

Systematic Review: The Relationship between Clinical Experience and Quality of Health Care

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Background: Physicians with more experience are generally believed to have accumulated knowledge and skills during years in practice and therefore to deliver high-quality care. However, evidence suggests that there is an inverse relationship between the number of years that a physician has been in practice and the quality of care that the physician provides.

Purpose: To systematically review studies relating medical knowledge and health care quality to years in practice and physician age.

Data Sources: English-language articles in MEDLINE from 1966 to June 2004 and reference lists of retrieved articles.

Study Selection: Studies that provided empirical results about knowledge or a quality-of-care outcome and included years since graduation or physician age as explanatory variables.

Data Extraction: We categorized studies on the basis of the nature of the association between years in practice or age and performance.

Data Synthesis: Overall, 32 of the 62 (52%) evaluations reported decreasing performance with increasing years in practice

for all outcomes assessed; 13 (21%) reported decreasing performance with increasing experience for some outcomes but no association for others; 2 (3%) reported that performance initially increased with increasing experience, peaked, and then decreased (concave relationship); 13 (21%) reported no association; 1 (2%) reported increasing performance with increasing years in practice for some outcomes but no association for others; and 1 (2%) reported increasing performance with increasing years in practice for all outcomes. Results did not change substantially when the analysis was restricted to studies that used the most objective outcome measures.

Limitations: Because of the lack of reliable search terms for physician experience, reports that provided relevant data may have been missed.

Conclusions: Physicians who have been in practice longer may be at risk for providing lower-quality care. Therefore, this subgroup of physicians may need quality improvement interventions.

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Quality assurance and performance evaluation have become central issues in medicine. Care is suboptimal in many different medical conditions and clinical settings (1–6). Although delivering high-quality care is important to all clinicians, this issue may be particularly relevant to certain subgroups, such as physicians with less specialized training and those who see a smaller volume of patients (7–10).

Physicians who have been in practice for more years may also be less likely to deliver high-quality care (11, 12). Medical advances occur frequently, and the explicit knowledge that physicians possess may easily become out of date. Therefore, although it is generally assumed that the tacit knowledge and skills accumulated by physicians during years of practice lead to superior clinical abilities (13), it is also plausible that physicians with more experience may paradoxically be less likely to provide technically appropriate care.

Few existing studies have had the specific goal of evaluating the effects of experience on the quality of medical care (11). However, length of time in clinical practice has been included as part of a set of physician characteristics that might explain variations in quality or that may be

confounders of the association between quality and other factors (13–18).

The purpose of this paper is to assess the robustness of the relationship between clinical experience and quality of care by systematically reviewing empirical studies. Although we define experience as the number of years a physician has been in practice, physician age and time in practice are highly correlated (11, 19, 20); therefore, for the purposes of this paper, we consider these variables to be interchangeable.

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METHODS

We searched MEDLINE (Ovid Technologies, 1966 to June 2004; English language) for terms describing physician experience (keywords: *physician age, clinician age, physician experience, clinician experience*), physician demographic characteristics (keywords: *physician characteristics, clinician characteristics*), practice variation (subject heading: *physician's practice patterns*), and performance in various domains (subject headings: *clinical competence, health knowledge, attitudes and practice, outcomes assessment [health care]*; keywords: *knowledge, guideline adherence, appropriateness, outcomes*). We retrieved potentially relevant articles and reviewed their reference lists to identify studies that our search strategy may have missed (Figure 1). We also searched our personal archives to identify additional studies. We included studies if they 1) were original reports providing empirical results; 2) measured knowledge, guideline adherence, mortality, or some other quality-of-care process or outcome; and 3) included years since graduation from medical school, years since certification, or physician age as a potential explanatory variable. We excluded studies if they described practice variation that is not known to affect quality of care (for example, assessed test-ordering behavior in clinical situations where optimal practice is unknown) or evaluated the performance of fewer than 20 physicians. For studies that examined several different end points, we included only those outcomes that are linked to knowledge or quality of care.

We used a standardized data extraction form to obtain data on study design and relevant results. We categorized studies into 4 groups on the basis of whether they evaluated knowledge (for example, knowledge of indications for blood transfusion), adherence to standards of care for diagnosis, screening, or prevention (for example, adherence to preventive care guidelines), adherence to standards of care for therapy (for example, appropriate prescribing), or health outcomes (for example, mortality). We classified the results of each study into 6 groups on the basis of the nature of the association between length of time in practice or age and performance: consistently negative, partially negative, no effect, mixed effect, partially positive, and consistently positive. "Consistently negative" studies were those for which all reported outcomes demonstrated a statistically significant decrease in performance with increasing years in practice or age. "Partially negative" studies showed decreasing performance with increasing experience for some outcomes and no association for others. We used similar definitions for "consistently positive" and "partially positive" studies. "Concave" studies found performance to initially improve with years in practice or age, then peak, and subsequently decrease.

We did not use formal meta-analytic techniques because the included studies used many different effect measures and some did not report parameter estimates.

Since studies based on self-reported practice may suffer

Context

While "practice makes perfect" in some situations, physicians' knowledge and performance may decline with the passage of time.

Contribution

Of 62 published studies that measured physician knowledge or quality of care and described time since medical school graduation or age, more than half suggested that physician performance declined over time for all outcomes measured. Only 1 study showed improved performance for all outcomes measured.

Implications

This review should provoke careful study of the relationship of physician experience and the quality of care. It also raises concerns about the adequacy of continuing professional education in medicine.

—The Editors

from social desirability bias (21), we explored the effect of study quality on results by subcategorizing studies according to whether they measured outcomes with self-reports (that is, using surveys and interviews) or observed practice (that is, using chart audits or administrative data review). We also compared studies according to whether they performed multivariable modeling to adjust for patient and physician covariates. We used the Fisher exact test to compare the observed frequencies. We conducted all analyses with SAS, version 8.2 (SAS Institute, Inc., Cary, North Carolina).

