RESEARCH LETTER

Use of Electronic Health Records for Automated Screening of Growth Disorders in Primary Care

Monitoring of linear growth is a well-established part of pediatric health care in the developed world. Although monitoring aims to support early diagnosis and timely treatment of disorders affecting growth, such disorders are often diagnosed late. This population-based study assessed the effectiveness of a novel computerized and automated growth monitoring (AGM) strategy integrated into an electronic health record (EHR) system in the primary care setting. Our hypothesis was that compared with standard growth monitoring (SGM), the AGM strategy would result in a better diagnostic yield and facilitate earlier diagnosis of disorders affecting growth.

Methods | Approximately 98% of the child population in Finland participates in a growth monitoring program, including 20 height measurements from the first postbirth measurement to aged 12 years. At scheduled visits, trained primary care nurses measure supine length (up to 24 months) or height using standardized techniques and equipment. The nurses analyze the length and height measures using 3 screening algorithms: (1) against population-based length and height references; (2) for distance from target height (calculated from parental heights); and (3) for change in growth rate (for details, see 3).

In this study, a prospective 1-year (2008-2009) AGM intervention was performed in the primary care setting of 1 municipality in Finland. The preceding 3 years (2005-2008) were used as a comparator (SGM). Automated growth monitoring included 2 additional automated steps in addition to SGM. First, the longitudinal growth data set of each measured child was automatically analyzed by the EHR integrated screening algorithms. Second, abnormal growth values were automatically transferred to a pediatric endocrinologist for review of the growth data. There were obvious erroneous height values in 3.1% of cases that were requested to be corrected. The endocrinologist then provided electronic consultation to the primary care physician in regard to further actions, but referral to secondary care was still dependent on the judgment of the primary care physician. The primary outcome was the diagnostic yield of primary or secondary growth disorders during the AGM intervention year vs the SGM control years.

Ethical approval was given by the local institutional ethics review board without the requirement for informed consent. A 2-sided threshold of $P < .05$ ($\chi^2$ and Fisher exact tests) was used to evaluate statistical significance; SPSS version 19.0 was used for all statistical analyses (SPSS Inc).

Results | During the control years, an annual mean (SD) of 33 029 (273) children were screened. A mean (SD) of 4 (1) children were diagnosed with a new primary or secondary growth disorder.

Figure. Clinical Effectiveness of Automated Growth Monitoring Integrated in an Electronic Health Record in Comparison to Standard Growth Monitoring

- **Standard growth monitoring, 2005-2008**
  - (control years)
  - Annual mean (SD) No. of children screened using standard growth monitoring (median age, 5.02 y [range, 0.01-12 y]): 33 029 (273)
  - Annual mean (SD) No. of measurements: 77 938 (1106)
  - (5) Annual mean (SD) No. of children referred to specialist care because of suspected growth disorder (0.22% [95% CI, 0.18%-0.28%; SD, 0.01] of screened children): 73

- **Automated growth monitoring, 2008-2009**
  - (intervention year)
  - Annual mean (SD) No. of children screened using automated growth monitoring (median age, 5.02 y [range, 0.01-12 y]; 88% previously screened with standard growth monitoring): 32 404
  - Annual mean (SD) No. of measurements: 77 409
  - (5) Annual mean (SD) No. of children referred to specialist care because of suspected growth disorder (0.64% [95% CI, 0.56%-0.74% of screened children): 209

- 64 (5) Annual mean (SD) No. of children with no growth disorder or idiopathic short stature (88.6% [95% CI, 79.1%-93.9%; SD, 0.3] of referred children)
- 4 (0) Annual mean (SD) No. of children with idiopathic short stature (5.5% [95% CI, 2.2%-13.3%; SD, 0.4] of referred children)
- 28 Children had primary or secondary growth disorder ($4\%$ [95% CI, 9.4%-18.7% of referred children)
- 19 Idiopathic short stature ($9.1\%$ [95% CI, 5.9%-13.8% of referred children)
- 162 No growth disorder or idiopathic short stature ($77.5\%$ [95% CI, 71.4%-82.7% of referred children)

*Data have been rounded. *Defined as the height of the individual more than 2 SD below the corresponding mean height for a given age and sex and in whom no identifiable disorder is present. *According to classification by the European Society for Pediatric Endocrinology.
During the AGM intervention year, the number of new diagnoses was 28 among the 32,404 screened children (88% were measured in the previous SGM years; Figure). The diagnostic yield of primary or secondary growth disorders was 0.1% (95% CI, 0.6-1.2) per 1000 screened children in the control years vs 0.9 (0.6-1.2) per 1000 in the AGM year (P < .001) (Table).

Referral to specialist care for a suspected growth disorder increased from an annual mean (SD) of 127 (5.0) referrals during the control years (0.22% [95% CI, 0.18%–0.28%]) of measured children) to 209 (0.64%; 95% CI, 0.56%–0.74%) during the AGM year (P = .001; Figure).

Fourteen of the 28 children (50.0%; 95% CI, 32.6–67.4%) diagnosed during the AGM year had 1 or more abnormal height measurements before the AGM intervention, with a median delay in diagnosis of 1.79 years (range, 0.08–10.26 years; Table).

**Discussion** | In this population-based cohort study, we showed that screening of growth disorders using algorithms integrated into an EHR system was associated with a higher rate of detection and referral to specialist care. Balancing the increased diagnostic yield is the increased workload of specialists and costs. We identified prevalent cases who were missed by the SGM in preceding years, which may partly explain the exceptionally good results of the 1-year AGM intervention. The subsequent detection rate of growth disorders with AGM remains to be established, but is likely to be lower. Because SGM was in use throughout the country, a more informative type of study design than the pre-post comparison was not possible. Whether the results are generalizable to other countries remains to be determined.

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