Primary medical care continuity and patient mortality: a systematic review

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Abstract

Background: A 2018 review of continuity with doctors in primary and secondary care concluded that mortality rates are lower with higher continuity of care.

Aim: This association was studied further to elucidate its strength and how causative mechanisms may work, specifically in the field of primary medical care.

Design and setting: Systematic review of studies published in English or French from database and source inception to July 2019

Methods: Original empirical quantitative studies of any design were included, from MEDLINE, Embase, PsycINFO, OpenGrey, and the library catalogue of the New York Academy of Medicine for unpublished studies. Selected studies included patients who were seen wholly or mostly in primary care settings, and quantifiable measures of continuity and mortality

Results: Thirteen quantitative studies were identified that included either cross-sectional or retrospective cohorts with variable periods of follow-up. Twelve of these measured the effect on all-cause mortality; a statistically significant protective effect of greater care continuity was found in nine, absent in two, and in one effects ranged from increased to decreased mortality depending on the continuity measure. The remaining study found a protective association for coronary heart disease mortality. Improved clinical responsibility, physician knowledge, and patient trust were suggested as causative mechanisms, although these were not investigated.

Conclusion: This review adds reduced mortality to the demonstrated benefits of there being better continuity in primary care for patients. Some patients may benefit more than others. Further studies should seek to elucidate mechanisms and those patients who are likely to benefit most. Despite mounting evidence of its broad benefit to patients, relationship continuity in primary care is in decline — decisive action is required from policymakers and practitioners to counter this.

Keywords: Continuity of patient care, primary health care, mortality

How this fits in

In 2018, a review of continuity of care was conducted with doctors in primary and secondary care; it concluded that mortality rates are lower with higher continuity. The study presented here not only confirms the association in the context of primary medical care, but also shows that it is variable and, indeed, not always present, possibly because the presumed benefits of continuity on mortality differ among different patient groups. The 13 studies reviewed say little about the mechanisms by which continuity may achieve lower mortality or why some patients may benefit more than others, and further research should focus on how, and when, continuity helps people, and how to achieve it in today's challenging context. As there is an ongoing decline in continuity, despite evidence of its benefits on mortality and other outcomes, policy initiatives and resources must enable and incentivise services that help patients to achieve it.

Introduction

Continuity of care is a core feature of general practice,[1-3] and defined as the care of individuals (rather than populations) over time. There are three main types of continuity:[3-5]

- relationship (or personal) — implies a trusting therapeutic relationship between the individual patient and at least one caring clinician;
- informational — the availability of records to all involved in the care of an individual; and
- management — coordination and communication between all groups.

Starfield *et al* l considered relationship continuity to be part of primary care's effect on improving outcomes, including patient satisfaction, and lower hospitalisation and emergency-room use.[6] Relationship continuity, leading to patient trust and improved adherence to advice, is a suggested mechanism for improved care effectiveness.[3,6] Measuring such relationships can be complex and needs approaches with patients and clinicians; however, counting contacts with the same person is much simpler because without such contacts a relationship cannot occur. Such use-based measurements of contacts can be called 'concentration of care' - namely, measuring to what extent patient contacts are concentrated on the same professional. They may appear synonymous with relationship continuity, although the relationship is implied rather than assessed.[7]

Care concentration supports informational and management continuity in primary care,[8] but concentration of care to support relationship continuity in primary care is declining in some countries; it is difficult for a patient to see their chosen doctor in a timely manner[9–11] and waits may cause diagnostic delay.[12] Although patients who are young and fit may neither want, nor need, to see the same doctor, older patients and those with multiple conditions often do;[13,14] as such, although relationship continuity in primary care has demonstrated care advantages,[2,6,11] evidence of better health outcomes, including decreased mortality, is needed to justify robust policies to support it.

A recent review of continuity with doctors in both primary and secondary care found a protective association against mortality.15 This association has been studied further by the authors, specifically in primary care, to elucidate its strength and how any causation may work in order to focus future research. Their objectives were to:

- investigate the association in primary care between continuity (relationship, informational, or management) and mortality in all studies with quantifiable measures of both; and

- appraise the proposed mechanisms, explaining any association between continuity and mortality — that is, the processes that might cause lower mortality with higher continuity.

Methods

Protocol

Prior to commencing this review, a study protocol was developed and registered with PROSPERO (reference number: CRD42017055578).

Definition

The following operational definition of primary care that focused on medical practitioners was added to Baker *et al's* published protocol:[16] care provided by physicians specifically trained for, and skilled in, comprehensive first contact and continuing care for persons with any undiagnosed sign, symptom, or health concern.

Eligibility criteria

Included studies were those that:

• were original empirical studies of any quantitative design;

• were published in English or French from the inception of the databases or sources used, until July 2019; and

• used quantifiable measures of both continuity and mortality in patients seen wholly, or mostly, in primary care settings.

