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Refereed paper

Patterns of referral in a Canadian primary care electronic health record database: retrospective cross-sectional analysis

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ABSTRACT

Background Databases derived from primary care electronic health records (EHRs) are ideally suited to study clinical influences on referral patterns. This is the first study outside the United Kingdom to use an EHR database to describe rates of referral per patient from family physicians to specialists.

Objective To use a primary care EHR database to describe referrals to specialist physicians; to partition variance in referral rates between the practice and patient levels.

Methods Retrospective cross-sectional analysis of de-identified EHRs of 33 998 patients from 10 primary care practices in Ontario, Canada. The study cohort included all patients who visited their family physician 1 April 2007 to 31 March 2008 ($n \geq$ 24 856). Specialist referrals for each patient were counted for 12 months following their index visit. Rates of referral were compared by sex, age, number of office visits, practice location and specialist type using *t*-tests or Pearson's correlation. Variance partitioning determined the proportion of variance in the overall referral rate accounted for by the practice and patient levels.

Results In total, 7771 patients (31.3%) had one or more referrals. The overall referral rate was 455/1000 patients/year (95% CI, 444–465). Rates were higher for females, older patients and rural practices. The referral rate correlated with the number of family physician office visits. Ninety-two percent of the total variance in referral rates was attributable to the patient (vs. practice) level.

Conclusions A Canadian primary care EHR database showed similar patterns of referral to those reported from administrative databases. Most variance in referral rates is explained at the patient level.

Keywords: electronic health records, referrals, variance partitioning

What this paper adds

- This is the first study outside the United Kingdom (UK) to use an electronic health record (EHR) database to describe patterns of referral from family physicians to all specialists.
- Referral patterns in this Canadian EHR database mirror those found in EHR studies from the UK, and administrative database studies in Canada and elsewhere.
- Most of the variance in referral rates is explained at the patient (vs practice) level.
- The large proportion of patient-level variance argues for the value of clinically oriented databases, such as primary care EHRs, for the further study of referral patterns.

Introduction

Patterns of referral from primary care to specialist physicians are of longstanding interest to health system administrators the world over. To policy makers, a referral is a marker of an unmet (or not-yet-met) health need, and constitutes an inflection point in that patient's cost-of-care trajectory. Patterns of referral reflect standards of care, scopes of physician practice and patient expectations, and thus have important implications for resource utilisation projections and human resource planning. Referral rates vary by geography,[1,2] policy,[3,4] physician characteristics[2,5,6] and patient characteristics.[1,7–9] Studies from several countries[1,2,5,7] suggest that most variability in referral rates arises from the patient (as opposed to the physician or practice) level, and that clinical factors (rather than demographic variables) are of particular importance.[6,10–12]

Exploring how clinical factors influence referral patterns requires a clinically oriented data source. Databases derived from primary care EHRs are ideally suited to study clinical influences on referral patterns. Unlike registries or health administrative databases, they contain extensive clinical details on all elements of health care for all conditions for all patients. Despite the potential of primary care EHRs to shed light on referral patterns, a recent literature review[13] found no studies outside of the UK[11,14,15] which utilise a primary care EHR database to describe referral patterns.

In Canada, almost all primary medical care is provided by family physicians, with access to specialist physicians (including general internists and most paediatricians) available only by referral. Since 2005 a network of 25 family physicians in 10 practices in Ontario, Canada has contributed de-identified EHR data to a researchable database as part of the Deliver Primary Healthcare Information (DELPHI) project based at the Centre for Studies in Family Medicine at the University of Western Ontario. The age and sex distribution of DELPHI physicians is broadly representative of Canadian physicians as a whole.[16]

To lay the foundation for future studies of referral patterns in the Canadian context, the current study is the first outside the UK to use a primary care EHR database to describe rates of referral to all specialist physicians. A secondary goal was to confirm, in the Canadian context, the importance of patient-level factors in explaining referral rate variance. Specifically, the research questions were:

- What are the rates of referral (number of referrals per patient per year) to specialist physicians for patients cared for by family physicians participating in the DELPHI project?
- What proportion of variance in referral rates can be attributed to the practice level versus the patient level?

Methods

Study design

The study was a retrospective cross-sectional design and the unit of analysis was the individual patient. The data extract utilised for the study contains the de-identified data for 33 998 patients, and 510 286 encounters from the period 1 October 2005 to 31 March 2009. The DELPHI project was approved by the University of Western Ontario's Review Board for Health Sciences Research Involving Human Subjects.

Sample

The sample included all consenting patients with at least one office visit between 1 April 2007 and 31 March 2008 to any of 23 participating family physicians. The first office visit for each patient within this time window was considered to be the index office visit. In order to ensure an equal window of exposure for each patient, we analysed all referrals in the 12-month period following each patient's index office visit. Duplicate referral records, referral records created in error and referral records created for a specialist consultation which had already occurred were excluded from analysis.