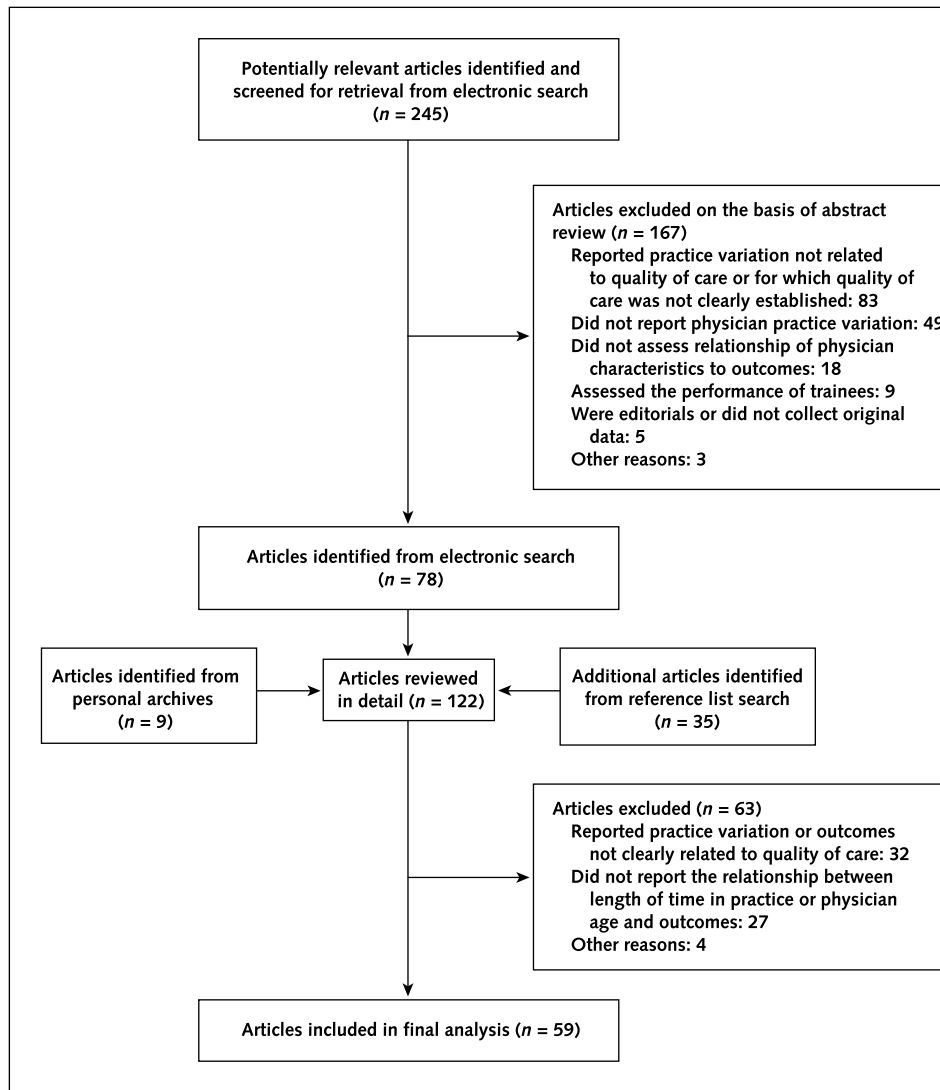
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RESULTS

Fifty-nine articles that reported data on 62 groups of relevant outcomes formed the basis of our analysis. Overall, 32 of the 62 evaluations (52%) demonstrated a negative association between increasing experience and performance (that is, performance decreased as experience increased) for all outcomes assessed; 13 (21%) reported a negative association for some outcomes but no association for other outcomes; 2 (3%) reported a concave relationship (that is, performance initially increased as experience increased, then peaked, and subsequently decreased); 13 (21%) reported no association; 1 (2%) reported a positive association (that is, performance increased as experience increased) for some outcomes but no association for other outcomes; and 1 (2%) reported a positive association for all outcomes assessed (Figure 2).

Figure 1. Selection process for studies included in analysis.



Knowledge

Twelve studies assessed the knowledge of practicing physicians, and all studies reported a negative association between knowledge and experience (Table 1). Studies by Ayanian and colleagues (7) and Salem-Schatz and colleagues (22) had large sample sizes, high response rates, and good sampling methods; used rigorous criteria to evaluate knowledge; and performed multivariate analysis.

Ayanian and colleagues (7) surveyed physicians to assess their beliefs about the survival benefit of therapies for acute myocardial infarction; the appropriate use of these therapies has been well-established in randomized, controlled trials. Specialists were more knowledgeable than generalists; however, after adjustment for this and other variables, physicians younger than 40 years of age were more likely to correctly believe in the value of therapies that improve survival (for example, thrombolytic agents,

aspirin, and β -blockers). They were also significantly less likely to believe in the value of therapies that have been disproved (for example, prophylactic lidocaine) ($P < 0.05$).

Salem-Schatz and colleagues (22) interviewed surgeons and anesthesiologists to assess their knowledge of the risks associated with and indications for the transfusion of blood products. They found a highly significant negative association between knowledge and the number of years the physicians had been in practice ($P < 0.001$).

Adherence to Standards of Practice for Diagnosis, Screening, and Prevention

Twenty-four studies have assessed the appropriateness of physician use of diagnostic and screening tests, as well as preventive health care (Table 2). Overall, 15 (63%) of these studies demonstrated that physicians in practice for

more years were less likely to adhere to standards of practice in this domain.

In the largest of these studies, Czaja and colleagues (33) surveyed participants to assess their adherence to cancer screening guidelines endorsed by the American Cancer Society and the National Cancer Institute. Physicians who had graduated more than 20 years before the survey were consistently less likely to adhere to recommended practices (odds ratio, 0.62 to 0.72; $P < 0.05$).

Using more objective measures of guideline adherence, Aubin and colleagues (17) assessed the practice of 21 physicians and found that after adjustment for patient and physician covariates, younger physicians were more likely to appropriately screen for hypertension (odds ratio, 1.11 [95% CI, 1.06 to 1.15]).