Searches

MEDLINE, Embase, and PsycINFO were searched for potentially relevant peer reviewed articles, along with Open Grey and the library catalogue of the New York Academy of Medicine for unpublished studies; the search strategy is outlined in Supplementary Box S1. One reviewer undertook the searches, developing the strategy in MEDLINE and adapting it for Embase, PsycINFO, and the grey literature. Citations in four relevant reviews of continuity in primary care[4–6,8] and in the 13 studies included in this review were also searched.

Data collection

After piloting the data extraction form, three reviewers undertook dual independent data extraction of each study. Two reviewers were assigned randomly to each study; as two articles were co-authored by one of the researchers, they were reviewed by the two researchers who had not been involved in those studies. Data were extracted independently and differences resolved through three-way discussion. Study authors were contacted for additional information if necessary; this included clarification from the health professionals involved. The researchers recorded:

• authors;

• publication year;

• country;

• design;

• primary medical care setting;

• numbers and types of patients;

• numbers of deaths;

• measure and type of continuity;

• covariates in statistical models (including other continuity variables);

• statistical model (for example, linear or logistic) and whether the outcome was transformed;

• continuity beta coefficient and variability estimate;

• measure of mortality — whether overall or disease specific; and

• the measurement periods for continuity and related monitoring periods for mortality, the raw measure, and translation into a hazards ratio, if relevant.

The reviewers captured any mechanisms proposed by the study authors about how continuity might impact mortality - whether hypothesised at the design stage or in discussion of observed results - and posited alternate explanations, if relevant.

Risk of bias in included studies

The 2011 version of the Mixed Methods Appraisal Tool (MMAT) was used;17 this allowed for the appraisal of randomised, non-randomised, quantitative descriptive, qualitative, and mixed-methods studies. It has been evaluated18 and includes three items for mixed-methods studies and four items for each of the other study types. Each item is rated categorically (yes, no, unclear), and the number ranked 'yes' enables an overall score to be reached. The reviewers' reasons for ratings, including strengths and weaknesses of studies and their assessment of the measures of continuity employed, were also recorded.

Synthesis of results

It was initially planned that a meta-analysis would be conducted to better assess the strength of the observed positive associations of continuity and mortality. Study authors were directly approached for additional and more-precise data. Some went to great trouble to help but, ultimately, meta-

analysis was found to be impossible because of differing outcome measures, continuity measures, timescales, and issues related to non-linear results curves (Supplementary Box S2).

Risk of bias across studies

Publication bias towards favourable associations between primary care continuity and mortality were anticipated; the grey literature were searched to try to mitigate this but nothing relevant was found.

Results

Study selection and characteristics

In total, 2785 articles were assessed for relevance and 13, conducted by 10 research teams, were included (Figure 1).[19–31] These were carried out in the US (n = 3),[19,23,24] Canada (n = 3),[20,22,28] England (n = 2),[29,30] Austria (n = 1),[31] France (n = 1),[21] Israel (n = 1),[26] South Korea (n = 1),[25] and the Netherlands (n = 1)[27] (Table 1). All measured relationship continuity from care-use patterns or by patient report. None specifically addressed informational or management continuity. All practitioners were physicians except in two US studies, which included some nurse practitioners and physicians' assistants.[19,24]

In two studies[29,30] the unit of analysis was the entire primary care practice population. Four studies[19,20,23,27] included only older patients (aged ≥60 or >65 years), and one of these[20] was restricted to people with diabetes (Table 1). Seven studies selected specific populations: five selected patients with chronic conditions (diabetes, hypertension, hypercholesterolaemia, or heart failure),[22,25,26,28,31] one selected military veterans,[24] and one selected salaried workers with ≥2 consultations.[21]

Data-collection periods ranged widely, from a few weeks[22] or months[28] to 17 years (Table 1).[27] Continuity data were collected before a cut-off point, followed by mortality measurement in five studies[22,24,25,27,28] while, in the remainder, continuity scores were calculated up to the time of death.

A quantitative analysis was not feasible because the continuity data could not be incorporated into a meta-analysis (Supplementary Table S1 and Supplementary Box S2).

Risk of bias within studies

All 13 studies were of quantitative observational design and either cross-sectional or with variable periods of follow-up. Assessed by MMAT, seven studies achieved the maximum score of compliance with four assessment items,[19–21,25,26,28,31] three studies scored 3,[24,29,30] and another three scored 2 (Table 2).[22,23,27] In the subjective assessments, the most common weakness was the measure of continuity, for example, use of proportions of consultations with a specific doctor (concentration of care) was used to indicate relationship continuity

Association between continuity and mortality

Twelve studies measured all-cause mortality, of which nine found a statistically significant protective effect of greater continuity (Table 3).[19–22,24–26,27,28] Two studies did not find a

statistically significant effect[29,31] and, in one, the effect varied from increased to decreased mortality depending on the measure of continuity used.[23]

Of the two studies that included entire practice populations, one found a protective association for coronary heart disease (CHD) mortality rates,[30] and the other found a protective association for cancer and chronic obstructive pulmonary disease mortality rates, but not for all-cause, CHD, or stroke mortality rates (data not shown).[29] Both of these studies, undertaken in England, used a patient-reported measure of continuity.

