Practice variation and practice guidelines: Attitudes of generalist and specialist physicians, nurse practitioners, and physician assistants

David A. Cook¹,²,³*, Laurie J. Pencille¹,⁴, Denise M. Dupras⁵, Jane A. Linderbaum¹,⁶, V. Shane Pankratz⁷, John M. Wilkinson⁸

¹ Knowledge Delivery Center, Mayo Clinic, Rochester, Minnesota, United States of America, ² Mayo Clinic Online Learning, Mayo Clinic College of Medicine, Rochester, Minnesota, United States of America, ³ Division of General Internal Medicine, Mayo Clinic, Rochester, Minnesota, United States of America, ⁴ Center for the Science of Health Care Delivery, Mayo Clinic, Rochester, Minnesota, United States of America, ⁵ Division of Primary Care Internal Medicine, Mayo Clinic, Rochester, Minnesota, United States of America, United States of America, ⁶ Department of Cardiovascular Diseases, Mayo Clinic, Rochester, Minnesota, United States of America, ⁷ Department of Internal Medicine, University of New Mexico Health Sciences Center, Albuquerque, New Mexico, United States of America, ⁸ Department of Family Medicine, Mayo Clinic, Rochester, Minnesota, United States of America

* cook.david33@mayo.edu

Abstract

Objective
To understand clinicians’ beliefs about practice variation and how variation might be reduced.

Methods
We surveyed board-certified physicians (N = 178), nurse practitioners (N = 60), and physician assistants (N = 12) at an academic medical center and two community clinics, representing family medicine, general internal medicine, and cardiology, from February—April 2016. The Internet-based questionnaire ascertained clinicians’ beliefs regarding practice variation, clinical practice guidelines, and costs.

Results
Respondents agreed that practice variation should be reduced (mean [SD] 4.5 [1.1]; 1 = strongly disagree, 6 = strongly agree), but agreed less strongly (4.1 [1.0]) that it can realistically be reduced. They moderately agreed that variation is justified by situational differences (3.9 [1.2]). They strongly agreed (5.2 [0.8]) that clinicians should help reduce healthcare costs, but agreed less strongly (4.4 [1.1]) that reducing practice variation would reduce costs. Nearly all respondents (234/249 [94%]) currently depend on practice guidelines. Clinicians rated differences in clinician style and experience as most influencing practice variation, and inaccessibility of guidelines as least influential. Time to apply standards, and patient decision aids, were rated most likely to help standardize practice. Nurse practitioners
and physicians assistants (vs physicians) and less experienced (vs senior) clinicians rated more favorably several factors that might help to standardize practice. Differences by specialty and academic vs community practice were small.

**Conclusions**

Clinicians believe that practice variation should be reduced, but are less certain that this can be achieved. Accessibility of guidelines is not a significant barrier to practice standardization, whereas more time to apply standards is viewed as potentially helpful.

**Introduction**

Practice variation is an important target for clinical systems improvement. Although some variation in clinical practice is justified, unwarranted variation—“variation that is not explained on the basis of illness, patient risk factors or patient preferences”[1]—is common. This can lead to underuse of effective care, overuse of non-beneficial services, and emphasis on physician opinions rather than patient preferences.[2, 3] Unwarranted variation has been linked to suboptimal outcomes[4–8] and to increased cost for the same outcome (i.e., inefficient care).[9, 10]

While clinical practice guidelines offer one potential solution to unwarranted practice variation,[5, 11, 12] implementation of guidelines encounters resistance, including both unintentional and intentional non-adherence.[13–17] Studies exploring clinicians’ reasons for resistance to guidelines have identified concerns about decreased autonomy, oversimplification of medicine, uncertainty regarding the evidence base, financial conflicts of interest, and potential litigation.[18–23] Interventions to improve guideline adherence have met with only modest success.[24] Other approaches to reducing practice variation include patient decision aids,[25, 26] clinical decision support,[27–29] provider performance feedback,[29, 30] provider financial incentives,[31–33] and regulatory changes,[34] yet these too have had limited impact. Given these suboptimal results, we believe that before further trying to solve the problem of practice variation, we ought to better understand the nature of practice variation itself, including clinician beliefs about the issue.

Qualitative studies have empirically identified sources of practice variation, including the clinician (including personal experiences and attitudes), the patient and family, and the work environment.[35–37] Conceptual models have added social values and regulatory bodies to the list.[38] Yet we found no quantitative studies that directly explored the prevalence of clinician attitudes about practice variation. Moreover, studies exploring attitudes about clinical practice guidelines[13, 19, 20] and evidence-based medicine[39, 40] have incompletely explored how attitudes vary across clinician characteristics such as time in practice, provider type, and specialty. To address these gaps, we surveyed generalist and specialist clinicians to answer the following research questions:

1. What do clinicians believe about the sources and impact of practice variation?
2. What do clinicians believe about the credibility and utility of clinical guidelines and other approaches to reduce variation?
3. How do these beliefs vary by provider type, time in practice, specialty, and practice location?
We anticipated that nurse practitioners / physician assistants (given the pragmatic nature of their training and practice), clinicians early in their career (who may rely on external supports as they continue to learn), and generalists (who must treat a wide variety of often-unfamiliar conditions), would have more favorable beliefs about guidelines than physicians, senior clinicians, and subspecialists, respectively.

