Effect of family medicine residents on use of diagnostic investigations

In a rural community emergency department

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Abstract

Objective To determine the effect of the presence of family medicine residents on the use of laboratory and imaging investigations in a rural emergency department (ED).

Design A retrospective cross-sectional electronic chart audit was completed. Background characteristics, as well as type and number of ordered investigations, were compared between study groups.

Setting Strathroy Middlesex General Hospital in Strathroy, Ont, a rural community hospital that sees approximately 20 000 ED visits per year.

Participants A total of 2000 sequential ED visits, including adult and pediatric patients. The test group consisted of patients seen while a resident was present in the ED. The control group consisted of patients seen while no residents were present in the ED.

Main outcome measures Twenty-two distinct categories of common ED investigations were studied.

Results There was no statistically significant difference between study groups for 19 of the 22 categories of investigations. There were significant differences in 3 categories: an increased number of D-dimer assays for patients seen while there were no residents in the ED (1.7% of patients vs 0.5% of patients, $P=.03$) and increased computed tomography and ultrasound imaging for patients seen while a resident was in the ED (4.8% vs 1.8%, $P=.0012$, and 5.3% and 1.7%, $P<.001$, respectively). These differences are likely not owing to resident involvement but are explained by a difference in test availability between groups.

Conclusion The study was underpowered for most categories of studied investigations. However, the trends demonstrated in this study suggest that the presence of family medicine residents in a rural community ED does not substantially affect the overall use of diagnostic investigations.

EDITOR'S KEY POINTS

- Concerns have been expressed that medical trainees increase costs by ordering unnecessary investigations. This study found that the presence of residents in a community emergency department (ED) did not increase the number of most types of investigations.
- Patients seen when residents were present in the ED were approximately 3 times as likely to have CT or ultrasound imaging, while patients seen when residents were not in the ED were approximately 3 times as likely to have D-dimer testing. This difference is believed to be attributable to test availability and not to the presence of residents.

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Effet de la présence de résidents en médecine familiale sur le recours à des examens diagnostiques

Dans un service des urgences d'une communauté rurale

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Résumé

Objectif Vérifier si la présence de résidents en médecine familiale dans un service des urgences (SU) rural modifie le recours aux examens de laboratoire et d'imagerie.

Type d'étude On a effectué une vérification rétrospective transversale de dossiers électroniques. On a comparé le nombre et la nature des examens demandés par chacun des groupes à l'étude, de même que leurs caractéristiques de base.

Contexte L'hôpital général Strathroy Middlesex, à Strathroy, Ont., un hôpital communautaire rural qui reçoit environ 20 000 patients à l'urgence chaque année.

Participants Un total de 2000 visites consécutives à l'urgence pour des patients adultes et des enfants. Le groupe expérimental était formé de patients vus à l'urgence en présence d'un résident, et le groupe témoin, de patients vus en absence de résidents.

Principaux paramètres à l'étude Un total de 22 catégories distinctes d'examens fréquemment demandés à l'urgence.

Résultats Pour 19 des 22 catégories d'examens, il n'y avait pas de différence statistiquement significative entre les groupes à l'étude. On notait toutefois des différences significatives dans 3 catégories : on demandait plus de dosage des D-dimères pour les patients quand il n'y avait pas de résident à l'urgence (1,7 % c. 0,5 % des patients, P = ,03) et plus de tomographies et d'échographies lorsqu'un résident était présent (4,8 % c. 1,8 %, P = ,0012 et 5,3 % c. 1,7 %, P < ,001, respectivement). Ces différences ne semblent pas dues à la participation des résidents, mais au fait que la disponibilité des examens n'était pas la même pour les 2 groupes.

Conclusion Cette étude n'était pas suffisamment approfondie pour la plupart des catégories d'examens à l'étude. Toutefois, les tendances observées dans cette étude suggèrent que la présence de résidents en médecine familiale dans le service des urgences d'une communauté rurale n'a pas d'effet important sur le nombre d'examens diagnostiques demandés.

POINTS DE REPÈRE DU RÉDACTEUR

- On a exprimé certaines inquiétudes selon lesquelles les étudiants en médecine augmenteraient les coûts de santé en demandant des examens inutiles. Dans cette étude, la présence de résidents dans un service des urgences (SU) communautaire n'a pas augmenté le nombre de la plupart des types d'examens.

- Lorsque des résidents étaient présents à l'urgence, les patients avaient 3 fois plus de chances d'avoir un examen par tomodensitométrie ou par échographie, alors qu'en l'absence de résidents, ils avaient 3 fois plus de chances d'avoir un dosage des D-dimères. Cette différence est vraisemblablement attribuable à la disponibilité plus ou moins grande de ces examens plutôt qu'à la présence des résidents.