Of the 11 studies that measured mortality and continuity in populations selected according to morbidity or age, 10 found a protective association of better continuity against all-cause mortality;[19–22,24–28,31] this was not the case with all measures of continuity in one study (Table 3).[23] Overall, the study findings suggest that relationship continuity has a variable, but generally protective, effect on mortality, which has greater magnitude for some patients. Where the data specified several levels of continuity, the dose–response curve varied: in one study,[19] there was a benefit for some continuity versus no continuity, but no further benefit for extra increases in continuity (non-linear association) (data not shown). The study by Maarsingh *et al*[27] found a progressive increase in benefit for additional increases in continuity (linear association) (data not shown).

The absence of benefit in Geroldinger *et al's* study, which was restricted to people with diabetes,[31] may be due to the very high levels of primary care continuity reported in the study, with 61.9% of patients having only a single GP and therefore a Continuity of Care Index of 1.0.

Reported mechanisms of any association

Statements pointing to potential mechanisms by which continuity might influence mortality were identified in seven studies,[19,21,23,25,27,28,31] three studies made no suggestions,[20,22,24] and three were unclear (Box 1).[26,29,30] The mortality reduction was attributed to greater physician knowledge of the patient,[23,25,28] increased patient trust enabling improved adherence to medical advice,[19,21,23,25] and to enhanced clinical responsibility being taken when the same physician offers care.[19] Authors of two studies suggested confounding mechanisms: Lustman et al suggested that very ill patients choosing to see the most readily available doctor could compromise continuity,[26] while Bentler et al indicated that higher mortality related to higher concentration of care among patients with more-serious illness.[23] Although no study explicitly stated that continuity might better protect against mortality in older populations or those with greater morbidity, most studies focused on such populations.

Discussion

Summary

No experimental studies were found. Nearly all the observational studies in the review suggested that relationship continuity was associated with a protective effect on mortality. However, as effect sizes were modest and variable, and a variety of designs and continuity measures were used, it is not possible to say whether the influence of continuity was greater in older populations or those with greater morbidity. The choice of different explanatory variables to include in regression models and different levels of analysis (patient, practice, or larger service unit) may also explain some of the variation between studies - such as, for example, the protective association for CHD that was found in Honeyford et al's study,[30] but not in that conducted by Levene *et al.*[29]

Strengths and limitations

This was a comprehensive, protocol-based search that focused specifically on primary care populations. However, there are some limitations: it was not possible to undertake a meta-analysis; publication bias cannot be ruled out; and continuity measures varied, with most being record based. Finally, a range of different settings and follow-up periods were also used, which were compatible with (but did not confirm) a wide-ranging effect. Since almost all the health professionals in the included studies were physicians, the authors are unable to comment on the effects of continuity with non-physician primary care practitioners.

Comparison with existing literature

The findings of this review are consistent with much of the literature on the benefits of continuity; however, exceptions to this include reports of delayed diagnosis of significant conditions such as cancer.[32,33] One study also noted that the care of patients seen by a single physician tended to gain lower professional rating scores,[34] and another four failed to find associations between continuity and favourable outcomes.[35–38] Such wide-ranging results suggest that a simple view that 'continuity is good for patients' may mask more complexity, for example, benefits for many patients may be reduced overall by disadvantages for a few.

No study in this review directly investigated the mechanisms to explain an association between continuity and mortality, and reverse causality remains possible - that is, that patients with a greater risk of death are less likely to see the same physician. A typical model was that relationship continuity increases physicians' personal knowledge of the patient, in turn leading to more appropriate treatment and improved patient trust. This may increase both disclosure of

relevant personal clinical details and a willingness to follow medical advice.[39] Pereira Gray *et al* argued that:

"*a 'personal doctor' with accumulating knowledge of the patient's history, values, hopes and fears will provide better care than a similarly qualified doctor who lacks such knowledge*".[40]

If accumulated knowledge is important, then continuity measurement needs to allow for this; in particular, seeing the same person does not equate with knowing them well, although the two may be correlated.[23] Empathy, for example, is a feature of the relationship and recent studies have shown that greater empathy is associated with improved outcomes.[41,42] As such, indices based on clinical contact records (concentration of care)[7] are, at best, proxy measures of the relationship in relationship continuity. Direct patient assessments of relationship continuity may be more appropriate than administrative measures from medical records;[23,43] this could explain why a patient-reported measure of continuity showed a protective association with mortality while concentration measures did not.[23] This also means that the patient-reported measures used in two studies[29,30] have considerable face validity. No studies in the present review considered the potential of continuity to improve patient safety and therefore reduce mortality, although there is some evidence that discontinuity can impair safety.[44,45]

A recent review suggests four mechanisms for how patients gain from relationship continuity:[46]

- Trust, with good communication;
- Patients not having to repeat their story;
- Feeling safe; and
- Ease of navigating the health system

