The Role of Physician and Practice Characteristics in the Quality of Diabetes Management in Primary Care: Systematic Review and Meta-analysis

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BACKGROUND: Despite evidence-based guidelines, high-quality diabetes care is not always achieved. Identifying factors associated with the quality of management in primary care may inform service improvements, facilitating the tailoring of quality improvement interventions to practice needs and resources.

METHODS: We searched MEDLINE, EMBASE, CINAHL and Web of Science from January 1990 to March 2019. Eligible studies were cohort studies, cross-sectional studies and randomised controlled trials (baseline data) conducted among adults with diabetes, which examined the relationship between any physician and/or practice factors and any objective measure(s) of quality. Studies which examined patient factors only were ineligible. Where possible, data were pooled using random-effects meta-analysis.

RESULTS: In total, 82 studies were included. The range of individual quality measures and the construction of composite measures varied considerably. Female physicians compared with males (odds ratio (OR) = 1.07, 95% CI: 1.04, 1.10), 8 studies), physicians with higher diabetes volume compared with lower volume (OR = 1.24, 95% CI: 1.05–1.47, 4 studies) and practices with Electronic Health Records (EHR) versus practices without (OR = 1.43, 95% CI: 1.11–1.84, 4 studies) were associated with a higher quality of care. There was no association between physician experience, practice location and type of practice and quality. Based on the narrative synthesis, increasing physician age and higher practice socio-economic deprivation may be associated with lower quality of care.

DISCUSSION: Identification of physician- and practice-level factors associated with the quality of care (female gender, younger age, physician-level diabetes volume, practice deprivation and EHR use) may explain differences across practices and physicians, provide potential targets for quality improvement interventions and indicate which practices need specific supports to deliver improvements in diabetes care.

KEY WORDS: diabetes; quality of care; primary care.

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INTRODUCTION

Routine management of diabetes is increasingly delivered in primary care where patients can receive care closer to home.^{1, 2} Despite the abundance of guidelines,^{3–5} high quality of care is not always achieved; risk factor control continues to be suboptimal,^{6–11} with international variation in the achievement of clinical targets.⁷ Interventions to improve diabetes management are not always successful, with limited impact on clinical outcomes.^{12, 13}

Understanding how to close this ‘evidence to practice gap’,^{14, 15} and successfully introduce and embed evidence-based care into real-life practice, is central to the delivery of effective, appropriate and safer clinical care.¹⁴ Primary care is a challenging setting in which to deliver evidence-based care. Managing complex and potentially co-morbid¹⁶ patients with chronic diseases such as diabetes, requires physicians to cope with competing priorities¹⁷ and time constraints¹⁸, compounded by workforce shortages.^{19–25} Identifying what factors influence the quality of diabetes management in primary care may inform strategies to improve adherence to evidence-based care and tailor quality improvement (QI) interventions to the real-life context.²⁶ This systematic review assembles existing evidence on relationship between primary care factors and measures of quality of diabetes care to (1) explore variation in quality across practices or physicians and (2) to determine practice and physician factors which contribute to the ‘evidence to practice’ gap.

METHODS

We conducted and reported the review in accordance with PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) statement²⁷ and the published protocol.²⁸

Eligibility Criteria

Eligible studies were cohort studies, cross-sectional studies and baseline data from randomised controlled trials (RCTs)

conducted among adults aged ≥ 18 years with diabetes (type 1 or type 2), which examined the association between physician and/or practice factors and quality of care. We excluded studies if they only examined patient factors. A preliminary search of the literature identified a priori physician and practice factors. Where we identified studies which examined other practice factors, we included them if the factors could be classified according to four out of five categories of the Cochrane Effective Practice and Organisation of Care (EPoC) 'Delivery Arrangements' domain²⁹ (see further eligibility details in Supplement 1).

The primary outcome of interest, *quality of diabetes care*, was a broad construct comprising of either individual objective measures of quality; performance of care processes or control of intermediate clinical outcomes (e.g. BP, cholesterol, HbA1c), screening for complications or attendance at screening services, prescribing of appropriate medications, treatment inertia or intensification or a composite of individual measures. Patient-reported outcomes, including functional status, health-related quality of life, satisfaction with treatment and treatment adherence were secondary outcomes. As quality of care should ideally be based on a range or composite of different measures^{30, 31} rather than a single measure such as HbA1c^{32, 33}, the review focused on studies examining multiple and/or composite measures of quality. Studies which examined only one individual quality measure were excluded.