Variables

For each patient in the sample, we extracted the following information from the EHR: unique patient identification number, sex, month and year of birth, practice number, dates of family physician office visits in the patient's 12-month study period and postal code of the family physician practice. For each referral, we extracted the date of referral and consultant specialty. We calculated age at index family physician office visit and assigned it to one of the following categories: 0–19 years; 20–44 years; 45–64 years; and 65 or more years. Each patient's total number of FP office visits was determined for their 12-month study period. Using the practice postal code, we classified practice location as urban or rural using Statistics Canada's Postal Code Conversion File 2006.[17] The type of specialist was recoded to identify referrals to each of the 33 medical specialties recognised by the Ontario Health Insurance Program,[18] plus a generic hospital/specialty clinic

category to capture referrals to settings which may include physicians from multiple specialties (e.g. 'hand clinic' staffed by both orthopaedic and plastic surgeons).

Analysis

We calculated rates of referral per year (number of referrals divided by the number of patients multiplied by 1000) as overall rates with confidence intervals, as well as rates by sex, age group, location of care, number of family physician office visits and consultant specialty. Differences in rates were determined using *t*-tests for categorical independent variables (sex, age group, location of care) and Pearson's correlation coefficient for the continuous independent variables (number of family physician office visits). Rates by sex within age group and by sex within age group within consultant specialty were also calculated. We conducted these analyses in SPSS 17.0.[19]

We determined the proportion of variance in the overall referral rate accounted for by the patient level and the practice level using a variance partitioning method. The referrals outcome was modelled as a Poisson count variable rather than as continuous because it does not follow a normal distribution but is skewed to the right, with a large number of patients having none or one referral and a few patients having a large number of referrals. Further, in order to account for variation at both the patient and the practice level, a multilevel model was required. Multilevel models allow for each level of interest to have its own variance which permits partitioning of the variance. Therefore, we modelled referrals as a count variable with a mixed effects multilevel Poisson regression using Stata 10.[20]

We ran an empty model (without covariates). In this way, there were no coefficients for covariates. Rather, all the variation resides solely at either the patient level or practice level. In this way, we were able to determine the proportion of variance in referrals that is attributable to the patient and the variance that is attributable to the practice. This empty model analysis is appropriate when the interest is in partitioning the variance between different levels rather than in looking at the factors associated with the referrals. The proportion of variance attributable to the patient was calculated as the patient-level variance divided by the total patient and practice variance.

Results

A total of 24 856 patients visited their family physician at least once between 1 April 2007 and 31 March 2008. Of these, 7771 (31.3%) had at least one referral to a specialist physician. A total of 11 297 referrals were made by the family physicians for these patients yielding an overall rate of 455 referrals per 1000 patients per year (95% CI, 444–465).

The referral rate was significantly higher for women (471/1000) than for men (436/1000), $P = 0.0001$, and increased with age for both males and females (Table 1). The referral rate for patients from rural practices (476/1000) was higher than those from urban practices (424/1000), $P = 0.0001$. The referral rate correlated with the number of family physician visits ($r = 0.393$, $P = 0.0001$).

Referral rates varied widely by consultant specialty. The highest overall referral rates were to general surgery (61 referrals/1000 patients), obstetrics and gynaecology (41/1000) and orthopaedic surgery (41/1000) (Table 2). When examined by patient sex and age category, general surgery had either the highest or second highest referral rate for both males and females aged 45 and older. For both males and females aged 0–19, the highest rates of referral were to paediatrics, otolaryngology and dermatology. The rate of referral to obstetrics and gynaecology among women aged 20–44 (156/1000) was much higher than for any other

Table 1 Referral rate per 1000 patients per year by age and sex

Age group (years)	Referral rate/1000 patients/year		*P*
	Males	Females	
0–19	229	213	0.283
20–44	388	476	**0.0001**
45–64	499	547	**0.015**
≥ 65	578	563	0.545
Overall	436	471	**0.001**

Numbers in bold are statistically significant at $P < 0.05$.

Table 2 Most frequently consulted specialties by sex – referral rates per 1000 patients per year

Males		Females		Combined total	
Specialty	Rate/1000	Specialty	Rate/1000	Specialty	Rate/1000
General surgery	62	Obstetrics/ gynaecology	76	General surgery	61
Orthopaedic surgery	42	General surgery	60	Obstetrics/ gynaecology	41
Urology	40	Orthopaedic surgery	40	Orthopaedic surgery	41
Otolaryngology	35	Dermatology	39	Dermatology	35
Internal medicine	34	Otolaryngology	31	Otolaryngology	33
Dermatology	31	Internal medicine	30	Internal medicine	32
Neurology	25	Neurology	26	Neurology	26
Not specified	25	Not specified	24	Urology	25
Cardiology	21	Gastroenterology	21	Not specified	24
Gastroenterology	20	Plastic surgery	17	Gastroenterology	20

Table 3 Variance partitioning between practice and patient levels

Random effects parameters	*n*	Variance estimate	Standard error	95% CI
Level 2 – practice	10	0.051	0.023	0.021–0.125
Level 1 – patient	24856	0.574	0.022	0.532–0.619
Total patient + practice variance		0.625		

specialty in any gender or age group. This prompted additional examination by age group which demonstrated no significant difference in overall referral rates between males and females when patients in the 20–44-year-old age group were excluded.