These reflect mechanisms suggested by authors of articles included in the present review and can all be included in the concept of agency theory.[47] Patients consult health professionals for meaning and understanding, knowledge, skills, and therapies; the clinician is their agent and shares the patient's world view, while adding appropriate and necessary value. Seeing the same clinician potentially enhances good agency, but a clinician seeing the same patient may also deviate from professional norms,[35] whereby the doctor and patient prioritise the patient's wishes, even if these conflict with professional standards – as such, an apparently good agent might not be to the patient's longer-term benefit. Another benefit from relationship continuity may be that GPs allow for previous consulting behaviour in patients they know, and so set different thresholds for responding with tests or treatments.[48] This could lead to cost savings and lower mortality if inappropriate medical activity was avoided. Consistent with the findings

of the present review, seeing the same physician may not only bring many virtues, but also some vices: virtues of knowledge, trust, and commitment are countered by overfamiliarity and restricted viewpoints. The virtues usually predominate, but not overwhelmingly so.

Implications for research and/or practice

Is the observed association causal? Perhaps patients who manage to concentrate their care to one provider[49] live longer for some other confounding reason. Such concentration may increase or decline near death, when greater need and urgency for consultations makes continuity both more desirable and more difficult. Research should also investigate the meaning of different measures of continuity and relate this to the relationship, informational, and management types described.

Studies are required on: the feasibility of improving continuity; continuity with other clinicians, especially nurses; and which patients benefit from continuity and which suffer. Randomised trials comparing enhanced continuity with normal care could be very persuasive. As older patients tend to want continuity, are more prepared to wait to obtain it,[49] and may - because of their increased multimorbidity – benefit more than their younger counterparts, primary care trials should initially focus on them. One such trial has started (personal communication, OR Maarsingh, 2020), but more are needed.

More qualitative work is also needed on: how continuity is achieved (or not) in modern practices with part-time clinicians; how patients achieve continuity; and how practices, and receptionists in particular, can enhance it.

Conclusion

The findings presented here are consistent with an association between continuity and mortality, although direct experimental evidence is desirable. Policymakers may aim to improve efficiency, even at the price of impersonal care, but should realise that the resulting discontinuities could make matters worse for patient satisfaction, hospital use, and, probably, mortality. New patterns of care must be designed to avoid these outcomes.

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Conflicts of interest. We have no conflicts of interest to declare

Ethical approval. Not required.

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Figure 1. PRISMA 2009 Flow Diagram for the selection of studies