Methods
Overview
Clinicians completed a 27-item survey regarding their beliefs about clinical guidelines and practice variation, as part of a larger study exploring clinical decision-making in the context of written clinical vignettes (manuscript submitted).

Questionnaire development
An extensive search of PubMed did not reveal an existing questionnaire that specifically addressed our questions regarding clinician attitudes about practice variation, so we created a new questionnaire. We used prior surveys and review articles[19, 20, 40–43] to generate a list of relevant themes. From these we developed 14 Likert-type items regarding clinical guidelines and practice variation generally (response options, 1 = strongly disagree, 6 = strongly agree), and 13 items exploring the impact on practice variation of six specific situational or personal factors and seven potential practice changes (response options, 1 = not at all, 4 = very). Authors DAC and DMD, both of whom have specialized training and extensive experience in survey item development, supervised the development process and examined the wording of each item. We iteratively reviewed and revised all items, including incorporation of findings from pilot-testing by two internal medicine physicians. Table 1 contains the final full text of all items. Respondents self-reported demographic information on their provider type, time in practice, specialty, and practice location. The survey also asked respondents to describe how they would manage four hypothetical patients (written clinical vignettes, not reported in this manuscript) presenting for routine management of hyperlipidemia or syncope. Two of the Likert-type items and all 13 impact items appeared after the vignettes; since not all respondents completed the vignettes, the response rate for these “second half” items is lower than for the 12 "first half" items.

Sampling, participants, and survey administration
We sent email invitations to all 617 clinicians (458 physicians, 123 nurse practitioners, and 36 physician assistants) in the Mayo-Rochester, MN Divisions of General Internal Medicine (N = 123), Primary Care Internal Medicine (N = 86), and Cardiology (N = 228), the Mayo-Rochester Department of Family Medicine (N = 92), and the Mayo Clinic Health System community sites in Austin, MN (N = 19) and La Crosse, WI (N = 69). Participants were offered a monetary incentive. The study was judged exempt by the Mayo Clinic Institutional Review Board.

We used SurveyMonkey to administer the questionnaire from 26 February to 20 April, 2016. The invitation email indicated that this was a "research study to understand how clinicians make decisions at the point of care." All data were anonymous although we did track responses. Invitees received up to two reminders.

Our original goal was to obtain data from 120 participants, and we over-enrolled participants in order to allow for those who might start but not finish the survey. The response to our invitations and the volunteer rate were higher than expected, such that we exceeded our target
and had to close the survey before all those invited had a chance to respond, due to limited funds for participant remuneration.

**Statistical analyses**

We report means, median, and standard deviation for each item. We determined the frequency of favorable responses (e.g., "agree" or "important") by dichotomizing results as above or below the midpoint of the respective scale. We classified time in practice as early (≤10 years), mid (11–20 years), and late (>20 years) career. We used Kruskal-Wallis tests to
compare responses across demographic subgroups. We used Cohen’s d to calculate a standardized mean difference for statistically significant models, and classified these differences as small (d = 0.2–0.49), moderate (d = 0.5–0.79), or large (d ≥ 0.8). To compare those who completed the entire survey vs those who completed only the first half we used chi-squared tests to compare demographic features, and used Kruskal-Wallis tests to compare responses for four a priori “key items” (regarding responsibility to reduce cost, benefit of reducing variation, dependence on guidelines, and justification of variation). We used Wilcoxon signed rank tests to compare item responses within individuals. To explore the possibility that nonrespondents were systematically different from respondents we compared available demographic information (provider type, specialty, and practice location) among respondents and non-respondents using the chi-squared test. Because we stopped enrollment before all those invited could respond, we modeled the probability of participation as a function of the time allowed to reply to the survey invitation. From this model, we predicted the probability of participation for all individuals according to the larger of either 14 days (the per-protocol minimum) or the actual time allowed to respond to the invitation. The “expected” response rate was the average of these individual-level predictions that accounted for the early withdrawal of some invitations. Given the large number of comparisons, we used a two-tailed alpha level of 0.01 as the threshold of statistical significance. We used SAS version 9.4 (SAS Institute Inc., Cary, North Carolina). We powered the study for the analysis of the vignette management (to be reported elsewhere), and estimated the required sample size at 120. We did not separately power this survey study.

Results
Two hundred fifty clinicians completed at least one questionnaire item (response rate 41%). We found no statistically significant differences in provider type, specialty, or practice location for respondents vs nonrespondents. As a secondary estimate of response, we determined the response rate expected if all those invited had had an equal chance of responding (i.e., if none had been uninvited) at 45%.