Several other studies provide contrary results. Streja and Rabkin (47) assessed the use of recommended preventive care measures and found that after adjustment for other physician covariates (such as specialty, practice style, and number of diabetic patients in their practice), older physicians were more likely than younger physicians to test for proteinuria (odds ratio, 2.62 [CI, 1.61 to 4.37]) and to refer their patients for screening ophthalmology assessments (odds ratio, 1.48 [CI, 1.01 to 2.18]). However, older physicians were no more likely to order a high-density lipoprotein cholesterol level test. Their analysis did not adjust for any patient variables, such as the presence of macrovascular and renal disease. Rhee (12) evaluated the performance of 454 physicians treating patients in 15 different medical and surgical diagnostic categories and found a concave relationship between years in practice and adherence to standards of practice. Physicians in practice for 6 to 15 years provided the most appropriate care, whereas phy-

sicians with more or fewer years of experience provided less appropriate care.

Adherence to Standards of Appropriate Therapy

Table 3 presents the 19 studies that have assessed the influence of physician age and years in practice on adherence to standards of therapy. Of these studies, 14 (74%) found a partially or consistently negative association between physician age and adherence to standards of appropriate use of therapy.

A large and well-designed study by Beaulieu and colleagues (64) examined the prescribing behavior of physicians caring for patients with stable angina. After multivariate adjustment in a hierarchical model, older physicians were significantly less likely to prescribe aspirin (odds ratio for physicians in practice for > 20 years compared with those in practice < 10 years, 0.58). Age did not affect use of β -blockers or lipid-lowering agents.

Outcomes

Seven studies present data on the relationship between number of years in practice and actual health outcomes (Table 4). The strongest of these was conducted by Norcini and colleagues (14), who analyzed mortality for 39 007 hospitalized patients with acute myocardial infarction managed by 4546 cardiologists, internists, and family practitioners. After controlling for a patient's probability of death, hospital location and practice environment, physician specialty, board certification, and the volume of patients seen, these researchers observed a 0.5% (SE, 0.27%) increase in mortality for every year since the treating physician had graduated from medical school.

Hartz and colleagues (11) specifically assessed the association between experience and mortality rates for sur-

Figure 2. Distribution of study results relating physician age to clinical performance in various domains.

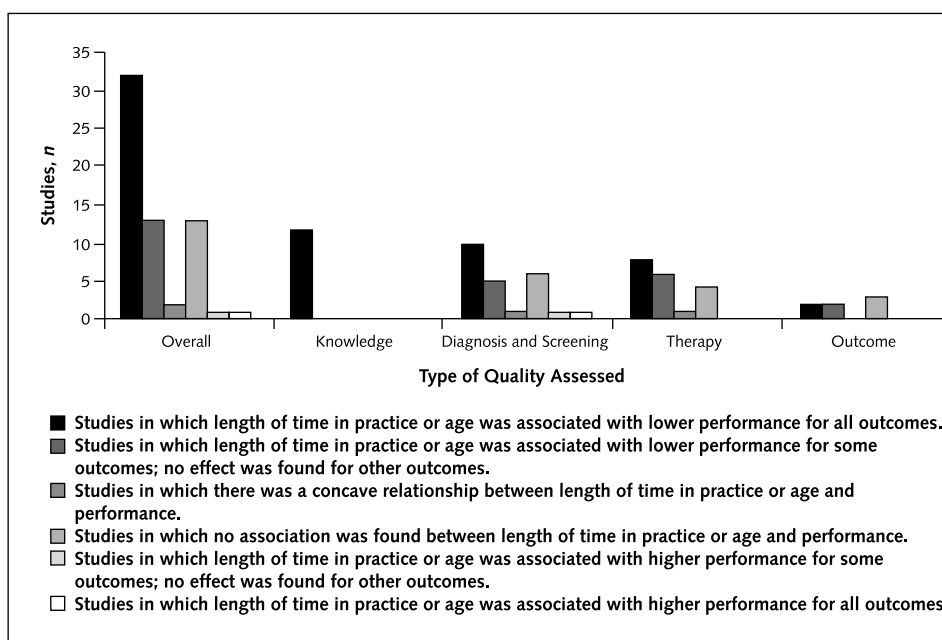


Table 1. Studies Relating Length of Time in Practice or Physician Age to Knowledge*

Study, Year (Reference)	Knowledge Being Assessed	Persons Studied, n	Results	Multivariate Adjustment for Physician Covariates?	Other Comments	Overall Effect?†
Salem-Schatz et al., 1990 (22)	Blood product transfusion	122 general surgeons, orthopedic surgeons, and anesthesiologists	Strong inverse association between years in practice and knowledge of transfusion risks and indications ($P = 0.0001$)	Yes	Knowledge assessment-based medical literature and NIH consensus conference; response rate, 91%	Consistently negative
Golden et al., 2001 (23)	Emergency contraception	233 pediatricians	Younger physicians and more recent graduates ($P = 0.02$) were more likely to identify FDA-approved methods of emergency contraception (age categorized as <40 y, 41–50 y, or >50 y)	No	Response rate, 24%	Consistently negative
Meskauskas and Webster, 1975 (24)	General medical knowledge	3356 internists certified ≥ 8 y earlier	Inverse relationship between age and ABIM recertification examination scores (age categorized as <40 y, 40–44 y, 45–49 y, 50–54 y, 54–59 y, 60–64 y, or ≥ 65 y)	No	Participants self-selected; tests of significance not presented	Consistently negative
Norcini et al., 1985 (25)	General medical knowledge	1947 internists	Inverse relationship between ABIM recertification examination scores and age (age categorized as <40 y, 40–49 y, 50–59 y, or ≥ 60 y)	No	Participants volunteered; tests of significance not presented	Consistently negative
Ramsey et al., 1991 (26)	General medical knowledge	289 internists certified 5 to 15 y earlier	Significant inverse correlation ($r = -0.3$) between score on ABIM examination questions and years since certification	Yes	Participants partially self-selected, but sample was representative of population	Consistently negative
Cruft et al., 1981 (27)	General surgical knowledge	478 surgeons certified ≥ 7 y earlier	Inverse relationship between age and performance on American Board of Surgery recertification examination (age categorized as 40–45 y, 46–50 y, 51–55 y, 56–60 y, or 61–73 y)	No	Participants self-selected; tests of significance not presented	Consistently negative
Gemson et al., 1991 (28)‡	HIV	473 internists, family practitioners, general practitioners, and obstetrician-gynecologists	Younger physicians had significantly more knowledge about AIDS ($P < 0.01$)	Yes	Knowledge assessed by using questions from National Center for Health Statistics survey and others devised by investigators; response rate, 63%	Consistently negative
Lewis et al., 1987 (29)‡	HIV	1000 general practitioners, family physicians, and general internists	Younger physicians had greater AIDS-related knowledge (consistent across variables assessed, although P values not reported)	Unclear	Measures of “competence” used were defined by group of expert clinicians at UCLA; response rate, 60%	Consistently negative
Shapiro, 1989 (30)	HIV	1271 general practitioners	Knowledge of HIV and AIDS decreased as years since graduation increased ($P = 0.008$)	Yes	Knowledge assessed with 6 questions designed by author; response rate, 70%	Consistently negative
Evans et al., 1984 (31)	Hypertension	56 family physicians	Highly significant inverse correlation between test scores and years since graduation ($r = -0.55$; $P < 0.001$)	No	Questionnaire validated to discriminate among physicians of different levels of training and specialty; response rate, 78%	Consistently negative
Ayanian et al., 1994 (7)	MI	1211 cardiologists, internists, and family practitioners	Physicians < 40 y of age had greater knowledge of evidence-based therapies ($P < 0.05$)	Yes	All physicians had served as the attending for at least 1 patient with MI within the preceding 3 mo; response rate, 61%	Consistently negative
Schroen et al., 2000 (32)	Non-small-cell lung cancer	1010 pulmonologists and thoracic surgeons	Physicians trained before 1980 more likely to underestimate survival ($P < 0.001$) and less likely to believe in value of chemotherapy in situations that have been well-established	No	Response rate, approximately 50%	Consistently negative

