sufficiently powered to show statistically significant changes, it is encouraging that the measured parameters moved in the expected direction. The median Cobb angle of referred patients became slightly higher (although in the expected direction. The median changes, it is encouraging that small and therefore not sufficiently.

CONCLUSIONS
Within our network of primary care pediatricians, we found that a QI program consisting of physician education, decision support available at the point of care, and longitudinal feedback of data on referral patterns substantially reduced unnecessary visits to orthopedic surgery for AIS. This approach could serve as a model for the development of other QI programs that seek to shift the locus of care from specialty to primary care in an attempt to maintain or enhance value while reducing cost.

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