The sample included 178 physicians, 60 nurse practitioners, and 12 physician assistants. Respondents had been in clinical practice a mean (SD) of 15.1 (11.3) years. Table 2 lists additional demographics. We found no statistically significant differences between the 153 respondents (61%) who completed the second half of the survey and those who completed only the first half, in demographic features (provider type, time in practice, specialty, or practice location; p > .15) or in responses to the key questionnaire items (listed in Methods; p > .06).

Main survey findings

Impact and sources of variation in care. Clinicians generally agreed that practice variation should be reduced (mean [standard deviation], 4.5 [1.1]; 1 = strongly disagree, 6 = strongly agree), but 65/152 (43%) respondents agreed less strongly that it can realistically be reduced (4.1 [1.0], p < .001). Clinicians believed that reducing variation would benefit most patients (4.6 [1.1]), and only slightly agreed that variation is justified by differences in clinical situations (3.9 [1.2]).

When asked to rate factors that influence practice variation (1 = no impact, 4 = high impact), respondents perceived differences in clinician style (3.3 [0.6]) and experience (3.2 [0.6]) as most influential, while patient differences (3.0 [0.7]) and preferences (2.9 [0.8]) were moderately influential. Lack of access to guidelines was only slightly/moderately influential (2.6 [0.9]).
When asked to rate factors that might help to standardized practice (1 = not at all helpful, 4 = very helpful), respondents rated time to identify and apply standards the highest (3.5 [0.7]), followed by patient decision aids (3.2 [0.8]), institution-wide standard practices (3.1 [0.9]), and standardized order sets (3.1 [0.9]). Having someone else order common tests was rated lowest (2.3 [1.1]).

Cost. Clinicians strongly agreed (5.2 [0.8], range 1–6) that clinicians have a responsibility to reduce the cost of care. They agreed less strongly (4.4 [1.1]) that reducing practice variation would reduce costs.

Guidelines and evidence. Nearly all respondents (234/249 [94%]) agreed that they depend on practice guidelines to help them provide patient care (mean 4.9 [0.9], range 1–6). They reported that they are quick to adapt their own practice to align with new guidelines (4.5 [0.9]) and agreed that clinicians should apply new research findings (4.5 [1.0]). Respondents were slightly less favorable regarding the ease of applying guidelines to their patients (4.2 [0.9]). Only 130/250 (52%) agreed that practice standards are hard to find and apply (mean 3.5 [1.3]).

Nearly all (239/248 [96%]) agreed that clinicians should encourage patients to follow guideline recommendations (4.9 [0.8]). The also agreed, but less strongly, that clinicians should resist patient requests that are not evidence-based (4.4 [1.1]).

**Analyses across clinician demographic subgroups**

Differences across provider type, time in practice, specialty, and practice location were generally small and not statistically significant (see Table 3, and S1 eTable). The statistically significant (at alpha 0.01) comparisons across provider type were that nurse practitioners and physician assistants rated more highly than physicians their trust in research (Cohen’s d = 0.42), dependence on practice guidelines (d = 0.35), quickness to align with practice guidelines (d = 0.32), and five actions that might help standardize their clinical practice (better access to guidelines and evidence, d = 0.65; more time to look up, appraise, and apply standards, d = 0.70; institution-wide standard practices, d = 0.87; decision aids for patient counseling, d = 0.56; and practice feedback, d = 0.47); all p ≤ 0.008.

We found statistically significant differences by time in practice for four items. Early- or mid-career clinicians reported higher agreement than late-career clinicians in dependence on

---

Table 2. Characteristics of invitees and respondents.

| Demographic | Feature | Invited No. (%) | Respondents No. (%) |
|-------------|---------|-----------------|---------------------|
| Provider type | Physician | 458 (74%) | 178 (71%) |
| | Nurse practitioner | 123 (20%) | 60 (24%) |
| | Physician assistant | 36 (6%) | 12 (5%) |
| Years in practice | ≤ 10 | - | 109 (45%) |
| | 11–20 | - | 66 (27%) |
| | > 20 | - | 69 (28%) |
| Specialty | Cardiology | 227 (37%) | 95 (38%) |
| | Family medicine | 181 (29%) | 76 (30%) |
| | Internal medicine | 209 (34%) | 79 (32%) |
| Practice location | Academic | 528 (86%) | 213 (85%) |
| | Community | 89 (14%) | 37 (15%) |

N = 250 respondents. Years in practice information not available for invited cohort, and not reported by 6 respondents.

https://doi.org/10.1371/journal.pone.0191943.t002
Only one analysis by specialty reached statistical significance, namely that cardiologists agreed more than internal medicine or family medicine clinicians that practice variation should be reduced (d = 0.29, p = .01; see S1 eTable). None of the comparisons between academic vs community practice location were statistically significant (p > .01; see S1 eTable).