* ABIM = American Board of Internal Medicine; FDA = U.S. Food and Drug Administration; MI = myocardial infarction; NIH = National Institutes of Health; UCLA = University of California, Los Angeles.

† “Consistently negative” studies were those for which all outcomes demonstrated a statistically significant decrease in performance with increasing years in practice or age. “Partially negative” studies were those that showed statistically significant decreasing performance with increasing years in practice or age for some outcomes and no effect for others. Similar definitions were used for consistently positive and partially positive studies. “Concave studies” found performance to initially improve with years in practice or age then peak and subsequently decline.

‡ Also reported results on adherence to standards of diagnosis, screening, and preventive health care.

Table 2. Studies Relating Length of Time in Practice or Physician Age to Adherence to Standards of Appropriate Diagnosis, Screening, and Preventive Health Care*

Study, Year (Reference)	Disease or Condition	Physician Group Studied	Sample Size, n	Results	Multivariate Adjustment for Patient Covariates?	Multivariate Adjustment for Physician Covariates?	Other Comments	Overall Effect?†
Self-reported practice (surveys or interviews)								
Czaja et al., 1994 (33)	Cancer screening	Family physicians, internists, general surgeons, and gynecologists	3436 physicians	Physicians who graduated >20 y ago less likely to adhere to screening practices (OR, 0.62–0.72; $P < 0.05$)	No	Yes	Only considered adherence with guidelines for use of interventions unanimously endorsed by multiple organizations; response rate, 67%	Consistently negative
Cook et al., 2001 (34)	Chlamydia screening	Family physicians, internists, gynecologists, and pediatricians	1600 physicians	No effect of length of time in practice and likelihood of screening (<10 y or >10 y in practice)	No	Yes	Guidelines established by CDC and USPSTF	No effect
Richards et al., 1998 (35)	Colon cancer screening for women	Primary care providers	508 physicians	Older physicians more likely to recommend screening contrary to national guidelines (OR, 3.42–3.79)	No	Yes	Response rate, 42%	Consistently negative
Epstein et al., 2001 (15)‡	Depression	Psychiatrists	278 physicians	Physicians in practice for fewer years significantly more likely to correctly diagnose depression (OR, 0.59 [95% CI, 0.43–0.81], for a 10-y increase in age or practice)	No	Yes	Appropriateness defined by consensus agreement of 4 national experts; analyses adjusted for medical comorbidity but not severity of depression; response rate, 53%	Consistently negative
Jacques et al., 1991 (36)	Diabetes	General practitioners, family physicians, and general internists	610 physicians	Physicians who had graduated more recently more likely to appropriately use glucose self-monitoring, hemoglobin A _{1c} measurements, ophthalmology examinations ($P < 0.001$); no effect was observed for blood pressure and weight assessment, foot examination, glycemic education; year of graduation categorized in 4 groups	No	Yes	Guidelines established by American Diabetes Association; response rate, 73%; almost all physicians performed screening interventions for which no age effect was observed (i.e., no variation in dependent variable)	Partially negative
Kenny et al., 1993 (37)	Diabetes	Primary care physicians	1434 physicians	Younger physicians more likely to adhere to preventive care guidelines for 6 of 8 procedures surveyed	No	Yes	Effect estimates not reported but results based on logistic regression; guidelines established by American Diabetes Association	Partially negative
Marrero et al., 1991 (38)	Diabetes	Primary care physicians	212 physicians	Younger physicians more likely to obtain a hemoglobin A _{1c} measurement (OR for every 10-y change in graduation date, 1.53; $P = 0.0017$); no relationship for use of glucose self-monitoring	No	No	Guidelines established by American Diabetes Association; response rate, 31%	Partially negative
Schwartz et al., 1991 (39)	Disease prevention and health promotion	Members and Fellows of ACP	1349 physicians	Appropriate use of health promotion and disease prevention practices decreased with increasing age (P value not presented)	No	Yes	Guidelines endorsed by several national agencies; response rate, 75%	Consistently negative
Sherman and Hershman, 1993 (40)	Exercise counseling	Primary care physicians	422 physicians	Physicians > 40 y of age more likely to counsel patients on exercise (OR, 3.08 [CI, 1.33–7.15])	No	Yes	Justification for exercise counseling based on research evidence; response rate, 61%	Consistently positive
Zerr et al., 1999 (41)	Fever in infants	Pediatricians and emergency department and family physicians	474 physicians	Physicians who had graduated longer ago less likely to adhere to guidelines (OR, 0.93 [CI, 0.91–0.96], per year since graduation)	No	Yes	Physicians provided with guidelines; adherence assessed by using clinical scenarios that presented children of different ages; response rate, 36%	Consistently negative
Gemson et al., 1991 (28)	HIV	Internists, family doctors, general practitioners, and obstetrician–gynecologists	473 physicians	Inverse relationship between years since graduation and adherence to New York State Department of Health AIDS prevention recommendations ($P < 0.01$)	No	Yes	Study also assessed knowledge (results presented separately); response rate, 63%	Consistently negative
Heath et al., 1997 (42)	HIV	Family physicians and specialists who treat HIV	868 physicians	Inverse relationship between physician age and use of appropriate preventive care strategies ($P < 0.001$ – 0.004)	No	Yes	Response rate, 38.2%–50%; guidelines were issued by provincial agency	Consistently negative