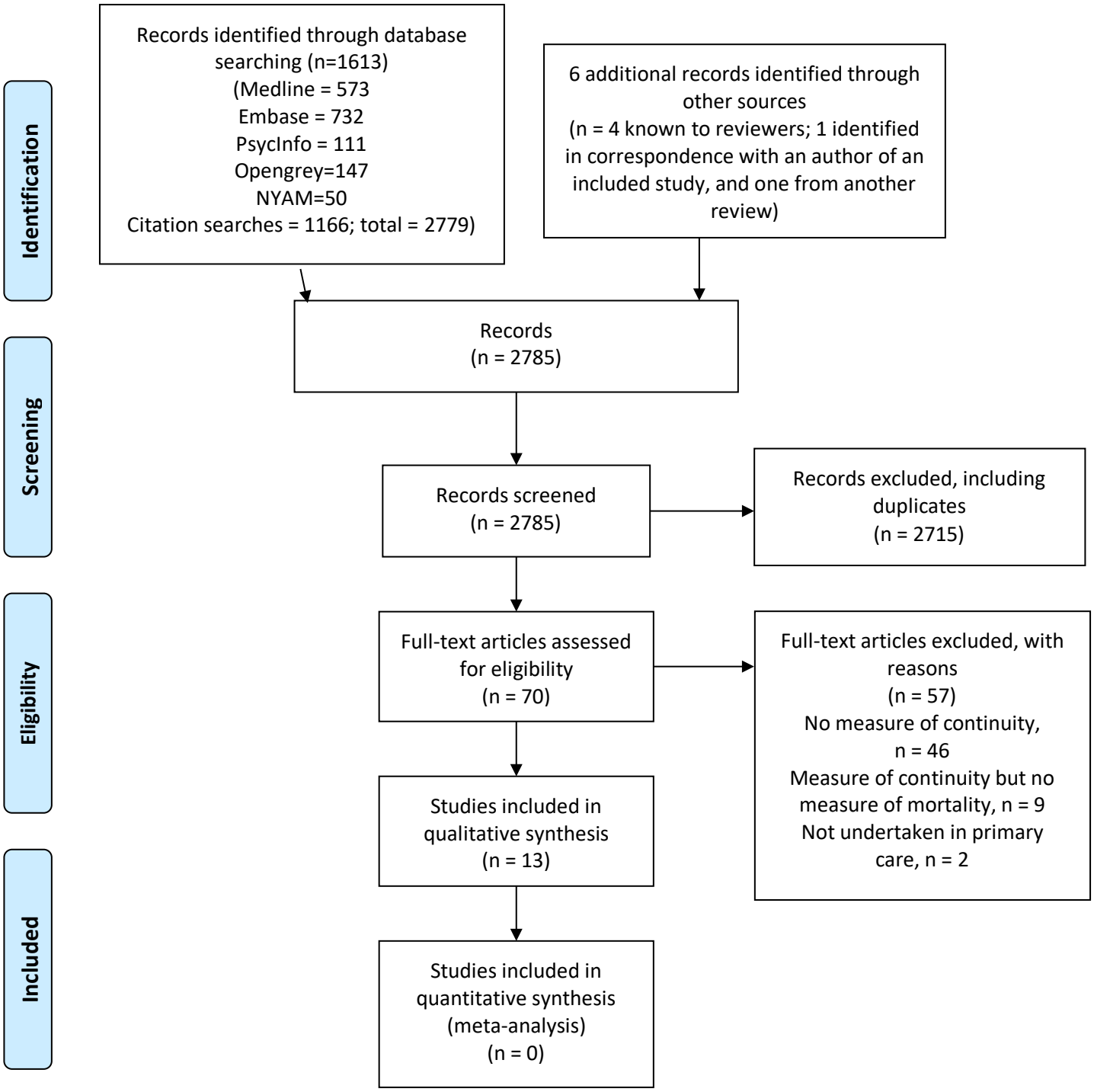

Table 1. Characteristics of included studies (grouped according to whether selected or entire populations were included, and ordered by year of publication)

Author and year of publication	Setting	Population details	N	Study design	f/u (yrs)	Follow up sequence*	Designed for CoC assess? Y/N	Data sources	Measure of continuity of care	All cause or disease specific mortality	Measure of mortality
Selected study populations											
Wolinsky 2010[19]	USA Primary Care	>70 years	5457	single retrospective cohort	12	CoC up to 12y with Mort	N	single interview with documentary follow-up	No more than 8 months between visits to the same primary care practitioner	All cause	Medicare files
Worrall 2011[20]	Canada Newfoundland Family Practice	>65 with diabetes	350	Single retrospective cohort	3	3y CoC with 3y Mort	N	provincial admin databases	UPC	All cause	Mortality Surveillance System
Leleu 2013[21]	France Primary Care	Salaried workers with 2 or more consultations; National sample	325742	Single retrospective cohort	3	CoC 6m with Mort 3y	N	National Health Insurance records	COCI	All cause	NHI database
McAlister 2013[22]	Canada Alberta Primary Care	>20 years with acute admission with first time diagnosis of heart failure	39249	single retrospective cohort	30 days	14d+1y CoC then 30d Mort	N	Alberta Health Admin databases	Seen by familiar physician <14 days of discharge	All cause	Alberta health insurance plan registry

Bentler 2014 [23]	USA Primary Care	>65years Medicare patients	1219	single cohort	5	1y CoC with 5y mortality	Y	mailed questionnaire and record based follow-up	multiple measures	All cause	Medicare files
Nelson 2014[24]	USA VHA Primary Care	Veterans with 2 or more consultations	4.3M	single retrospective cohort	1	1y CoC then 1y mortality	N	VHA records	UPC	All cause	VHA files
Shin 2014[25]	S Korea Primary Care	hypertension, diabetes, or hypercholesterolaemia	47433	Single retrospective cohort	5	CoC 2y then mortality 5y	N	Korean National Health Insurance enrolees	UPC	All cause and CVD	national death registry
Lustman 2016[26]	Israel primary care	Type 2 diabetes aged 40 – 75 years	23,679	Single retrospective cohort	2	CoC 1+1y with mortality 1+1y**	N	HMO records database	UPC	All cause	HMO records database
Maarsingh 2016[27]	Netherlands General Practice	>60 years	1712	single retrospective cohort	17	7-17y CoC then 1-14y Mort	N	triennial home interviews	Hirfindahl-Hirschman Index	All cause	linked municipal registers
McAlister 2016[28]	Canada Alberta Primary Care	>20 years with new diagnosis of heart failure made during an admission or ED attendance	24373	retrospective cohort	0.5	1y+1m CoC then 6m Mort	N	Alberta H Admin databases	UPC	All cause	Alberta health insurance plan registry
Geroldinger 2018[31]	Austria, all medical disciplines and general practice	18 and over with at least two diabetic medication records during index year	51,717	Single retrospective cohort	3.7 yrs	1yr CoC then mortality in years up to study end date	Y	Austrian social security database	Bice Boxerman COCI	All cause	Austrian social security database

Entire primary care populations											
Levene 2012[29]	England General Practice	all patients	51.5M	cross-sectional	n/a	2y CoC with 2y Mort	N	NHS QOF and ONS data	Able to see preferred GP	All cause, and CHD, cancer, stroke, COPD mortality	National statistics
Honeyford 2013[30]	England General Practice	all patients E Midlands	1.7M	Cross-sectional	n/a	CoC 1y with 2y Mort	N	NHS QOF and ONS data	Able to see preferred GP	CHD mortality	Primary Care mortality database

* CoC ***with*** mortality means overlapping measurement periods (mortality may extend longer)
CoC ***then*** mortality means sequential measurement periods

** the two years' data collected and analysed separately and later combined when differences found to be insignificant

Table 2. Assessment of risk of bias using the MMT.[17] All the studies were of quantitative descriptive design and were assessed against the MMT question items for this design.