Cet article a fait l'objet d'une révision par des pairs.
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With increasing health care demands, there has been an increase in the number of medical trainees in Canada.[1] In part to accommodate the increased number of residents, there has been an effort to increase rural medical training.[2] Many family medicine residents are now completing much of their training in smaller community hospitals.[3]

There is also an ongoing push to maximize efficiency in all areas of medical care delivery given growing health care costs. An often targeted area is diagnostic investigations.[4-6] Concerns have been expressed that medical trainees increase costs by ordering unnecessary investigations. A review of the literature was inconclusive, with several studies showing that residents substantially increased investigations[7-11] and other studies showing little or no change.[12-17] Most such studies were completed in inpatient settings,[7-15] at large urban teaching centres,[7-13,16,17] and in the United States.[7-10,13-17]

This retrospective chart audit was conducted to determine the effect of family medicine residents on the frequency of laboratory and imaging investigations ordered in a rural community emergency department (ED) in Canada. At Strathroy Middlesex General Hospital (SMGH) in Strathroy, Ont, family medicine residents work with staff physicians on many shifts in the ED. Other shifts are covered by staff physicians working alone. This situation provided an opportunity to assess the effect of the presence of residents on the number of investigations ordered while minimizing confounding factors such as staffing differences, geographic location, seasonal changes, and patient population.

METHODS

The study was approved by the University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects.

This cross-sectional study reviewed 2000 sequential visits to the SMGH ED starting on July 1, 2011. The SMGH ED sees approximately 20 000 patients every year. The ED is staffed primarily by physicians who have either Certification in Family Medicine or Certification in Family Medicine with Special Competence in Emergency Medicine. A few physicians work full time in the ED; however, most are part-time ED physicians with responsibilities in other areas of family practice. A minority of shifts that the ED physicians are unable to cover are staffed by locum physicians. Each 24-hour day is divided into 3 shifts: 7 AM to 3 PM, 2 PM to 10 PM, and 9 PM to 7 AM. Each shift is covered by a single physician who might be working with a family medicine resident. Residents work exclusively with staff physicians and do not work with locum physicians.

The electronic medical record of each patient visit was reviewed for background characteristics and any investigations ordered. Background characteristics collected include Canadian Triage and Acuity Scale (CTAS) level, patient age group and sex, and time of visit. Categories of investigations collected include basic chemistry, basic hematology, extended chemistry, erythrocyte sedimentation rate or C-reactive protein tests, blood gas tests, coagulation assays, D-dimer assays, pregnancy assays, upper abdomen enzyme tests, cardiac enzyme tests, urinalysis, urine cultures, blood cultures, throat cultures, stool cultures, genital cultures, urine toxicology, serum toxicology, laboratory investigations not included in other categories, plain film x-ray scans, computed tomography (CT) scans, and ultrasound scans. For each visit, the attending physician was cross-referenced with staffing schedules to determine if the attending physician was a staff physician or a locum physician and if the physician was working with a resident. For ED visits that spanned the shifts of more than 1 attending physician, the background characteristics and investigations for that visit were attributed to the first attending physician.

Patients who were directly admitted by physicians from other services and patients who were seen by locum physicians were excluded from this study. The remaining visits were then classified into 2 groups based on the presence or absence of a resident in the department. The background characteristics and the number of investigations in each group were then compared and statistical significance was determined using Pearson χ^2 analysis. Statistical significance was set at $P \leq .05$.

RESULTS

The 2000 patient charts corresponded to a study period between July 1, 2011, and July 30, 2011. Of the 2000 visits, 14 were direct admissions to other services and were therefore excluded. Another 366 patients were seen by locum physicians and were also excluded. Of the remaining 1620 patients, 709 patients were seen when no residents were present and 911 were seen with a resident present in the department. A comparison of patient demographic markers including CTAS level, age group, sex, and time of day seen was made between the 2 patient groups (**Table 1**). A comparison of the frequency of investigations was also made between the 2 groups (**Table 2**).

DISCUSSION

This study suggests that the presence of residents in a community ED does not increase the number of

Table 1. Patient background characteristics for each study group

DEMOGRAPHIC CHARACTERISTIC	NO RESIDENT IN THE ED, N (%) (N = 709)	RESIDENT PRESENT IN THE ED, N (%) (N = 911)	*P* VALUE*
CTAS level†			
• 1	4 (0.6)	1 (0.1)	.10
• 2	54 (7.6)	66 (7.2)	.78
• 3	277 (39.1)	319 (35.0)	.09
• 4	368 (51.9)	518 (56.9)	.05
• 5	6 (0.8)	7 (0.8)	.86
Age group‡			
• Pediatric	166 (23.4)	190 (20.9)	.22
• Adult	394 (55.6)	481 (52.8)	.27
• Geriatric	149 (21.0)	240 (26.3)	.01
Sex			
• Male	360 (50.8)	462 (50.7)	.98
• Female	349 (49.2)	449 (49.3)	.98
Time of day or type of shift§			
• Day	21 (3.0)	538 (59.1)	< .001
• Evening	355 (50.1)	207 (22.7)	< .001
• Night	333 (47.0)	166 (18.2)	< .001