Table 3. Survey results: Subgroup analyses by provider type and years in practice.

| Question / statement | Provider type | Years in practice | P |
|----------------------|---------------|-------------------|---|
|                      | Physicians    | NP/PA             |    |
|                      | N = 178 Mean (SD) | N = 72 Mean (SD) |    |
| Agree / disagree (range 1–6) | | | |
| Apply latest research findings | 4.4 (1.0) | 4.6 (1.1) | .08 |
| Responsibility to reduce costs | 5.2 (0.8) | 5.1 (0.8) | .30 |
| Reducing variation would benefit patientsa | 4.6 (1.0) | 4.4 (1.2) | .68 |
| Hard to find & understand practice standards | 3.5 (1.3) | 3.3 (1.3) | .26 |
| Reducing variation would reduce costsa | 4.4 (1.1) | 4.3 (1.1) | .30 |
| Trust research & systematic reviewsa | 4.1 (0.9) | 4.5 (1.0) | .001 |
| Depend on practice guidelinesa | 4.8 (0.9) | 5.1 (0.9) | .002 |
| Easy to apply practice guidelinesb | 4.2 (1.0) | 4.5 (1.0) | .02 |
| Variation justified by clinical situations | 3.8 (1.2) | 4.2 (1.1) | .03 |
| Quick to adapt to align with guidelinesa | 4.4 (0.8) | 4.7 (0.9) | .008 |
| Encourage patients to follow guideline recommendationsc | 4.8 (0.7) | 4.9 (0.8) | .18 |
| Resist patient requests not grounded in evidence | 4.4 (1.0) | 4.3 (1.2) | .91 |
| Variation should be reducedab | 4.5 (1.1) | 4.6 (0.9) | .64 |
| Variation can realistically be reducedb | 4.1 (1.0) | 4.0 (0.9) | .44 |
| How much impact on between-clinician variation? (range 1–4) | | | |
| Lack access to evidence & guidelinesb | 2.6 (0.8) | 2.8 (0.9) | .12 |
| Lack awareness evidence & guidelinesb | 2.9 (0.7) | 3.0 (0.7) | .39 |
| Differences in context & patient populationab | 3.0 (0.7) | 3.0 (0.7) | .90 |
| Differences in clinician experience & trainingb | 3.2 (0.7) | 3.3 (0.6) | .22 |
| Differences in clinician style & preferencesb | 3.2 (0.7) | 3.3 (0.6) | .75 |
| Individual patient preferencesb | 2.8 (0.8) | 3.0 (0.8) | .08 |
| How helpful to standardize your practice? (range 1–4) | | | |
| Access to guidelines & evidenceab | 2.8 (0.9) | 3.4 (0.8) | < .001 |
| Time to look up, appraise, & apply standardsb | 3.3 (0.7) | 3.8 (0.5) | < .001 |
| Clear institution-wide standard practicesb | 2.9 (0.9) | 3.6 (0.6) | < .001 |
| Standardized order setsb | 3.0 (0.9) | 3.3 (0.9) | .07 |
| Decision aids for patient counselingb | 3.1 (0.9) | 3.6 (0.6) | .001 |
| Feedback comparing my practice with othersab | 2.8 (1.0) | 3.3 (0.8) | .009 |
| Someone else order straightforward testsb | 2.2 (1.1) | 2.3 (1.1) | .62 |

NP/PA = nurse practitioner / physician assistant, SD = standard deviation, yrs = years. See Table 1 for exact wording and response options for each item. Six respondents did not report time in practice.

a Missing 1 data point (N = item total-1).
b Sample size N = 153 for this item unless otherwise noted by additional footnote; provider type N = 105 physicians, N = 48 NP/PAs; time in practice N = 70 at ≤10 years, N = 39 at 11–20 years, N = 39 at >20 years.
c Missing 2 data points (N = item total-2).
d Missing 3 data points (N = item total-3).

https://doi.org/10.1371/journal.pone.0191943.1003
Discussion

The physicians, nurse practitioners, and physician assistants responding to this survey agreed that practice variation should be reduced, but many seemed to have reservations about the feasibility of this aim. Time to appraise and apply practice standards was rated as most helpful in standardizing practice. By contrast, access to guidelines was not perceived to be an important factor in creating or resolving practice variation. Clinicians perceived that differences in clinician style and experience have more influence on variation than patient differences or preferences. In subgroup analyses, nurse practitioners and physician assistants had more favorable beliefs than physicians about practice guidelines and the potential value of several other changes to help standardize practice. Younger clinicians rated nearly all proposed approaches to standardization as more helpful. These differences were, with one exception, small or moderate in magnitude (Cohen’s d<0.8). Generalists and specialists, and those at academic vs community sites, had overall similar beliefs.