	Is the sampling strategy relevant to address the quantitative research question?		Is the sample representative of the population under study?	Are measurements appropriate (clear origin, or validity known, or standard instrument)?	Is there an acceptable response rate/follow-up (60% or above)?	Overall score
Selected study populations						
Wolinsky 2010 [19]	yes		x	x	X	4
	no					
	unclear	x				
	comments	unclear				
Worrall 2011[20]	yes	x		x	X	4
	no					
	unclear		x			
	comments		45 patients had to be excluded			
Leleu 2013[21]	yes	x	x	x	x	4
	no					
	unclear					
	comments					
McAlister 2013[22]	yes	x			x	2
	no					
	unclear		x	x		
	comments		16357 patients having more than one admission were excluded.	UPC is known, familiar physician less so. No separate analysis for UPC and deaths		
Bentler 2014[23]	yes	x		x		2
	no				x	
	unclear		x			
	comments		Limited to Fee For Service patients	questionnaire items not validated for this study.	The survey sample was 6,060, but only 1,219 were included in the analysis	
Nelson 2014[24]	yes		x	x	x	3
	no	x				
	unclear					
	comments	Older males	But not of general population			
Shin 2014[25]	yes	x	x	x	x	4

	no					
	unclear					
	comments					
Lustman 2016[26]	yes	x	x	x	x	4
	no					
	unclear					
	comments					
Maarsingh 2016[27]	yes	x			1712/3107	2
	no		x	x	X (55%)	
	unclear					
	comments		disadvantaged under-represented			
McAlister 2016[28]	yes	x	x	x		4
	no					
	unclear					
	comments					
Geroldinger 2018	yes	x	x	x	x	4
	no					
	unclear					
	comments					
Entire primary care populations						
Levene 2012[29]	yes	x	x		x	3
	no			x		
	unclear					
	comments			weak continuity measure		
Honeyford 2013[30]	yes	x	x		(x)	3
	no					
	unclear			x		
	comments					

Table 3. Summary of Findings (HR=hazards ratio; OR=odds ratio; IRR=incidence rate ratio)

Author and year	Mortality measure	Summary finding (95% CI)
Selected populations		
Wolinsky 2009[19]	All cause	HR 0.84 (0.77 to 0.91) for high continuity
Worrall 2011[20]	All cause	HR 0.50 for high continuity
Leleu 2013[21]	All cause	HR 0.96 (0.95 to 0.96) for high continuity
McAlister 2013[22]	All cause	HR for death within 12 months no visits with familiar physician 1; for all visits with familiar physician 0.77 (0.70 to 0.86)*
Bentler 2014[23]	All cause, time to death	Patient reported (provider duration) measure: HR highest tertile vs lowest tertile of continuity 0.54 (0.37 to 0.80)
Nelson 2014[24]	All cause	OR 0.94 (0.91 to 0.96) for high continuity
Shin 2014[25]	All cause 5-year survival rate	HR 1.12 (1.04 to 1.21) for continuity below the median
Lustman 2016[26]	All cause	OR 0.59 (0.50 to 0.70) for high continuity
Maarsingh 2016[27]	All cause	lowest continuity category showed 20% more mortality than highest category, HR1.20 (1.01 to 1.42)
McAlister 2016[28]	All cause	HR 0.72 (0.63 to 0.81) with 1 or more follow-up visits with familiar physician, with HR 1 for no visits and 0.98 (0.80 to 1.20) for visits with unfamiliar physician only*
Geroldinger 2018[31]	All cause	primary care continuity: COCI of 1 in comparison 0.74, HR = 0.95 (0.87 to 1.03)
Entire primary care populations		
Levene 2012[29]	All cause	IRR 0.999 (0.997 to 1.01) for high continuity
Honeyford 2013[30]	CHD mortality	IRR 0.994 (0.989 to 1.000) for high continuity

*additional data provided by study authors

Table 4. (Suggested mechanisms) by which any type of continuity might influence mortality