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Table 2—Continued

Study, Year (Reference)	Disease or Condition	Physician Group Studied	Sample Size, n	Results	Multivariate Adjustment for Patient Covariates?	Multivariate Adjustment for Physician Covariates?	Other Comments	Overall Effect?†
Lewis et al., 1987 (29)	HIV	Primary care physicians	1000 physicians	Inverse relationship between years in practice and appropriateness of diagnostic work-up (consistent across variables assessed, although <i>P</i> values not reported)	No	Unclear	Measures of “competence” used were defined by group of expert clinicians at UCLA; study also assessed knowledge (results presented separately); response rate, 60%	Consistently negative
Skotniski et al., 1996 (43)	HIV	Primary care physicians	480 physicians	No significant association between physician age and likelihood of testing a high-risk patient	No	Unclear	Response rate, 50%; older physicians were more likely to test any patient who asked to be tested (not entirely in keeping with guidelines but unclear)	No effect
Roetzheim et al., 1991 (16)	Mammography	Primary care physicians	565 physicians	Physicians < 50 y of age were more likely than older physicians (72% vs. 49%; <i>P</i> < 0.001) to fully adhere to American Cancer Society recommendations	No	No	Response rate, 42%	Consistently negative
Ely et al., 1998 (44)	Preventive care guidelines	Primary care physicians	146 physicians	Physician age or year of graduation not associated with preventive care practices	No	Yes	Appropriateness defined by recommendations from the USPSTF; response rate, 70%	No effect
Rattay et al., 2004 (45)	Weight counseling	Pediatricians	813 physicians	Physician age not associated with frequency of weight counseling	No	Yes	Age categorized as <45 y or >45 y	No effect
Observed practice (chart audit)								
Ford et al., 1987 (46)	Breast, rectal, and small-cell lung cancer	Physicians in community hospital oncology programs	Not reported (2892 patients)	Physicians with fewer years in practice more likely to adhere to guidelines for breast and rectal cancer staging and consultation (<i>P</i> < 0.01– <i>P</i> < 0.001); no age effect was observed for small-cell lung cancer	No	No	Effect of age persisted regardless of how involved physicians were in guideline creation process	Partially negative
Streja and Rabkin, 1999 (47)	Diabetes	Primary care physicians	22 physicians (519 patients)	Physicians with >15 y experience more likely to test for proteinuria (OR, 2.62 [CI, 1.61–4.37]) and refer for ophthalmology (OR, 1.48 [CI, 1.01–2.18]) but not more likely to order an HDL cholesterol test (OR, 1.04 [CI, 0.97–1.06])	No	Yes	Did examine effect of patient characteristics on appropriate screening, but did not enter these variables into the same model as physician characteristics	Partially positive
Anis et al., 2004 (48)	Dietary and exercise counseling	Primary care physicians	38 physicians (4344 patients)	No effect of length of time in practice and likelihood of counseling	Yes	Partial	Physician covariates not significant on univariate analysis and not included in multivariate analysis	No effect
Aubin et al., 1994 (17)	Hypertension	Family physicians	21 physicians (847 patients)	Younger physicians more likely to appropriately screen for hypertension (OR, 1.11 [CI, 1.06–1.15])	Yes	Yes	Adjusted for patient age, sex, number of visits, type of visit, but not patient comorbidity; did not specify threshold for older vs. younger	Consistently negative
Hulka et al., 1976 (49)	Several (4 conditions)	Family physicians, internists, gynecologists, and pediatricians	61 physicians (1258 patients)	Physicians in practice for fewer years more likely to appropriately manage infants (<i>P</i> < 0.01). No difference observed for managing pregnancy, diabetes, or heart failure	Yes	Yes	Performance scores were developed on the basis of consensus panel discussions, all involving at least 4 family physicians as well as other physicians	Partially negative
Rhee, 1976 (12)	Several (15 diagnostic categories)	Physicians in Hawaii	454 physicians (2517 patient discharges)	Inverted “V” relationship between years in practice and adherence with standards of practice (<i>F</i> = 0.01)—physicians in practice 6–15 y provided the most appropriate care; physicians with more or fewer years in practice provided less appropriate care	No	Yes	Performance scores were developed on the basis of norms established by a “panel of physicians”; criteria not fully presented but seem to focus largely on diagnostic evaluation	Concave
Saraiya et al., 2002 (50)	Tuberculosis screening for foreign-born persons	Physicians who performed screening	491 physicians (5739 patients)	No consistent effect of number of years in practice on adherence with CDC screening recommendations	No	No	Did not have demographic data on 30% of physicians; 75% of physicians were primary care providers	No effect

* ACP = American College of Physicians; CDC = Centers for Disease Control and Prevention; HDL = high-density lipoprotein; OR = odds ratio; USPSTF = U.S. Preventive Services Task Force.

† “Consistently negative” studies were those for which all outcomes demonstrated a statistically significant decrease in performance with increasing years in practice or age. “Partially negative” studies were those that showed statistically significant decreasing performance with increasing years in practice or age for some outcomes and no effect for others. Similar definitions were used for consistently positive and partially positive studies. “Concave studies” found performance to initially improve with years in practice or age then peak and subsequently decline.

‡ Also reported results on adherence to standards of therapy—results presented separately.