Limitations

The generalizability of our findings is limited by the response rate and the sampling from a single geographic region and health system. While it is possible that those completing the survey had stronger feelings about the topic than those who did not, the invitation email did not mention practice variation or clinical practice guidelines, and respondents were similar to non-respondents for available demographics. We acknowledge the large number of statistical tests and suggest that statistically significant findings should be interpreted cautiously, highlighting potentially interesting relationships that may merit further study. Finally, it is possible that those responding to the second-half items were systematically different from those who responded only to the first-half items (although we found no differences between these groups in demographic features or responses to the key items), or that the clinical vignettes could have shaped their responses to the second-half items.

Strengths include the sample that encompassed multiple provider types and specialties, and both academic and community sites; the carefully developed survey; and the sample size that exceeded our planned enrollment.

Integration with prior work

Our findings extend those of earlier qualitative studies[35, 36, 40] by prioritizing the factors that influence variation. Our findings also parallel prior work exploring the adoption of or resistance to clinical practice guidelines, namely that physicians have favorable attitudes about practice guidelines in general yet remain somewhat skeptical of specific recommendations, have difficulty applying them to specific patients, and lack time to do so.[18–20] A recent review of studies exploring non-adherence to guidelines found that much non-adherence is intentional, and at least partly warranted by patient decisions or case-specific contraindications.[13] Similar to our results, at least one US study has found more favorable attitudes among younger physicians.[44] By contrast with our findings, a study in Norway found significantly greater challenges for generalists compared with non-generalist physicians.[43]

Implications

The clinicians in this sample did not express strong concerns about practice variation: about two-thirds agreed that variation is justified by relevant clinical differences, and the vast majority indicated that they already follow guidelines themselves. While some variation is indeed justified,[13] studies suggest that non-adherence to guidelines is widespread.[1, 16,
Moreover, clinicians’ perceptions of their own guideline adherence is typically more favorable than reality.[46–48] Yet even if clinicians are mistaken in their beliefs, their perceptions must be taken seriously and at face value. It will be difficult to fix the problem if those involved fail to recognize its magnitude, importance, or potential for correction. Changing attitudes will require that beliefs be acknowledged, needs understood, evidence sought, and misperceptions corrected. Systems-level solutions will play an essential role in standardizing practice, but attempts to circumvent clinicians, i.e., through automated implementation of guidelines, may backfire. We note, for example, that the lowest-rated item on our survey was a potential practice change in which someone else would order common or straightforward tests.

Physicians seem to have lingering doubts that practice variation can be reduced. This may reflect low "outcome expectancy"—the belief that certain outcomes will result from given actions.[49] Before clinicians will invest personal effort, they must believe that their efforts will result in desired outcomes.[18] Low outcome expectancy may reflect concerns about the effectiveness of currently-available solutions including guidelines,[18, 19, 21, 22] decision aids,[25] clinical decision support tools,[27] and individual performance feedback.[30] Research to identify new solutions, and how to more effectively implement existing ideas, remains a top priority. Alternatively, doubts about reducing practice variation may reflect a lack of personal self-efficacy—the capability to perform at a certain level in a specific task and context.[50] Research exploring how to influence clinicians’ self-efficacy and other motivations may prove insightful.[49, 51, 52]

Although younger clinicians and nurse practitioners and physician assistants rated several items higher than senior clinicians and physicians, relative prioritizations (rankings) were generally uniform across subgroups. This suggests that solutions need not target specific groups during development, although testing during implementation would be warranted.

Perhaps most importantly, our respondents indicated that the factor anticipated to most help standardize their clinical practice is not new standards or better access to guidelines, but is rather time to apply existing standards. Others have reported similar beliefs.[18, 19] This suggests that instead of focusing attention exclusively on developing and implementing guidelines, we might have more success by freeing up clinicians’ time or reducing the time needed to apply patient-tailored guideline recommendations. Since decreasing clinicians’ time burden is likely unrealistic (and, even if achieved, might not actually be used to study and apply standards), we propose to focus on how to efficiently integrate practice standards into clinicians’ workflow.

Conclusions

Clinicians believe that practice variation should be reduced, but are less certain that this can be achieved. Accessibility of guidelines is not a significant barrier to practice standardization, whereas more time to apply standards is viewed as potentially helpful.

Supporting information

S1 eTable. Survey results: Subgroup analyses by specialty and practice location. (DOCX)

Acknowledgments

We thank Phil Einspahr for his support in administering the survey.
Author Contributions

Conceptualization: David A. Cook, Laurie J. Pencille, John M. Wilkinson.

Data curation: David A. Cook, Laurie J. Pencille, Denise M. Dupras, Jane A. Linderbaum, John M. Wilkinson.

Formal analysis: David A. Cook, V. Shane Pankratz.

Investigation: David A. Cook, Laurie J. Pencille, Denise M. Dupras, Jane A. Linderbaum, V. Shane Pankratz, John M. Wilkinson.

Methodology: David A. Cook, Denise M. Dupras, V. Shane Pankratz.