CTAS—Canadian Triage and Acuity Scale, ED—emergency department, SMGH—Strathroy Middlesex General Hospital.
*P values calculated using the Pearson χ^2 method.
†Scale ranges from highest acuity (level 1) to lowest acuity (level 5).
‡Age characteristics were broadly grouped to represent pediatric (0-17 y), adult (18-59 y), and geriatric (≥ 60 y) patient populations.
§Time of day or type of shift during which patient was seen. Three specific physician shifts exist in the ED at SMGH: the day shift from 7 AM to 3 PM, the evening shift from 2 PM to 10 PM, and the night shift from 9 PM to 7 AM.

investigations. This was the case for 19 of 22 categories of laboratory and imaging investigations studied (**Table 2**). The only significant differences between the study groups were for CT scans, ultrasound scans, and D-dimer assays. Specifically, patients seen when residents were present in the ED were approximately 3 times as likely to have CT or ultrasound imaging ($P = .0012$ and $P < .001$, respectively), while patients seen when residents were not in the ED were approximately 3 times as likely to have D-dimer testing ($P = .03$). However, we suspect that the noted differences are directly attributable to test availability and not owing to the presence or absence of residents.

In terms of background characteristics, the 2 patient groups were very similar for most categories (**Table 1**). However, one significant difference between the groups was the distribution of time of day during which the patients were seen ($P < .001$ for all). Specifically, most patients seen when residents were present were seen during daytime hours, while the opposite was true for patients seen when no residents were present. This is confirmed by checking the staffing schedule, which shows residents are predominantly scheduled for daytime shifts. It is possible that the minor differences in patients with a CTAS level of 4 and in geriatric patients between the 2 study groups are also owing to this shift distribution, with the daytime shifts having a higher volume of less acute and older patients.

More important, we believe that this unequal shift distribution is the likely explanation of the differences in imaging and D-dimer testing noted in **Table 2**. At the SMGH site, an operational constraint is that during evening and night shifts, ultrasound scans are not available and CT scans require direct verbal approval from the attending radiologist. Therefore, stable patients seen during evening and night shifts who require further imaging are discharged home with instructions to return the following day. Given this variance in imaging availability and the evident bias toward daytime shifts for residents, we were not surprised that the number of CT and ultrasound examinations ordered for patients seen when residents were present was significantly higher ($P = .0012$ and $P < .001$, respectively) than for patients seen when no residents were present. The shift distribution might also explain the increased use of D-dimer testing in the group of patients seen when no residents were present. Our suspicion is that the difficulty in obtaining CT scans overnight is creating a bias toward D-dimer testing.

The remaining data suggest that the presence of family medicine residents in this rural community ED did not change the number of diagnostic investigations. The data for both groups are remarkably similar across all the categories of investigations. This is in keeping with previous work by Sexton et al[16] and McNamara and Kelly,[17] which showed no increase in investigations after introduction of trainees in hospital EDs. To our knowledge, our study is the first to examine the effect of family medicine residents in an ED setting, the first to determine the effect of residents on a large number of common ED investigations, and the first such study conducted in a Canadian ED. Although our data align with those of other studies assessing the clinical effect of residents,[12-17] they are also in conflict with many others[7-11] that show the presence of residents does substantially increase the burden of diagnostic investigations or associated cost. One possibility for the lack of consensus in the literature is the clinical situations in which the studies were performed. The previous studies by McNamara and Kelly[17] and Sexton et al[16] were performed in the emergency medicine environment, as was our study. This differs from most of the other studies, which were conducted in various inpatient services. We suspect that given the acuity, possible severity, and short duration of