Table 3. Studies Relating Length of Time in Practice or Physician Age to Adherence to Standards of Appropriate Therapy*

Study, Year (Reference)	Disease or Condition	Physician Group Studied	Sample Size, n	Results	Multivariate Adjustment for Patient Covariates?	Multivariate Adjustment for Physician Covariates?	Other Comments	Overall Effect?†
Self-reported practice (surveys or interviews)								
McFall et al., 1994 (51)	Breast cancer	Family physicians, internists, gynecologists, and general surgeons	1460 physicians	Physicians in practice for ≥ 20 y chose therapy less consistent with NIH recommendations for 3 of 6 treatments studied (OR, 0.56–0.78); no age effect was observed for other therapies	No	Yes	Physicians were not oncologists but reported participating in decision making about treatment and referral; response rate, 71%	Partially negative
Epstein et al., 2001 (15)	Depression	Psychiatrists	278 physicians	Physician age did not influence appropriate prescribing of an antidepressant	Limited	Yes	Appropriateness defined by consensus of 4 national experts; analyses adjusted for medical comorbidity but not severity of depression; response rate, 53%	No effect
Epstein et al., 1996 (20)	Depression and anxiety	Psychiatrists	38 physicians	"Accuracy score" (reflecting agreement with expert consensus) decreased as a function of years in practice ($P < 0.01$)	No	Yes	Appropriateness established by expert consensus; response rate, 19%	Consistently negative
Montaner et al., 1996 (52)	HIV	Physicians in British Columbia	463 physicians	Physicians < 45 y of age significantly more likely to appropriately use antiretroviral therapy ($P = 0.004$); no age effect observed for other management areas	No	Yes	Appropriateness assessed by using provincial guidelines; overall response rate, 14%	Partially negative
Roy-Byrne et al., 2002 (53)	Panic disorder	Primary care physicians	37 physicians (58 patients)	Length of time in practice did not predict appropriate prescribing	Yes	Yes	Based on patient reports (all enrolled in clinical trial); appropriateness based on previously published algorithm	No effect
Stolley et al., 1972 (13)	Prescribing of 5 specific drugs (ritalin, equagesic, chloramphenicol, vitamin B ₁₂ , and oral contraceptives)	Primary care physicians	37 physicians	Appropriateness decreased as years in practice increased ($P < 0.01$)	No	No	Appropriateness assessed by at least 13 experts who rated any given drug, and the total panel consisted of 33 individuals; response rate, 84%	Consistently negative
Observed practice (chart audit or administrative data review)								
Hynes, 1994 (54)	Breast cancer	Physicians treating breast cancer	Not reported (3972 patients)	Appropriateness of surgical care increased with increasing years in practice but decreased after 14 y of experience ($P < 0.01$); physicians in practice for more years were less likely to provide postmastectomy rehabilitation therapy	Yes	Yes		Concave
Becker et al., 1971 (55)	Chloramphenicol use	Primary care physicians	37 physicians	Likelihood of prescribing chloramphenicol increased as years since graduation increased ($P < 0.01$)	No	Yes	All prescriptions of chloramphenicol were judged to be inappropriate given limited indications	Consistently negative
Ray et al., 1976 (56)	Chloramphenicol use	Physicians in Tennessee caring for Medicaid patients	3409 physicians	Number of years since medical school graduation did not predict use of chloramphenicol	No	Yes	All prescriptions of chloramphenicol were judged to be inappropriate given limited indications	No effect
Moride et al., 2002 (57)	Depression	General practitioners and psychiatrists	1527 physicians	Graduation from medical school before 1970 associated with increased odds of suboptimal treatment duration (OR, 1.12 [95% CI, 1.01–1.24])	Yes	Yes	Patient covariates include age, sex, and health status but not illness severity	Consistently negative

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geons performing cardiac artery bypass grafting. After adjustment for both patient and physician variables, they found that physicians who have been in practice longer had

higher operative mortality rates ($P < 0.001$). In contrast, Burns and Wholey's (69) large study of patients hospitalized for various conditions found no difference in mortality

Table 3—Continued

Study, Year (Reference)	Disease or Condition	Physician Group Studied	Sample Size, n	Results	Multivariate Adjustment for Patient Covariates?	Multivariate Adjustment for Physician Covariates?	Other Comments	Overall
Anderson et al., 1997 (19)	Drug prescribing in elderly patients	Physicians in British Columbia	6344 physicians (819 369 drug claims)	Physicians < 45 y of age had significantly lower rates of inappropriate drug selection for all 4 classes of drugs studied ($P < 0.001$, for most analyses)	No	Yes	Used the same criteria as Beers et al. (58) to define appropriateness	Consistently negative
Beers et al., 1993 (58)	Drug prescribing in elderly patients	Physicians practicing in nursing homes in Los Angeles	309 physicians	Physician age or years since graduation not significantly related to appropriate prescribing	No	Yes	Appropriateness defined on the basis of consensus of expert opinion	No effect
Dhalla et al., 2002 (59)	Drug prescribing in elderly patients	Physicians in Ontario	2424 physicians (19 911 patients)	Patients of physicians > 50 y of age had a higher odds of receiving an inappropriate medication (OR, 1.14 [CI, 1.05–1.23]; $P = 0.002$)	Limited	Yes	Adjusted for patient age and sex only; used the same criteria as Beers et al. (58) to define appropriateness	Consistently negative
Geller et al., 1996 (60)	Hysterectomy	Physicians performing hysterectomy	339 physicians (36 104 patients)	Physicians in practice for 15–19 y and 25–29 y perform more hysterectomies than physicians in practice for 0–4 y ($P < 0.05$); no effect observed for physicians of other ages	Yes	Yes	Also controlled for sociodemographic and financial patient factors in addition to clinical covariates	Partially negative
Payne et al., 1984 (61)	Several (10 conditions)	Physicians in the Midwest	1135 physicians (3163 patients)	Physicians in practice for 0–9 y provided more appropriate care than other physicians	No	Yes	Tests of significance not presented; criteria for appropriateness defined by consensus; no difference between physicians with 10–19 y and >20 y of experience	Consistently negative
Sanazaro and Worth, 1985 (18)	Several	Internists	66 physicians	Number of cases treated inappropriately increased with number of years since graduation ($P < 0.05$)	No	No	Appropriateness judged by panel appointed by ACP and ASIM; participants were all volunteers	Consistently negative
Fehrenbach et al., 2001 (62)	Myocardial infarction	Physicians treating acute myocardial infarction	473 physicians (578 patients)	Physicians trained before 1980 less likely to prescribe β -blockers ($P < 0.05$); in multivariate adjustment, OR of receiving β -blocker for patients of physicians trained before 1980 was 0.66 (CI, 0.40–1.03)	Yes	Yes	Borderline-significant results after multivariate adjustment; patients all belonged to 1 large national HMO	Partially negative
Willison et al., 2000 (63)	Myocardial infarction	Physicians treating acute myocardial infarction	1452 physicians	Physicians > 50 y of age less likely to prescribe aspirin to eligible patients ($P < 0.001$); relationship did not persist after multivariate adjustment; no effect observed for thrombolysis	Yes	Yes	Also adjusted for hospital volume	Partially negative
Beaulieu et al., 2001 (64)	Stable angina	Physicians in Quebec	3293 physicians (11 141 patients)	Older physicians significantly less likely to prescribe aspirin (OR for < 10 y in practice, 1.7 compared with physicians in practice > 20 y; $P < 0.05$); no effect seen for β -blockers or lipid-lowering agents	Yes	Yes		Partially negative