Identification and Selection of Studies

We conducted literature searches of MEDLINE, EMBASE, CINAHL and Web of Science for studies conducted between January 1990 and March 2019, and published in English, which examined the association between physician and/or practice-level factors and quality of diabetes care in primary care. We searched databases using Medical subject headings (MeSH) and keywords for (1) diabetes; (2) primary care; (3) practice or physician factors, broad (e.g. 'practice characteristics') or specific (e.g. 'gender', 'experience') terms; and (4) quality of care (see EMBASE strategy in Supplement 1). Reference lists of included studies were screened. Search results and full-text articles were independently assessed by two reviewers (FR and COD). Disagreements were resolved through consensus or referral to a third reviewer.

Data Extraction and Quality Assessment

Using a standard form, FR extracted data on study design, region, sample size, patient and physician characteristics and quality measure(s). Authors were contacted for additional data if required. Study quality was assessed (by FR) using the modified Joanna Briggs Institute critical appraisal checklists for descriptive studies.³⁴ Articles were not excluded from the review based on the quality assessment.

Synthesis

We conducted a meta-analysis where at least two studies examined a comparable individual or composite quality measure. In general, studies were not included in a meta-analysis if the data were unavailable, exposure or outcome variables were not comparable, there was no adjustment for confounders, or if a continuous outcome variable was measured but data were unavailable to calculate the standardised mean difference (SMD). Studies which could not be included in a meta-analysis were included in a narrative synthesis. We conducted random-effects meta-analyses of the adjusted effect estimates using the inverse variance method in RevMan 5.3 (Nordic Cochrane Centre). Where unavailable from the article or study authors, 95% CIs and/or standard errors (SE) were calculated from the effect estimate and p value.^{35, 36} Forest plots were used to visually assess the estimates and corresponding CIs across studies. Statistical heterogeneity was assessed with the I^2 statistic. Forest plots are presented with and without pooled effects. We highlight where analyses indicated significant heterogeneity ($I^2 > 60\%$).

RESULTS

From 7198 records, 78 were retained (Fig. 1), and four were identified from reference lists. Most studies were from the US ($n = 38$) or UK ($n = 18$) (Suppl. Table 1). Sample size varied considerably from smaller local studies³⁷ to large-scale national studies.³⁸ Some studies focused on specific sub-groups, e.g. Medicare beneficiaries (≥ 65 years),^{37, 39–42} or patients with type 2 diabetes.^{37, 43–54} Most studies involved a mix of private/public centres^{41, 49, 50, 55–60} and academic/non-academic^{43, 58} and teaching/non-teaching practices.^{44, 54, 61–67} Included studies examined individual ($n = 41$), composite ($n = 24$) or both ($n = 11$) quality measures. Seven examined treatment intensification or inertia. Individual indicators used to construct composite measures ranged from four process measures^{68, 69} to 18 process and outcome indicators from the Quality and Outcomes Framework (QOF)^{44, 68, 70, 71} (Suppl. Table 2).

Frequent individual measures (> 20 studies) were HbA1c testing ($n = 34$), eye examination or referral to ophthalmology ($n = 31$), lipid testing ($n = 30$) and HbA1c level/target ($n = 27$) (see Suppl. Tables 3–5 for a detailed overview). Three physician factors (gender, experience and diabetes volume) and practice factors (location, type and presence of an EHR) were included in the meta-analyses.

Some studies did not adjust for confounders ($n = 11$)^{37–39, 65, 72–78}, examine patient-level factors or include them as covariates ($n = 33$)^{37, 38, 40, 41, 44, 46, 47, 57, 61, 63–65, 67, 68, 70–76, 78–89} (Suppl. Table 6). Where general practice data were used to determine outcomes, few explained the data abstraction process,^{58, 60, 64, 74, 84, 90–95} or cited the reliability.^{44, 50, 55, 60, 70, 84, 90, 92, 94, 95} In some studies, exposure ascertainment^{42, 50, 51, 65, 70, 76, 83, 91, 96–99} and inclusion criteria for practices

Fig. 1 Flow diagram showing the study selection process for the current review.

and/or physicians^{52, 56, 60, 64, 65, 67, 75–77, 80, 83, 84, 89, 100, 101} were unclear or not reported. Two studies used volunteer practices.^{43, 102} Reporting of the total number of practices, physicians or patients, was inconsistent.