Table 2. Ordered investigations by study group

INVESTIGATION	NO RESIDENT IN THE ED, N (%) (N = 709)	RESIDENT PRESENT IN THE ED, N (%) (N = 911)	*P* VALUE*
Basic chemistry†	161 (22.7)	207 (22.7)	.99
Basic hematology‡	169 (23.8)	210 (23.1)	.71
Extended chemistry§	25 (3.5)	44 (4.8)	.20
ESR and CRP test	3 (0.4)	5 (0.5)	.72
Blood gas test‖	8 (1.1)	22 (2.4)	.06
Coagulation	38 (5.4)	42 (4.6)	.49
D-dimer assay¶	12 (1.7)	5 (0.5)	.03
Pregnancy test#	31 (4.4)	30 (3.3)	.26
Upper abdomen enzyme test**	59 (8.3)	76 (8.3)	.99
Cardiac enzyme test††	50 (7.1)	55 (6.0)	.41
Urinalysis	21 (3.0)	26 (2.9)	.90
Urine culture	48 (6.8)	59 (6.5)	.81
Blood culture	15 (2.1)	9 (1.0)	.06
Throat culture	21 (3.0)	33 (3.6)	.46
Stool culture	7 (1.0)	4 (0.4)	.18
Genital culture‡‡	6 (0.8)	6 (0.7)	.66
Urine toxicology§§	16 (2.3)	15 (1.6)	.37
Serum toxicology‖‖	11 (1.6)	13 (1.4)	.84
Other laboratory examinations¶¶	39 (5.5)	49 (5.4)	.91
Plain film x-ray scans	191 (26.9)	269 (29.5)	.25
CT scans	13 (1.8)	44 (4.8)	.0012
Ultrasound scans##	12 (1.7)	48 (5.3)	< .001

CRP—C-reactive protein, CT—computed tomography, ED—emergency department, ESR—erythrocyte sedimentation rate, INR—international normalized ratio, MDMA—3,4-methylenedioxymethamphetamine.

*P values calculated using the Pearson χ^2 method.

†One or more of sodium, potassium, chloride, bicarbonate, urea, creatinine, or glucose tests, or anion gap.

‡One or more of leukocyte count, erythrocyte count, hemoglobin test, hematocrit measurement, mean corpuscular volume, red blood cell distribution width, thrombocyte count, differential white blood cell count, and blood film test.

§One or more of albumin, total protein, calcium, magnesium, or phosphate tests.

‖One or more of capillary, arterial, or venous gas tests.

¶One or more of INR, partial thromboplastin time, or fibrinogen test.

#One or more of qualitative or quantitative serum or urine β-human chorionic gonadotropin tests.

**One or more of alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, γ-glutamyltransferase, lipase, or bilirubin (indirect or direct reacting) tests.

††One or more of creatine kinase or troponin tests.

‡‡One or more of vaginal culture, cervical culture, urethral culture, gonorrhea test, or chlamydia test.

§§One or more of amphetamine, barbiturate, benzodiazepine, cannabinoid, cocaine, methadone, methamphetamine, MDMA, morphine, oxycodone, or tricyclic antidepressant tests.

‖‖One or more of salicylate, acetaminophen, or ethanol tests.

¶¶Any laboratory investigations not specifically included in any other category.

##Excludes bedside ultrasound investigations.

patient encounters in the ED, residents are being more closely monitored than in other clinical situations. This results in minimal deviation for residents from the practice pattern of the attending physician in the ED.

Limitations

We acknowledge that this study has several limitations in its design and implementation. Most notable is the difference in shift distribution between the study groups. An additional limitation is the absence of some common investigations. The electronic records at SMGH do not include documentation of electrocardiograms. As such, this investigation was excluded from the study. Likewise, although formal urinalysis was included, this study did not account for the frequent use of bedside "urine dips," of which there are no electronic records. The SMGH also lacks magnetic resonance imaging capabilities, and data on this imaging modality were therefore not available

for study. Another limitation of this study is the use of aggregate categories of investigations. This study does not differentiate between patients who had single or multiple tests within the same category: it would consider patients who had a single versus multiple plain film x-ray scans or patients who had a single lithium level measurement versus a full serum toxicology panel to be equal. Given this, it is conceivable that residents could cause a difference in investigations that would not be determined by the methodology of this study. A further limitation is the lack of blinding. Given the lack of available resources for this study, the data collection was completed entirely by the primary author (A.S.). Finally, the total number of enrolled patients, which was 1620, meant the study was underpowered to determine significance between the study groups for most categories for the small differences that were found. However, we propose that even if these differences were found to be significant upon a repeated, properly powered study, these small differences would likely have a minimal effect on overall diagnostic costs in the ED.

Conclusion

The trends demonstrated in this study suggest that the presence of family medicine residents in a rural community ED does not substantially affect the overall use of diagnostic investigations. We propose that based on these results, concerns about increased use of diagnostic resources by residents and associated financial costs are currently unfounded, and should not impede smaller community EDs from instituting training opportunities for family medicine residents. However, we also suggest that given the lack of adequate statistical power available in this study, further study is required to determine the effect of some of the small non-significant differences noted in this study. We further suggest that studies assessing other markers such as length of stay, wait times, and patient outcomes also need to be conducted to determine the total effect of residents in the ED.

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Contributors

Dr Seong completed the literature review, data collection, statistical analysis, and writing of the manuscript. **Dr Osmun** initiated the study concept, provided supervision, and reviewed the manuscript for submission.

Competing interests

None declared

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