* ACP = American College of Physicians; ASIM = American Society of Internal Medicine; HMO = health maintenance organization; NIH = National Institutes of Health; OR = odds ratio.

† “Consistently negative” studies were those for which all outcomes demonstrated a statistically significant decrease in performance with increasing years in practice or age. “Partially negative” studies were those that showed statistically significant decreasing performance with increasing years in practice or age for some outcomes and no effect for others. Similar definitions were used for consistently positive and partially positive studies. “Concave studies” found performance to initially improve with years in practice or age then peak and subsequently decline.

rates for physicians of different ages, but physicians in practice for more years had longer lengths of stay even after adjustment for patients’ comorbid conditions and other physician factors.

Study Quality

To determine the influence of methodologic quality on study results, we stratified the 43 reports pertaining to adherence to standards of practice on the basis of whether

outcomes were assessed by using self-reported data or more objective measures (that is, use of chart audits or administrative databases). Overall, 30 (70%) of these studies demonstrated a consistently or partially negative association between length of time in practice or physician age and adherence to standards of care. While the proportion of studies that found a consistently or partially negative association was slightly larger for self-reported studies than for

Table 4. Studies Relating Number of Years in Practice or Physician Age to Health Care Outcomes

Study, Year (Reference)	Disease or Condition	Physician Group Studied	Sample Size, n	Results	Multivariate Adjustment for Patient Covariates?	Multivariate Adjustment for Physician Covariates?	Other Comments	Overall Effect?*
Norcini et al., 2000 (14)	Acute myocardial infarction	Family practitioners, internists, and cardiologists	4546 physicians	Mortality for patients admitted with acute myocardial infarction increased by 0.5% for every year since physician graduated from medical school ($P = 0.05$)	Yes	Yes	Also corrected for hospital factors (e.g., access to advanced cardiac care)	Consistently negative
Blanc et al., 2003 (65)	Asthma	Physicians treating asthma	147 physicians (317 patients)	Number of years since medical school graduation not related to patients' self-reported health status or asthma-specific quality of life	Yes	Yes	Surveyed patients and physicians separately and then linked results using hierarchical regression models; sample included very few younger physicians	No effect
O'Neill et al., 2000 (66)	Carotid endarterectomy	Surgeons	507 physicians (12 725 patients)	Mortality of patients undergoing endarterectomy increased with years since licensure ($P < 0.001$); no relationship between length of time in practice and combined "bad outcome" (death or morbidity)	Yes	Yes	Data for surgeon age available for 440 physicians; years since licensure was strongest predictor of mortality	Partially negative
Hartz et al., 1999 (11)	Coronary bypass surgery	Surgeons	275 physicians (83 547 patients)	More years in practice significantly associated with higher mortality ratios ($r = 0.22$, $P < 0.001$)	Yes	Yes		Consistently negative
Katon et al., 2000 (67)	Depression	Primary care physicians	63 physicians (1599 patients)	Physician age not related to patients having persistent or residual depressive symptoms after initiation of antidepressant medication or other quality-of-care measures	Yes	Yes	Study did not find any significant physician characteristics to explain variability in quality of care	No effect
Davidson et al., 1995 (68)	Drug prescribing in elderly patients	General practitioners	366 physicians	No age effect on mortality or hip fracture rate	Limited	No	Adjusted for patient age by using analysis of covariance	No effect
Burns and Wholey, 1991 (69)	Several (11 medical and 5 surgical conditions)	Attending physicians for hospitalized patients	54 571 discharges	Physicians in practice for more years had significantly longer lengths of stay after adjustment for patient comorbid condition for 9 of 16 diagnoses evaluated ($P < 0.05$); years in practice did not predict length of stay for other diagnoses or for mortality	Yes	Yes	Results adjusted for multiple covariates, suggesting increased length of stay may be unnecessary	Partially negative

* "Consistently negative" studies were those for which all outcomes demonstrated a statistically significant decrease in performance with increasing years in practice or age. "Partially negative" studies were those that showed statistically significant decreasing performance with increasing years in practice or age for some outcomes and no effect for others. Similar definitions were used for consistently positive and partially positive studies. "Concave studies" found performance to initially improve with years in practice or age then peak and subsequently decline.

those studies that used objective measures (71% vs. 62%), these differences were not statistically significant ($P > 0.2$).

Stratifying studies on the basis of whether they performed a multivariable analysis yielded similar results: 71% of the studies that adjusted for patient covariates found a consistently or partially negative association compared with 74% of studies that did not adjust for these factors, and 68% of the studies that adjusted for physician covariates found a consistently or partially negative association compared with 67% of studies that did not.

DISCUSSION

Although based on heterogeneous studies, our systematic review of empirical studies evaluating the relationship between clinical experience and performance suggests that physicians who have been in practice for more years and

older physicians possess less factual knowledge, are less likely to adhere to appropriate standards of care, and may also have poorer patient outcomes. These effects seem to persist in those studies that adjusted for other known predictors of quality, such as patient comorbidity and physician volume or specialization. The results are somewhat paradoxical since it is generally assumed that clinical experience enhances knowledge and skill and, therefore, leads to better patient care.