PHYSICIAN FACTORS

Gender

Individual Measures. Twenty-one studies examined gender.^{43, 47–49, 51, 53, 57, 69, 80, 81, 91, 92, 99, 103–110} Thirteen studies used individual outcome measures.^{43, 47–49, 51, 91, 92, 99, 104–109}, nine of which^{48, 91, 104–110} were included in a meta-analysis. Overall, female gender was associated with higher quality of care (any individual measure) (OR = 1.07, 95% CI:1.04–1.10) (Fig. 2). There was substantial statistical heterogeneity ($I^2 = 79\%$). Of the seven studies examining individual measures which could not be included in the meta-analysis^{43, 47, 49, 51, 92, 99, 53}, four found no association,^{43, 47, 51, 99} while two found that among

female physicians, quality was higher^{49, 92} or reported mixed results.⁵³

Composite Measures. The seven studies using a composite measure^{57, 69, 80, 81, 103, 104, 108} could not be pooled. Four^{80, 81, 103, 108} reported no significant association, while three^{57, 69, 104} found an association between female gender and higher quality.

Professional Experience

Individual Measures. Eight studies defined experience as years since graduation^{80, 89} or in practice.^{43, 47, 49, 81, 109, 110} Six used individual outcome measure,^{43, 47, 49, 89, 109, 110} two of which were suitable to include in a meta-analysis.^{43, 89} The pooled estimate was not significant (OR = 1.01, 1.00–1.02) (Fig. 3). Of the four other studies which examined individual measures,^{47, 49, 109, 110} three found no association,^{47, 49, 110} while one reported physicians with >15 years in practice had higher odds of proteinuria testing.¹⁰⁹

Fig. 2 Physician gender and individual measures of quality (pooled). Berthold et al. included patients with type 2 only; Ferroni et al. included non-insulin-treated patients only; Pham et al. analysed data from Medicare beneficiaries ≥ 65 years. Berthold et al. used targets HbA1c $< 7.0\%$ and LDL-C < 130 mg/dl; Kim et al. used targets HbA1c $< 8.5\%$ and LDL-C < 130 mg/dl.

Fig. 3 Physician years of experience and individual measures of quality (pooled). Spann et al. used targets HbA1c <7.0% and LDL-C <100 mg/dl; McGinn et al. used targets HbA1c <9% and LDL-C <130 mg/dl.

Composite Measures. Two studies used a composite measure of quality.^{80, 81} Only one had data available.⁸⁰ Neither study reported experience was associated with quality.^{80, 81}

Diabetes Volume

Individual Measures. Eight studies examined the volume of patients with diabetes per physician.^{49, 55, 99, 107, 109, 111–113} One study examined clinical inertia.¹¹³ Seven used individual outcome measures^{49, 55, 99, 107, 109, 111, 112}, four of which were

included in a meta-analysis.^{107, 109, 111, 112} The pooled estimate indicated higher volume was associated with higher quality (OR = 1.24, 1.05–1.47) (Fig. 4). Three other studies examined individual measures^{49, 55, 99} one of which found higher volume was associated with higher quality.⁵⁵

Composite Measures. Only one study used a composite measure¹¹¹ and found higher volume was associated with higher quality.¹¹¹

Fig. 4 Physician volume of patients with diabetes and individual measures of quality (pooled) Holmboe et al. volume group V (32–66 patients) vs. volume group I (1–4 patients); Ferroni et al. 56–70 patients vs. ≤55 patients; Turchin et al. per 10 patients annually; Streja et al. >20 patients vs. ≤20 patients.

Other Physician Factors

Other common primary care physician factors (≥ 5 studies) not included in a meta-analysis were age,^{47, 51, 57, 69, 81, 89, 93, 99, 104, 107, 110, 113} training,^{42, 66, 72, 81, 88, 93, 103, 105} and panel size/workload.^{37, 43, 49, 55, 57, 68, 69, 71, 81, 97, 99, 103, 104, 114} The relationship of panel size with quality was inconsistent. Seven of twelve studies examining physician age reported a significant association: older physician age was associated with lower quality.^{57, 69, 89, 99, 104, 107, 113} Four of seven studies examining training reported a significant positive association with quality.^{42, 81, 88, 93}

PRACTICE FACTORS

Location

Individual Measures. Ten studies examined practice location (rural vs. urban).^{40, 47, 56, 57, 73, 81, 83, 102–104} Three examined

individual measures.^{40, 47, 73} These were not included in a meta-analysis. One found no association with quality.⁴⁷ Results were inconsistent among the other two studies.^{40, 73}