Project administration: David A. Cook, Laurie J. Pencille.

Resources: David A. Cook.

Supervision: David A. Cook.

Validation: David A. Cook, Laurie J. Pencille, Denise M. Dupras.

Writing – original draft: David A. Cook.

Writing – review & editing: David A. Cook, Laurie J. Pencille, Denise M. Dupras, Jane A. Linderbaum, V. Shane Pankratz, John M. Wilkinson.

References

1. Corallo AN, Croxford R, Goodman DC, Bryan EL, Srivastava D, Stukel TA. A systematic review of medical practice variation in OECD countries. Health Policy 2014; 114:5–14. https://doi.org/10.1016/j.healthpol.2013.08.002 PMID: 24054709

2. Wennberg JE. Unwarranted variations in healthcare delivery: implications for academic medical centres. BMJ 2002; 325:961–964. PMID: 12399352

3. Wennberg JE. Time to tackle unwarranted variations in practice. BMJ 2011; 342:687–690.

4. McCabe C, Kirchner C, Zhang H, Daley J, Fisman DN. Guideline-concordant therapy and reduced mortality and length of stay in adults with community-acquired pneumonia: playing by the rules. Arch Intern Med 2009; 169:1525–1531. https://doi.org/10.1001/archinternmed.2009.259 PMID: 19752411

5. Patel J, Ahmed K, Guru KA, Khan F, Marsh H, Shamim Khan M, et al. An overview of the use and implementation of checklists in surgical specialties—a systematic review. Int J Surg 2014; 12:1317–1323. https://doi.org/10.1016/j.ijsu.2014.10.031 PMID: 25448652

6. van Diepen S, Bakal JA, Lin M, Kaul P, McAlist er FA, Ezekowitz JA. Variation in critical care unit admission rates and outcomes for patients with acute coronary syndromes or heart failure among high- and low-volume cardiac hospitals. J Am Heart Assoc 2015; 4.e001708. https://doi.org/10.1161/JAH A.114.001708 PMID: 25729089

7. Adam MA, Goffredo P, Youngwirth L, Scheri RP, Roman SA, Sosa JA. Same thyroid cancer, different national practice guidelines: When discordant American Thyroid Association and National Comprehensive Cancer Network surgery recommendations are associated with compromised patient outcome. Surgery 2016; 159:41–50. https://doi.org/10.1016/j.surg.2015.04.056 PMID: 26345426

8. Boland GM, Chang GJ, Haynes AB, Chiang YJ, Chapgar R, Xing Y, et al. Association between adherence to National Comprehensive Cancer Network treatment guidelines and improved survival in patients with colon cancer. Cancer 2013; 119:1593–1601. https://doi.org/10.1002/cncr.27935 PMID: 23280510

9. Clough JD, Rajkumar R, Crim MT, Ott LS, Desai NR, Conway PH, et al. Practice-Level Variation in Outpatient Cardiac Care and Association With Outcomes. J Am Heart Assoc 2016; 5.

10. Clough JD, Patel K, Shrank WH. Variation in Specialty Outpatient Care Patterns in the Medicare Population. J Gen Intern Med 2016; 31:1278–1286. https://doi.org/10.1007/s11606-016-3745-8 PMID: 27259290

11. Wooll SH, Grof R, Hutchinson A, Eccles M, Grimshaw J. Clinical guidelines: potential benefits, limitations, and harms of clinical guidelines. BMJ 1999; 318:527–530. PMID: 10024268

12. Worral G, Chauk P, Frea kD. The effects of clinical practice guidelines on patient outcomes in primary care: a systematic review. CMAJ 1997; 156:1705–1712. PMID: 9220922
13. Arts DL, Voncken AG, Medlock S, Abu-Hanna A, van Weert HC. Reasons for intentional guideline non-adherence: A systematic review. *Int J Med Inform* 2016; 89:55–62. https://doi.org/10.1016/j.ijmedinf.2016.02.009 PMID: 26980359

14. Urkin J, Allenbogen M, Friger M, Vinker S, Reuveni H, Elahayani A. Acute pharyngitis: low adherence to guidelines highlights need for greater flexibility in managing paediatric cases. *Acta Paediatr* 2013; 102:1075–1080. https://doi.org/10.1111/apa.12364 PMID: 23879261

15. Patel N, Tong L, Ahn C, Singal AG, Gupta S. Post-polypectomy Guideline Adherence: Importance of Belief in Guidelines, Not Guideline Knowledge or Fear of Missed Cancer. *Dig Dis Sci* 2015; 60:2937–2945. https://doi.org/10.1007/s10620-015-3685-x PMID: 25947332

16. Carpentier MY, Vernon SW, Bartholomew LK, Murphy CC, Bluethmann SM. Receipt of recommended surveillance among colorectal cancer survivors: a systematic review. *J Cancer Surviv* 2013; 7:464–483. https://doi.org/10.1007/s11764-013-0290-x PMID: 23677524