Study	Suggested mechanisms
Selected populations	
Wolinsky 2009 [19]	"Continuity is expected to result in improved doctor-patient relationships, enhanced physician knowledge of the patient, great rapport and disclosure, increased compliance, reduced hospitalization rates, increased patient and physician satisfaction, reductions in disability levels, costs and missed appointments, and improved problem recognition and management."
Worrall 2011[20]	None
Leleu 2013[21]	Consultations with the same primary care practitioner can lead to a better understanding of patients' health needs and better management.
McAlister 2013[22]	None
Bentler 2014[23]	'Longitudinal continuity provides a chance for interpersonal continuity to develop, which means that knowledge, trust, and respect have developed over time, allowing better interaction and communication. Interpersonal continuity includes instrumental (provider knowledge about the patient) and affective (mode of behaviour towards the patient) that contribute to a good relationship.'
Nelson 2014[24]	None. Continuity regarded as a feature of the Primary Care Medical Home.
Shin 2014 [25]	'A physician who attends the same patient regularly is likely to have better knowledge of him or her, to recognize problems earlier, and to provide higher quality of care. Furthermore, patients who have continuity with the same physician are more likely to adopt better self-management behaviours and to increase adherence to medication recommendations, probably because of greater trust and to have higher satisfaction with their physicians.'
Lustman 2016[26]	'It is not possible to say if higher interpersonal continuity is causal in reducing mortality, this result is as likely due to very ill patients changing doctors, or going to the most readily available doctor'
Maarsingh 2016[27]	'The assumed benefits of continuity of care include a better patient–provider relationship, increased patient satisfaction, improved uptake of preventive care, enhanced adherence to treatment, more accessible health care, and reduced healthcare use and costs. Especially vulnerable patients, such as older patients, are considered to benefit from continuity of care, as they are likely to have multiple chronic conditions'.
McAlister 2016[28]	'It seems reasonable to hypothesize that healthcare providers (physicians or nurses/pharmacists) who have a longer-term relationship with a patient are likely to have a better sense of that patient's unique situation and the numerous nonmedical issues that influence hospitalization risk'
Geroldinger 2018[31]	Patients who benefit from multidisciplinary care, which is reflected by low total continuity, may have a smaller risk of mortality. Measures of continuity are sensitive to the types of medical disciplines taken into account.
Entire primary care populations	
Levene 2012[29]	"Starfield et al [15] identified mechanisms potentially accounting for the beneficial impact of primary care on population health, including greater access to needed services, better quality of care, greater focus on prevention, earlier disease management, and the cumulative effect, with a holistic focus, of greater continuity and comprehensiveness".
Honeyford 2013[30]	In a referenced conceptual model, the authors suggest that quality primary health care (access with sustained patient relationships and/or interventions) can modify the relationship between risk factors and probability of death.

Supplementary data

Box S1. Search strategies

Database: Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) <1946 to Present>
Search Strategy:
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1 continuity of patient care.mp. or "Continuity of Patient Care"/
2 (continuity adj2 care).mp.
3 (continuum adj2 care).mp.
4 continuity.mp.
5 (trust* adj2 (doctor* or practitioner* or physician* or provider* or patient*)).mp.
6 (interpersonal or inter personal).mp.
7 (bice adj boxerman).mp.
8 ((personal or most responsible or main or regular or same or known) adj (doctor* or practitioner* or physician*)).mp.
9 COC.mp.
10 (care adj (transition or transitions)).mp.
11 (coordination or co-ordination or coordinating or co-ordinating).mp.
12 or/1-11
13 primary health care.mp. or Primary Health Care/
14 primary care.mp.
15 primary practitioner*.mp.
16 general practitioner*.mp.
17 exp general practice/
18 family physicians.mp. or Physicians, Family/
19 family pract*.mp.
20 or/13-19
21 mortality.mp. or exp Mortality/
22 death rate*.mp.
23 death$1.mp.
24 mo.fs.
25 or/21-24
26 12 and 20 and 25
27 case reports.pt.
28 letter.pt.
29 editorial.pt.
30 personal narratives.pt.
31 27 or 28 or 29 or 30
32 26 and 31
33 26 not 32
34 limit 33 to (english or french)

Database: Embase from 1974
Search Strategy:

---

1 continuity of patient care.mp. or patient care/
2 (continuity adj2 care).mp.
3 (continuum adj2 care).mp.
4 continuity.mp.
5 (trust adj2 (doctor* or practitioner* or physician* or provider* or patient*)).mp.
6 (interpersonal or inter personal).mp.
7 (bice adj boxerman).mp.
8 ((personal or most responsible or main or regular or same or known) adj (doctor* or practitioner* or physician*)).mp.
9 coc.mp.
10 (care adj (transition or transitions)).mp.
11 (coordination or co-ordination or coordinating or co-ordinating).mp.
12 or/1-11
13 exp primary health care/
14 primary care.mp.
15 (primary practitioner* or general practitioner*).mp.
16 exp general practice/
17 general practitioner/ or family physician*.mp.
18 family pract*.mp.
19 (primary health care or primary healthcare).mp.
20 or/13-19
21 exp mortality/ or mortality.mp.
22 (death rate* or deathrate*).mp.
23 death$1.mp.
24 21 or 22 or 23
25 12 and 20 and 24
26 limit 25 to (editorial or letter)
27 25 not 26
28 limit 27 to (english or french)
29 limit 28 to article
30 limit 29 to medline
31 29 not 30

PsycINFO (inception year 1967)