Composite Measures. Eight studies used a composite measure^{50, 56, 57, 81, 83, 102–104}, three of which included in a meta-analysis.^{83, 102, 104} There was no association between location and quality (OR = 1.02, 0.87–1.19) (Fig. 5a). Of the five other composite studies, three found no association with quality,^{57, 81, 103} two reported mixed results by intervention arm⁵⁶ and one favoured urban practices.⁵⁰

Type of Practice

Individual Measures. Twelve studies compared group with solo/single-handed practices.^{37, 44, 45, 47, 58, 66–68, 71, 89, 104, 105} Nine studies used individual outcome measures,^{37, 44, 45, 47, 66,}

(a) Location

(b) Type

Fig. 5 Practice location and type and quality of care (pooled).

^{67, 89, 104, 105} three of which were included in a meta-analysis.^{89, 104, 105} There was an association between practice type and delivery of lipid test (favouring group practices) (Suppl.Figure 4). Of six other studies examining individual measures,^{37, 44, 45, 47, 66, 67} four found no association,^{37, 44, 47, 67} one found group practices performed better on some measures⁶⁶ and one found patients attending group practices were more likely to be treated with lipid-lowering drugs.⁴⁵

Composite Measures. Four studies used a composite outcome measure,^{58, 68, 71, 104} and two were included in a meta-analysis. There was no association between practice type and a composite quality measure (OR = 1.58, 0.74–3.38) (Fig. 5b). Of two other composite studies, one reported an association favouring group practices.⁷¹

There was no association between type and quality overall (any measure, individual or composite) and high statistical heterogeneity ($I^2 = 68\%$) (OR = 1.27, 0.99–1.64) (Fig. 5b).

Electronic Health Records

Individual Measures. Sixteen studies examined the use of EHRs.^{41, 43, 56–58, 60, 63, 66, 84, 85, 90, 94, 102, 105, 115, 116}

Five studies examined individual measures,^{43, 63, 66, 105, 115} two of which were included in a meta-analysis.^{43, 66} Having an EHR was only significantly associated with one measure, HbA1c control (OR = 1.54, 1.11–2.14) (Suppl.Figure 5). Of three other studies examining individual measures^{63, 105, 115} all found the presence/use of an EHR was associated with better performance on some measures.^{63, 105, 115}

Composite Measures. Eleven studies used a composite quality measure.^{41, 56–58, 60, 84, 85, 90, 94, 102, 116} Two studies using the same exposure (EHR vs. none) were included in a meta-analysis.^{41, 57, 58, 84} A practice EHR was associated with higher quality (OR = 2.23, 1.60–3.09) (Fig. 6). Of nine other studies using composite measures,^{56, 57, 60, 84, 85, 90, 94, 102, 116} four did not report a significant association^{56, 85, 90, 102} while five found the presence/use of a practice EHR was associated with better performance.^{57, 60, 84, 94, 116}

Overall, practices with EHRs were more likely to achieve higher quality (any measure, individual or composite) (OR = 1.43, 1.11–1.84) (Fig. 6).

Fig. 6 Electronic Health Record (EHR) at practice and the association with quality (pooled). He et al. estimates relate to older men only, estimates for older women were not significant (OR = 1.1, 0.63–1.91), with inclusion of this data the pooled estimate is still significant. Van Doorn Klomberg et al. compared practice performance in highest vs. lowest quartile for HbA1c, BP and cholesterol control; Spann et al. used targets for good control of HbA1c ($\leq 7\%$), BP ($\leq 130/85$ mmHg) and LDL-C (< 100 mmol/mol).

Other Practice Factors

Other practice factors identified (≥ 5 studies) were practice deprivation,^{38, 54, 64, 67, 68, 70, 71, 86, 103, 117, 118} diabetes prevalence^{38, 47, 64, 67, 68, 71, 86, 87, 103, 117} or volume,^{45, 51, 69, 73, 84, 116, 119} number of patients in a practice^{38, 47, 50, 64, 68, 71, 76, 86, 95, 103, 120, 121}, number of GPs,^{37, 54, 56, 61, 64, 69, 70, 80, 95, 102, 103} or nurses,^{64, 66, 68, 71, 95, 102, 103} nurse or physician assistant involvement,^{39, 43, 45, 47, 52, 59, 65, 73, 121–123} and use of a register/recall system.^{43, 46, 64, 66, 72, 78, 103} The relationship of these factors with quality was inconsistent. One exception was practice socio-economic deprivation; all studies which reported a significant association (8/11) found higher deprivation was associated with lower quality.^{38, 64, 67, 71, 86, 103, 117, 118}