17. Sivananthan SN, Puyat JH, McGrail KM. Variations in self-reported practice of physicians providing clinical care to individuals with dementia: a systematic review. *J Am Geriatr Soc* 2013; 61:1277–1285. https://doi.org/10.1111/j.1532-5415.2012.04132.x PMID: 23899524

18. Cabana MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud PA, et al. Why don’t physicians follow clinical practice guidelines? A framework for improvement. *JAMA* 1999; 282:1458–1465. PMID: 10535437

19. Carlsen B, Glenton C, Pope C. Thou shalt versus thou shalt not: a meta-synthesis of GPs’ attitudes to clinical practice guidelines. *Br J Gen Pract* 2007; 57:971–978. https://doi.org/10.3399/096016470782604820 PMID: 18252073

20. Farquhar CM, Kofa EW, Slutsky JR. Clinicians’ attitudes to clinical practice guidelines: a systematic review. *Med J Aust* 2002; 177:502–506. PMID: 12405894

21. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation-A Scoping Review. *Healthcare (Basel)* 2016; 4(3).

22. Kastner M, Bhattacharya O, Hayden L, Makarski J, Estey E, Durocher L, et al. Guideline uptake is influenced by six implementability domains for creating and communicating guidelines: a realist review. *J Clin Epidemiol* 2015; 68:498–509. https://doi.org/10.1016/j.jclinepi.2014.12.013 PMID: 25684154

23. Nuckols TK, Lim YW, Wynn BO, Mattke S, MacLean CH, Harber P, et al. Rigorous development does not ensure that guidelines are acceptable to a panel of knowledgeable providers. *J Gen Intern Med* 2008; 23:37–44.

24. Flodgren G, Hall AM, Goulding L, Eccles MP, Grimshaw JM, Leng GC, et al. Tools developed and disseminated by guideline producers to promote the uptake of their guidelines. *Cochrane Database Syst Rev* 2016:CD010669. https://doi.org/10.1002/14651858.CD010669.pub2 PMID: 27546228

25. O’Connor AM, Llewellyn-Thomas HA, Flood AB. Modifying unwarranted variations in health care: shared decision making using patient decision aids. *Health Aff (Millwood)* 2004; Suppl Variation: VAR63–72.

26. Reames BN, Shubeck SP, Birkmeyer JD. Strategies for reducing regional variation in the use of surgery: a systematic review. *Ann Surg* 2014; 259:616–627. https://doi.org/10.1097/SLA.000000000000248 PMID: 24240626

27. Fiander M, McGowan J, Grad R, Pluye P, Hannes K, Labrecque M, et al. Interventions to increase the use of electronic health information by healthcare practitioners to improve clinical practice and patient outcomes. *Cochrane Database Syst Rev* 2015:CD004749. https://doi.org/10.1002/14651858.CD004749.pub3 PMID: 25770311

28. Prevedello LM, Raja AS, Ip IK, Sodickson A, Khorasani R. Does clinical decision support reduce unwarranted variation in yield of CT pulmonary angiogram? *Am J Med* 2013; 126:975–981. https://doi.org/10.1016/j.amjmed.2013.04.018 PMID: 24157288

29. Forrest CB, Fiks AG, Bailey LC, Localio R, Grundmeier RW, Richards T, et al. Improving adherence to otitis media guidelines with clinical decision support and physician feedback. *Pediatrics* 2013; 131:e1071–1081. https://doi.org/10.1542/peds.2012-1988 PMID: 23478660

30. Ivers N, Jamtvedt G, Flottorp S, Young JM, Odgaard-Jensen J, French SD, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev* 2012; 6:CD000259.

31. Scott A, Sivey P, Ait Ouakrim D, Willenberg L, Naccarella L, Furler J, et al. The effect of financial incentives on the quality of health care provided by primary care physicians. *Cochrane Database Syst Rev* 2011:CD008451. https://doi.org/10.1002/14651858.CD008451.pub2 PMID: 21901722

32. Houle SK, McAlister FA, Jackevicius CA, Chuck AW, Tsuyuki RT. Does performance-based remuneration for individual health care practitioners affect patient care?: a systematic review. *Ann Intern Med* 2012; 157:889–899. https://doi.org/10.7326/0003-4819-157-12-201212180-00009 PMID: 23247940
33. Baxter PE, Hewko SJ, Pfaff KA, Cleghorn L, Cunningham BJ, Elston D, et al. Leaders’ experiences and perceptions implementing activity-based funding and pay-for-performance hospital funding models: A systematic review. Health Policy 2015; 119:1096–1110. https://doi.org/10.1016/j.healthpol.2015.05.003 PMID: 26004845

34. McCulloch P, Nagendran M, Campbell WB, Price A, Jani A, Birkmeyer JD, et al. Strategies to reduce variation in the use of surgery. Lancet 2013; 382:1130–1139. https://doi.org/10.1016/S0140-6736(13)61216-7 PMID: 23590797

