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Title	Patient and non-patient factors and resource use associated with short internal medicine hospital admissions: a multicentre cross-sectional study
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Reviewer 1	Lee-Ann T. Hawkins MD
Institution	Department of Medicine, University of Calgary, Calgary, Alta.
General comments (author response in bold)	<p>Verma et al of the GEMINI team (a collaboration of researchers from 5 teaching hospitals in the Greater Toronto Area) have conducted a novel, multi-centre cross-sectional study of patient and physician factors associated with short duration admission to Internal Medicine. This Canadian study is highly relevant given the current inpatient bed shortages across the country and high costs associated with inpatient admission and services delivered. Furthermore, there is little data available on this population of patients and so the data reported in this study is both novel and much needed. Although the data reported is descriptive, the parallel analyses of the two hospitalization durations (<24 hours and <72 hours) provide a framework that could be used to determine how best to serve these populations of patients in an attempt to avoid admission and reduce cost. The inclusion of ICD-10 diagnosis data as well as the type of services delivered within the admission timeframe are important when looking at development of service delivery that could reduce admission. Moreover, this study should serve as an example that other regions in Canada could follow in order to more fully understand their own inpatient resource allocation.</p> <p>The GEMINI team has designed a strong study and they have described their methods adequately. Inclusion and exclusion criteria are well defined. The authors have identified and accounted for any bias that could hinder their results (ex. Lack of physician sex bias due to subspecialty given the homogenous Internal Medicine cohort of attending physicians). Their interpretation of the results sheds light on other factors that could be important but that weren't measured due to limitations in their study design (ex. Resident practices overnight, patient seen by Internal Medicine in the Emergency Department but not admitted). These are areas for future research.</p> <p>I support accepting this manuscript for publication but recommend trimming to reduce its size. The supplementary tables do not add value to the paper and could be removed.</p> <p>Thank you for the comments and the opportunity to revise and resubmit.</p>
Reviewer 2	Brian Lucas MD
Institution	White River Junction VA Medical Center, Medicine Services, Vermont
General comments (author response in bold)	<p>Verma et al address a topical issue in a well-written paper using data from 5 hospitals in Canada that spans 3 years. They found several characteristics (of physicians, patients, and 'situations') that are associated with short hospitalizations to general internal medicine services. However, several important issues ought to be considered further, which I enumerate below.</p> <p>Major 1: Are the multilevel models accurately described? In the footnote to Table 2, the authors describe a 3-level model with patients at level 1, nested within physicians at level 2, nested within hospitals at level 3. Although the authors' data structure does have 3-levels, their statistical model only has 2, because the hospitals are modeled as fixed effects. Most authors recommend delineating a level only when a random effect is assigned to it (see Rabe-Hesketh S, Skrondal A. Multilevel and longitudinal modeling using Stata. Volume 1: Continuous Responses, 3rd Ed. Stata Press; College</p>

Station, TX; 2012, page 386). More importantly, the authors give the impression that patients are wholly nested within physicians. But weren't many of the patients (especially over a 3-year period) readmitted under different physicians? Another way to build the model, which accounts for repeat admissions, is to treat hospitalizations as level 1. This would be a 2-level model with physicians and patients at level 2 (each with their own random intercept) and hospitalizations at level 1. The salutary benefit of this portrayal is that the 'situational' characteristics are actually hospitalization characteristics. (Some authors may portray these hospitalizations as 'non-multiplicative interactions' between physician and patient; others portray them as 'additive crossed random-effects models', see Rabe-Hesketh & Skrondal, page 446). Whatever the authors decide, they should clearly explain how repeat admissions (i.e., clustering within patients) was accounted for.

Major 2: The sampling frame (denominator) is the wrong one. Just as the authors have described, the revealing comparisons are between characteristics of the short-admission and non-short-admission patients. However, the population from which the patients should be sampled is all patients referred for admission, not just those who were eventually admitted. Isn't it possible, for example, that certain physicians are discharging all of the potentially short-admission patients on referral, before they are even admitted? Doing so actually paradoxically increases their likelihood of having non-short-admission patients. This is, I think, a manifestation of the 'Will Rogers phenomenon,' an artifact that has been described in stage migration for cancer (N Engl J Med 1985;312:1604). Although the authors mention this issue briefly in Interpretation regarding why women physicians may have had lower likelihoods of short-admissions (page 13, line 15), it is a subtle but important point that deserves more highlight. For example, perhaps one potential intervention (page 11, lines 9 through 39) is to facilitate more discharges directly from the ED?

Major 3: Why have the authors generated subject-specific instead of population-averaged odds ratios? Their current odds ratios are slightly inflated because of this. More importantly, their interpretation is non-standard. Rather than the average effects for patients, their odds ratios reflect the average effects for the average physician (see Neuhaus et al. A comparison of cluster-specific and population-average approaches for analyzing correlated binary data. Int Stat Rev 1991;59:25-35 and Hedeker et al. A note on marginalization of regression parameters from mixed models of binary outcomes. Biometrics 2018;74:354).

Minor 1: Who makes admission decisions? Is it the emergency room physician or the admitting hospitalist (see Major 2 above)? This should be clearly described.

Minor 2: How do trainees fit in at these academic hospitals? Were the 'most responsible physicians' always attending physicians? Surely the trainees (particularly the more ones) influence the attending physicians. If trainees were possible factors, the authors should explain why they weren't incorporated into the models.

Minor 3: Beyond the decision to admit, another pertinent decision relevant to the outcome of interest is the decision to discharge. Was the 'most responsible physician' usually the discharging physician? This distinction should be described.

Minor 4: A related issue is how often the 'most responsible physician' transitioned on and off service, because the frequency of these transitions may impact length of stay by, for example, 'cleaning house' before transitions occur. At a minimum hospitalists' rotation durations should be described.

Minor 5: Did the treatments and studies described in Table 4 (and on page 7, lines 10 through 20 and on page 10, lines 23 through 35) all occur on the GIM ward? If so, this should be mentioned. If not, I am not sure why they are relevant.

Minor 6: Others have found (see reference no. 9, for example) that consultations are a major factor in length of stay. If whether or not a consultation was performed is not available in the dataset, this should be mentioned as a limitation.

Minor 7: How was length-of-stay defined? From ED door, referral to GIM, order to admit to GIM, or arrival on the GIM ward? This should be described.

Minor 8: Present the ICC. Given the importance of reporting the ICC (Ukoumunne Obioha et al. Evaluation of health interventions at area and organisation level. BMJ 1999;319:376), and given that the ICC is readily obtainable from the authors' mixed-effects models, it should be reported.

Minor 9: Increase the intervals for age and years since graduation (Table 2) so that they are more meaningful (eg, 5- or 10-year intervals).

Thank you for the comments and the opportunity to revise and resubmit.