DISCUSSION

Based on studies combined in a meta-analysis, this review identified female gender, higher physician volume of patients with diabetes and a practice EHR favoured higher quality of care in primary care. Findings were not significant for physician experience, practice location or type. Among studies not included in a meta-analysis, some evidence suggested that increasing physician age and higher practice deprivation were associated with lower quality. As such, most factors were not modifiable. The range of individual quality measures and the construction of composite measures varied considerably.

The association between female physicians and higher quality of care is consistent with existing research examining preventative care for women^{124, 125}, management of chronic health failure¹²⁶ and inpatient care.¹²⁷ Provider attitudes and beliefs about diabetes¹²⁸, the quality of patient-provider communication and interpersonal skills^{18, 128}, can support or hinder management. Previous work has posited that different communication styles between male and female physicians¹²⁹ and/or greater focus by female physicians on preventive care^{130, 131} may be some reasons for differences in the quality of care.

Just over half of the included studies examining physician age reported a significant association. The finding, that older age is associated with poorer quality, fits with some studies of age/experience among hospital and primary care-based physicians^{132–134}, but not all.^{135, 136} Ultimately the evidence is mixed, with more work needed to understand the relationship and reach a definitive conclusion. Older GPs may be less inclined to adopt and implement new practices and standards of care.¹³⁷ Also, they may only appear to have a lower quality of care; as senior physicians, they may have an older and more complex patient cohort. However, most studies controlled for patient comorbidities or patient complexity.^{57, 69, 99, 104, 107} Notably few adjusted for practice factors^{57, 69, 89, 104}; the mixed findings may reflect unaccounted for practice factors, e.g. academic-affiliation or private/public status. If GPs deliver care differently according to their age or practice position understanding why could drive strategies to better support care delivery, e.g. continuing education or addressing their caseload.

In terms of caseload, the diabetes volume-quality relationship is less clear. The relationship between *practice-level* diabetes prevalence or volume and quality was inconsistent. However, in a meta-analysis we found diabetes volume at the *physician level* was positively associated with quality, fitting with work in the acute setting.^{138, 139} We may expect practices with high diabetes prevalence to be more proactive in improving management. However, higher utilization by people with diabetes¹⁴⁰ may place greater demand on practice staff and resources, with a negative effect on quality. The association between prevalence and poorer quality reported by some of the studies could also reflect the higher prevalence in more deprived areas^{141, 142}, given deprivation was negatively associated with quality.^{38, 64, 67, 86, 117, 118} The positive relationship between physician-level diabetes volume and quality of care could reflect greater expertise gained through more exposure,¹³⁹ and may suggest the benefits of having a GP or nurse dedicated to diabetes care delivery; care models involving GPs with specialist interest have demonstrated a positive impact on outpatient attendances^{143, 144} and HbA1c control.¹⁴⁵

Our findings on practice location do not reflect challenges faced by rural practices, particularly in the US; i.e., limited access to specialists, funding and educational opportunities.¹⁴⁶ However, most studies could not be included in a meta-analysis, and among the few reporting an association^{40, 50, 56, 73}, findings were mixed. In the USA, private practices outside of federally qualified health centres or academic centres face similar resourcing challenges^{147, 148}, further suggesting the importance of these unaccounted for practice factors.

Our finding that practices with EHRs performed better supports existing qualitative work suggesting the quality of information technology¹⁸ and lack of EHRs¹⁴⁹ is a barrier to diabetes management. The magnitude of the overall effect estimate across quality measures (OR = 1.43, 1.11–1.84) was greater than that observed for physician gender (OR = 1.06, 1.03–1.10) or diabetes volume (OR = 1.24, 1.05–1.47). The effect (relative risk of receipt of care processes) achieved in trials of diabetes QI interventions has been found to range from 1.22 (1.13–1.32) for eye screening to 1.28 (1.13–1.44) for performance of a renal function check.¹³ With ongoing calls to develop electronic healthcare (e-health) in primary care¹⁵⁰, as a modifiable factor, EHR adoption should be facilitated as part of QI interventions.