35. Wilson ME, Rhudy LM, Ballinger BA, Tescher AN, Pickerin g BW, Gajic O. Factors that contribute to physician variability in decisions to limit life support in the ICU: a qualitative study. Intensive Care Med 2013; 39:1009–1018. https://doi.org/10.1007/s00134-013-2896-x PMID: 23559079

36. Brouwers MC, Makarski J, Garcia K, Akram S, Darling GE, Ellis PM, et al. A mixed methods approach to understand variation in lung cancer practice and the role of guidelines. Implement Sci 2014; 9:36. https://doi.org/10.1186/1748-5908-9-36 PMID: 24655753

37. Grant A, Sullivan F, Dowell J. An ethnographic exploration of influences on prescribing in general practice: why is there variation in prescribing practices? Implement Sci 2013; 8:72. https://doi.org/10.1186/1748-5908-8-72 PMID: 23799906

38. Reschovsky JD, Rich EC, Lake TK. Factors Contributing to Variations in Physicians’ Use of Evidence at The Point of Care: A Conceptual Model. J Gen Intern Med 2015; 30(Suppl 3):S555–561.

39. McColl A, Smith H, White P, Field J. General practitioner’s perceptions of the route to evidence based medicine: a questionnaire survey. BMJ 1998; 316:361–365. PMID: 9487174

40. Zwolsman S, te Pas E, Hooft L, Wieringa-de Waard M, van Dijk N. Barriers to GPs’ use of evidence-based medicine: a systematic review. Br J Gen Pract 2012; 62:e511–521. https://doi.org/10.3399/bjgp12X652382 PMID: 22781999

41. Hajjaj FM, Salek MS, Basra MK, Finlay AY. Non-clinical influences on clinical decision-making: a major challenge to evidence-based practice. J R Soc Med 2010; 103:178–187. https://doi.org/10.1258/jrsm.2010.100104 PMID: 20436026

42. Mercuri M, Gafni A. Medical practice variations: what the literature tells us (or does not) about what are warranted and unwarranted variations. J Eval Clin Pract 2011; 17:671–677. https://doi.org/10.1111/j.1365-2753.2011.01689.x PMID: 21501341

43. Carlsen B, Bringedal B. Attitudes to clinical guidelines—do GPs differ from other medical doctors? BMJ Qual Saf 2011; 20:158–162. https://doi.org/10.1136/bmjqs.2009.034249 PMID: 21209148

44. Tunis SR, Hayward RS, Wilson MC, Rubin HR, Bass EB, Johnston M, et al. Internists’ attitudes about clinical practice guidelines. Ann Intern Med 1994; 120:956–963. PMID: 8172440

45. Gouvea M, Novaes Cde O, Pereira DM, Iglesias AC. Adherence to guidelines for surgical antibiotic prophylaxis: a review. Braz J Infect Dis 2015; 19:517–524. https://doi.org/10.1016/j.bjid.2015.06.004 PMID: 26254691

46. Steinman MA, Fischer MA, Shlipak MG, Bosworth HB, Oddone EZ, Hoffman BB, et al. Clinician awareness of adherence to hypertension guidelines. Am J Med 2004; 117:747–754. https://doi.org/10.1016/j.amjmed.2004.03.035 PMID: 15541324

47. Linder JA, Schnipper JL, Tsurikova R, Volk LA, Middleton B. Self-reported familiarity with acute respiratory infection guidelines and antibiotic prescribing in primary care. Int J Qual Health Care 2010; 22:469–475. https://doi.org/10.1093/intqhc/mzq052 PMID: 20935008

48. Oderda GM, Shiozawa A, Walsh M, Hess K, Brixner DI, Feehan M, et al. Physician adherence to ACR gout treatment guidelines: perception versus practice. Postgrad Med 2014; 126:257–267. https://doi.org/10.3810/pgm.2014.05.2774 PMID: 24918810

49. Cook DA, Artino AR Jr. Motivation to learn: an overview of contemporary theories. Med Educ 2016; 50:997–1014. https://doi.org/10.1111/medu.13074 PMID: 27628718

50. Bandura A: Self-efficacy. In: Encyclopedia of human behavior. Volume 4. Edited by Ramachaudran VS. New York: Academic Press; 1994: 71–81

51. Brydges R, Butler D. A reflective analysis of medical education research on self-regulation in learning and practice. Med Educ 2012; 46:71–79. https://doi.org/10.1111/j.1365-2933.2011.04100.x PMID: 22150198

52. Ng JYY, Ntoumanis N, Thøgersen-Ntoumani C, Deci EL, Ryan RM, Duda JL, et al. Self-Determination Theory Applied to Health Contexts: A Meta-Analysis. Perspectives on Psychological Science 2012; 7:325–340. https://doi.org/10.1177/1745691612447309 PMID: 26168470