The multilevel mixed effects Poisson regression estimated the patient-level variance as 0.574 with a standard error of 0.022 and the practice-level as 0.051 with a standard error of 0.023 for a total variance in the model of 0.625. The proportion of the total variance in referral rates attributed to the patient level was 0.918 (0.574/0.625) with the remaining 0.082 (0.051/0.625) attributed to the practice level. Table 3 provides the summary of the variance partitioning analysis.

Discussion

Principal findings

In this first study of referral rates from a North American primary care EHR database, patterns of referral were similar to those published elsewhere. Referral rates increased with age,[1,8,11,21] and most referrals were to surgical specialists.[12,21] Women were referred more often than men.[1,8,21] The rate of referral per patient correlated with the number of family physician office visits. The vast majority of the variance (91.8%) in referral patterns came from the patient, rather than the practice, level.[6,11,12]

Referrals of women of childbearing age to obstetricians/gynaecologists account for the difference in overall referral rates between men and women. While

the correlation between number of family physician office visits and rate of referral is important, this study was not designed to distinguish between morbidity burden and exposure effect as explanations for the higher referral rate among frequent attenders. The current study's finding that referral rates were higher for patients from rural practices runs counter to the conventional wisdom that urban physicians refer more readily.[2,7] Because this study was not designed to explore this in detail, and given that other authors have found the relationship between geography and referral rates to be complex,[1] the rural/urban comparison in this study should be interpreted with caution.

Implications of the findings

Referral patterns from primary care to specialist physicians have been described from primary care EHR databases in the UK,[11,14,15] and from health administrative databases elsewhere.[1,3,6] The current study is the first non-UK research to use a primary care EHR database to replicate referral patterns from previous studies. The large proportion of variance attributed to the patient level argues for the importance of continuing to develop such clinically oriented databases as a resource for referral pattern research.

Comparison with the literature

Direct comparison of referral rates between studies is difficult due to dissimilarities in context and methodology. The most comparable study is by Chan and Austin,[1] in which they utilise 1997/1998 provincial health administrative data to calculate a referral rate of 560/1000/year from family physicians to specialist physicians for all patients in the same province of Ontario, Canada. The difference from the present study (overall referral rate 455/1000/year) may reflect changes in referral patterns over time, or differences in patient characteristics (e.g. morbidity burden, socio-economic status) and practice characteristics (e.g. case-mix) between DELPHI practices/physicians and those in the province as a whole. The lower referral rate of DELPHI practices relative to Chan's provincial rate is not attributable to poor regional access to specialist physicians, as per-capital specialist supply in southwestern Ontario (where DELPHI practices are located) is above the provincial average.[22]

In a study of referrals from a UK primary care database, Sullivan *et al.*[11] found a similar partitioning of variance (95.4% patient level, 4.6% practice level) despite the fact that the proportion of referred patients was markedly lower (14.7% of all patients referred, compared with 31.3% in the current study). While accounting for practice-level clustering when studying referral rate variance is necessary,[8] the current study suggests that modelling patient characteristics is even more important.

Limitations of the method

This study did not have a mechanism to identify referrals which may have been missing from the database. As a study of practice attenders, results are not generalisable to the population at large. Because of the potential significance of practice- and provider-level clustering, results are generalisable only to the extent that DELPHI patients, providers and practices resemble their counterparts in the general population. Measuring the representativeness of DELPHI physicians and practices was beyond the scope of the current study.

Call for further research

Future research on referral patterns must proceed in two directions. First, external validation of the EHR-derived referral data, by linkage to health administrative datasets, is necessary to confirm the credibility of EHR referral pattern findings. Second, the influence of the patient level on referral patterns suggests that progress in the field will benefit from our growing ability to perform analyses which incorporate patient-level clinical data of the sort which are beginning to become available through primary care EMR databases. A measure of morbidity burden is necessary to distinguish between clinical need and exposure effect as an explanation for the association between rate of referral and number of family physician visits.

Conclusions

This is the first study outside the UK to describe referral patterns from a primary care EHR-derived database. Patterns of referral largely replicate those reported from other sources. The vast majority of variance in referral rates was found to be attributable to the patient (as opposed to practice) level. Primary care EHR-derived databases may yield important insights regarding patient-level influences on referral patterns.

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CONFLICTS OF INTEREST

None.

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