Our findings have many possible explanations. Perhaps most plausible is that physicians' "toolkits" are created during training and may not be updated regularly (70). Older physicians seem less likely to adopt newly proven therapies (71, 72) and may be less receptive to new standards of care (73). In addition, practice innovations that involve theoretical shifts, such as the use of less aggressive

surgical therapy for early-stage breast cancer or protocols for reducing length of stay, may be harder to incorporate into the practice of physicians who have trained long ago than innovations that add a procedure or technique consistent with a physician's preexisting knowledge (74).

Our findings may also reflect the substantial environmental changes that have occurred in medicine over the past several decades; evidence-based medicine has been widely adopted, and quality assurance techniques, such as disease management and performance evaluation, are frequently used. More experienced physicians may have less familiarity with these strategies and may be less accepting of them. Given this, our results may represent a cohort effect; that is, when the current generation of more recently trained physicians has been in practice for a longer time, there may be smaller differences between their practice and those of their younger colleagues than our data would suggest.

Our study has several limitations. First, although we attempted to systematically review the literature on the association between number of years in practice or physician age and performance, our search strategy may have missed reports. This reflects the limited attention to this issue and the lack of consistent search terms to identify clinical experience. In addition, studies that were specifically designed to assess the relationship between experience and performance but found no association may have been less likely to be submitted or accepted for publication, and published studies that included number of years in practice or age among other physician characteristics may not have presented non-statistically significant results for these particular variables. Therefore, while we have no reason to suspect that we were more likely to identify studies showing decreasing performance with age, our findings are still potentially subject to an under-reporting bias.

Second, few reports included in this review were designed to specifically evaluate length of time in practice as their primary characteristic of interest. Consequently, our results may have been due to chance arising from multiple testing. However, we believe this is unlikely given the relative consistency of the results in several different domains, their "dose-response" relationship, and their overall plausibility. Moreover, restricting our analysis to the 32 studies that considered a broader set of physician characteristics, including number of years in practice or age as the focus of their investigation (that is, excluding those studies that considered physician age or number of years in practice only as confounders), does not change our results: 21 of the 32 (66%) studies reported a consistently or partially negative association between physician age and performance, whereas only 1 study demonstrated a partially positive association.

Third, disagreements may exist between clinical practice guidelines (33), and, thus, establishing appropriate norms may be difficult. As a result, assessing performance on the basis of guideline adherence may not reliably assess

health care quality. Despite this, some studies included in our review used norms that had been adopted by several professional associations and that consequently reflect widely accepted standards of practice. Even for these studies, we observed age effects.

Finally, length of time in practice may be associated with other dimensions of quality that are not captured by the outcome measures that we evaluated. While we identified studies that assessed various conditions and aspects of performance, the relationship between age and performance may be different for other diseases and outcomes. For example, older physicians may be more effective at delivering the humanistic, rather than the technical, aspects of medical care. If this were true, one would expect that the patients of older physicians would report higher satisfaction, which has been demonstrated in some studies (75, 76) but not others (77, 78). Alternatively, physicians who have been in practice for a longer time may have better clinical judgment and may thus provide better care in complex cases or may be better diagnosticians. These outcomes have not been rigorously assessed.

Despite these limitations, our results are troubling. Although it is difficult to draw firm conclusions about the performance of older physicians in managing specific conditions or clinical scenarios, our results do suggest that older physicians may need quality improvement interventions that are generally applicable to all physicians. In addition, the requirements that are imposed on physicians to keep up to date and to demonstrate continuing competence should be further considered. Widely adopted continuing medical education techniques, such as the distribution of printed materials and lectures, are largely ineffective even in experimental conditions (79). Our results reinforce this. Moreover, many experienced physicians are exempt from the recertification requirements to which their more recently trained colleagues must adhere. For example, the American Board of Internal Medicine only requires physicians who received initial Board certification in or after 1990 to appear for periodic recertification examinations.

Our results also have implications for further research. The link between experience and performance should be further evaluated with studies that are designed a priori to specifically measure this association. These studies should use objective and widely accepted measures of performance; should be disease- or process-specific; and should be replicated for physicians of different specialties, demographic characteristics (such as sex), and different environment practices. The effect of age for physicians who routinely collaborate with other physicians, who frequently engage in evidence-based discussions, or whose practices are influenced by disease management, performance feedback, and computerized reminder systems may be different from that for physicians who practice in relative isolation or in more traditional settings.

An optimal study would follow a particular cohort of physicians over time. However, this is not practical and

may be confounded by other secular trends in health care provision. Alternative designs would be similar to those of the highest quality included in our review and would adequately control for patient comorbidity, other physician factors, and the clustering of patients within physicians. These studies should also model the nature of the relationship between experience and performance since performance may improve during the initial phases of independent practice, plateau for some period of time, and then decrease. Finally, the ability of behavior change strategies to reduce the disparities in quality created by physician age should be evaluated in well-controlled clinical trials.

In summary, our results suggest that physicians with more experience may paradoxically be at risk for providing lower-quality care. The extent, magnitude, and nature of these results must be clarified, and added attention should be given to this subgroup of physicians who may need quality improvement interventions.

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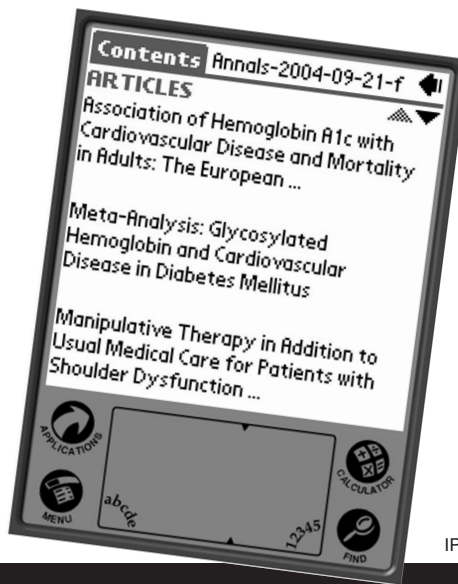
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