S1 "continuity of patient care" OR SU continuum of care
S2 continuity N2 care
S3 continuum N2 care
S4 continuity
S5 trust* N2 (doctor* or practitioner* or physician* or provider* or patient*)
S6 interpersonal or "inter personal"
S7 bice W1 boxerman
S8 bice and boxerman
S9 (personal or "most responsible" or main or regular or same or known) W1 (doctor* or practitioner* or physician*)
S10 COC
S11 care W1 (transition or transitions)
S12 coordination or co-ordination or coordinating or co-ordinating
S13 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S9 OR S10 OR S11 OR S12
S14 "primary health care" or "primary healthcare"
S15 DE primary health care
S16 "primary care"
S17 "primary practitioner*" or "general practitioner*"
S18 "family physician*" OR DE general practitioners
S19 "family pract*"
S20 S14 OR S15 OR S16 OR S17 OR S18 OR S19
S21 mortality OR DE (death and dying) OR DE mortality rate
S22 "death rate*"
S23 death or deaths
S24 (S21 OR S22 OR S23)
S25 S13 AND S20 AND S24

Open Grey Search (inception year 2011)

Search strategy:
(((continuity OR continuum) NEAR care) OR (trust* NEAR (doctor* OR practitioner* OR physician* OR patient*)) OR (bice AND boxerman) OR ((personal OR most responsible OR main OR regular OR same OR known) NEAR (doctor* OR practitioner* OR physician*)) OR COC OR (care NEAR (transition OR transitions))) AND (primary OR general OR family) AND (mortality OR (death OR deaths))
Website: http://www.opengrey.eu/
To cite or link to this reference: http://hdl.handle.net/10068/980091

NYAM (inception year 1999): separate searches for

continuity of care and primary
continuum of care and primary
Continuity of patient care as subject heading
Interpersonal
Inter personal
Transition and care
Personal and doctor(s)
Personal and physician(s)
Personal and practitioner(s)

Table S1. GRADE summary of findings table.

Outcomes	Risk with low continuity	Corresponding risk with high continuity	Relative effect (95% CI)	Number of participants	Quality of evidence	comments
mortality					**Low**	**Studies with different populations and different measures of continuity. A summary statistic not feasible**
	Meta-analysis of included studies not feasible		**Some variation in effect, but majority of studies indicate protective effective of higher continuity**		**Observational studies. No consistent dose response gradient. Publication bias likely.**	

Box S2. Attempted synthesis of results

A meta-analysis was considered, but was ultimately not deemed viable. Of the 11 selected papers, six used a common statistical method, survival analysis, producing a hazard ratio derived from a Cox proportional hazards model. It was decided that estimates from these six studies should be meta-analysed together if possible. McAlister[28] had to be omitted as the reference category was 'no visits'. Of the remaining studies, each continuity predictor had a different configuration, ranging from 'continuous' to categorical with five categories.

It was thought that it might be possible to calibrate some of the predictors in order to achieve a dose-response curve for each study using software created for this kind of situation[A1]. The aim of a dose–response meta-analysis is to see if there is any association between increasing dose levels and the outcome, in order to "make inference about the shape of the association from multiple aggregated dose–response data" [A2]. The usual method consists of estimating the regression coefficients for the study-specific trends separately, and then combining them using meta-analysis. The Metadose macro [A3] accomplishes three main objectives: to create a dose-response estimate for each study, to assess linearity for each study, and to meta-analyse the dose response estimates from the different studies. Confirming linearity is important because if a study features an association that is *non*-linear, then the true relationship between predictor and outcome is not represented by a linear coefficient, and will be under-estimated (and hence biased). The metadose macro does not generate a nonlinear estimate based on a random effects model.
Unfortunately, only three of our eligible studies had three or more levels of continuity, meaning that only for those three would it be possible to evaluate the linearity assumption (if n levels <3 then the linearity assumption cannot be rejected). However, one of these authors (Bentler)[23] was not able to access the extra data needed for the macro. Furthermore, a standard requirement for meta-analysis of non-linear curves is that the studies provide at least two non-referent relative risks[A2]. The remaining two generated highly nonlinear (quadratic) associations between continuity and mortality, but because they produced opposite looking functional forms from each other, it was decided not to synthesize them in a meta-analysis. This was because the available software (the metadose macro in SAS) only runs *fixed* effects nonlinear dose response meta analyses, and the opposite nature of the patterns comparing the two studies would mean a random effects model would be essential. The 'dosresmeta' package in 'R' and Stata's mvmeta procedure both support random effects nonlinear dose response meta-analysis, but extra data required for these procedures were not available. A further technical point is that methods have not yet been devised for calculating dose-response associations from categorical predictors where the continuous variable is censored, as is the case for variables with a 0-1 range.

Additional References

A1. Nicola A, Li R, Wolk A, et al. Meta-Analysis for Linear and Nonlinear Dose-Response Relations: Examples, an Evaluation of Approximations, and Software. *Am J Epidemiol*. 2012;175(1):66–73.

A2. Alessio C, Thomas I, Orsini N. A Pointwise Approach to Dose-Response Meta-Analysis of Aggregated Data. *Int J Stat Med* 2018;7:25-32.

A3. The SAS %METADOSE Macro. Li R, Spiegelman D. August 26, 2010. https://cdn1.sph.harvard.edu/wp-content/uploads/sites/271/2012/08/Metadose-Documentation-2010.pdf.