Given most factors were not modifiable it is important (1) to be *cognisant* of these factors and how they could influence implementation of service changes and (2) to consider *tailoring* to accommodate these factors when introducing interventions or service changes into routine practice. Changes introduced widely (e.g. within a national health service like the UK NHS) or in specific sectors or organisations (e.g. Department of Veterans Affairs or Kaiser Permanente in the USA) could involve practices delivering care in different contexts, i.e. without an EHR, a longer established practice with older GPs, higher diabetes volume or based in a deprived area. Practices may implement initiatives differently, adapting to

the ‘normal conditions’¹⁵¹ of their practice, contextual features which may contribute to the ‘evidence to practice’ gap and yet not necessarily accounted for during evaluative studies.

For example, information technologies (EHRs) need to be well designed to enhance existing practice and not place additional demands on staff.^{152, 153} Their implementation should be considered in light of other non-modifiable factors, e.g. caseload, diabetes volume (and clinician skills/experience as a result). Staff with appropriate skills are crucial to underpin the CCM^{152, 153} However, education and caseload are difficult to address within the constrained primary care setting. Solutions proposed involve task delegation to non-physician staff¹⁷ (e.g. panel management assistants in Kaiser Permanente¹⁵⁴), nurse substitution¹⁵⁵ or co-located or outreach specialists.^{156, 157} For example, specialist nurses conducting clinics in practices, can provide inhouse education and support.^{158–161} While plausible, these approaches require not only sufficient resourcing of outreach specialists¹⁵⁹, particularly in rural primary care¹⁶² but protected physician/practice time (e.g. to direct panel management, liaise with specialists to identify education and organizational needs and tailor support accordingly^{160, 163}). In the US context, these approaches may be more feasible in larger, hospital-affiliated practices.

While this review did not use Wagner’s Chronic Care Model (CCM) as a framework a priori, some factors identified are relevant to the model.¹⁶⁴ For example, physician-patient communication is central to patient self-management support, a key element of the CCM.¹⁶⁵ Given our findings on physician gender, further exploration of communication styles between male and female physicians specifically as they relate to self-management is warranted. In line with the CCM framework¹⁶⁴, we found information systems (EHRs) were associated with higher quality of care. Together with supporting the core components of structured care delivery (i.e. register/recall) EHRs facilitate additional capabilities like clinician decision support¹⁶⁶, another CCM element posited to drive high-quality care.

In line with an existing review, we identified variability in the number and type of quality indicators used across studies.³⁰ This suggests the need for better selection criteria when choosing indicators and agreement on a standardised composite quality of diabetes care measure.

STRENGTHS AND LIMITATIONS

Unlike reviews focusing on one specific practice factor¹⁶⁷, we used broad search terms together with a range of a priori factors to identify all possible studies which examined a given factor. It is possible our search strategy may have missed other specific factors not identified a priori. However, we are confident we have identified all literature for the a priori factors ($n = 19$) and for the main additional factors (≥ 5 studies). Furthermore, reviewing the reference lists indicated that most

relevant studies had been identified. As our review includes factors which may not be the study focus (e.g. model covariate but with available effect estimates) data were less well-reported and sometimes not available from study authors. For example, data were often not reported for factors found to have no significant association with quality.

Included studies were, for the most part, cross-sectional, and the causal relationship between physician and practice factors is tentative. Owing to variation in exposures and outcomes used, together with the lack of reported data, the meta-analyses included only a small number of studies and results should be interpreted with caution. To aid the reader we have also summarised the findings from the studies which could not be included in a meta-analysis. Some analyses indicated considerable statistical heterogeneity ($I^2 > 60\%$). As few studies could be included in the meta-analyses this precludes an investigation of sources of heterogeneity; however, we suggest this was largely due to variation in composite outcome measures. We provide details of these measures for the reader to make their own judgement.

CONCLUSION

As stated by the Institute of Medicine in their seminal report, quality is a property of institutions, not individuals.^{168, 169} Our findings may inform targeted support of practice-level improvements and guide strategies to better implement structured diabetes management. Further research is needed: (1) to understand the way in which specific physician profile (gender, age and experience) and diabetes volume influences quality and (2) to examine the impact of practice rurality and status (academic-affiliation, public/private) which could not be adequately examined. Lastly, agreement on standard composite quality measures is crucial to increase comparability across studies and establish a clear picture of the quality of diabetes management in primary care.

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Compliance with Ethical Standards:

Conflict of Interest: The authors declare that they do not have a conflict of interest.

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