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The frequency, nature and impact of GP-assessed avoidable delays in a population-based cohort of cancer patients

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ABSTRACT

Background: There is a growing emphasis on the speed of diagnosis as an aspect of cancer prognosis. While epidemiological data in the last decade have quantified diagnostic timeliness and its variation, whether and how often prolonged diagnostic intervals can be considered avoidable is unknown.

Methods: We used data from the English National Cancer Diagnosis Audit (NCDA) on 17,042 patients diagnosed with cancer in 2014. Participating primary care physicians were asked to identify delays in diagnosis that they deemed avoidable, together with the 'setting' of the avoidable delay and key attributable factors. We used descriptive analysis and regression frameworks to assess validity and examine variation in the frequency and nature of avoidable delays.

Results: Among 14,259 patients, 24% were deemed to have had an avoidable delay to their diagnosis. Patients with a reported avoidable delay had a longer median diagnostic interval (92 days) than those without (30 days). Of all avoidable delays, 13% were deemed to have occurred pre-consultation, 49% within primary care, and 38% within secondary care. Avoidable delays were mostly attributed to the test request/performance phase (25%). Multimorbidity was associated with greater odds of avoidable delay (OR for 3 + vs no comorbidity: 1.43 (95% CI 1.25–1.63)), with heterogeneous associations with cancer site.

Conclusion: We have shown that GP-identified instances of avoidable delay have construct validity. Whilst the causes of avoidable diagnostic delays are multi-factorial and occur in different settings and phases of the diagnostic process, their analysis can guide improvement initiatives and enable the examination of any prognostic implications.

1. Introduction

There is a growing body of evidence demonstrating the negative impact of delays in cancer diagnosis on disease severity [1], choice of treatment [2], prognosis (including mortality) [3] and patient experience [4]. Additionally, perceptions of the timeliness and accuracy of the diagnostic process are important for the general public and for policy makers [5,6]. Missed diagnostic opportunities are deemed to have occurred when something different could have been done to make the correct diagnosis earlier [7]. These are estimated to affect 1 in 20 adults receiving outpatient care in the US [8].

Patient, provider or health care system factors, or their combination, may be associated with prolonged intervals in cancer diagnosis [9,10], which have been associated with poorer outcomes [11]. However, in spite of epidemiological evidence about variation in diagnostic timeliness [12,13], there is relatively little appreciation of how often prolonged diagnostic intervals can be considered avoidable, and of related contributory factors [14].

The English National Cancer Diagnosis Audit (NCDA) was carried out during 2016-17 to help clinicians to reflect on their individual practice, and to improve the understanding of the diagnostic process for patients subsequently diagnosed with cancer [15]. As part of the NCDA, participating physicians were asked to identify delays in diagnosis that in their view were avoidable and to categorise them using a previously derived taxonomy [16]. Against the above background, our aim was to generate evidence about how often there may be avoidable delays in the diagnosis of cancer, their type and context. To do so, we used GP-recorded audit data linked with population-based cancer registration data to examine the construct validity of GP-assessed avoidable delays in our data.

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2. Methods

2.1. Data

We used data from the English NCDA [15]. Primary care data on 17,042 malignant cancer cases diagnosed in 2014 (excluding non-melanoma skin cancer [17]) from 439 practices (~5% of English general practices) were collected from September 2016 to February 2017 via a secure online portal. Each participating general practice was provided with the list of its patients diagnosed in 2014 according to the national cancer registry and asked to provide details on their diagnostic process. The patient cohort was representative of the national incident cohort (2014) considering age, sex and cancer site. Participating practices were similar to non-participating practices on a range of metrics including clinical quality scores and patient experience, although they were somewhat larger and had slightly fewer patients per GP. Cancers determined to have been screen-detected either by National Cancer Registration and Analysis Service (NCRAS) records [18] and verified by the GP (n = 1006) or where the GP indicated referral by screening (n = 231) were *a priori* deemed not relevant to this study and excluded from analysis.

The audit questionnaire required GPs to state whether or not in their opinion an avoidable delay had occurred and the nature of that delay (Box 1) [19]. GPs had access to coded and free text within the electronic health record of each patient to make this judgement. The outcomes of interest were avoidable delay status and the nature of the avoidable delay characterised across three dimensions: the setting; the phase in the diagnostic pathway; and to what or whom it could be attributed.

2.2. Construct validity

We hypothesised *a priori* that patients with avoidable delays would have had substantially longer interval values and greater frequency of multiple pre-referral consultations compared to those without. We described the primary care interval (days from first presentation of symptoms to referral), the diagnostic interval (days from presentation to diagnosis); and the number of pre-referral consultations by avoidable delay category. Based on the Caper studies conducted by Hamilton et al. [20], we considered it very unlikely that cancers will be symptomatic earlier than 2 years pre-diagnosis, therefore interval values were restricted to 0–730 days [12]. Differences of interval length and number of consultations between the known groups were tested for statistical significance using Mann Whitney U or ANOVA.

Additionally, to understand the impact of avoidable delay on the diagnostic interval (outcome variable), and consistent with prior literature, we used quantile regression [21,22] on all patients to estimate both crude and adjusted associations by avoidable delay status. Standard errors were bootstrapped with 200 replications to calculate the 95% confidence intervals.

Because prolonged intervals to diagnosis and avoidable delay are not identical constructs, we additionally hypothesised *a priori* that some patients with prolonged interval values would not have been deemed to have had an avoidable delay. We therefore examined interval length categories by estimating the proportion of patients who exceeded the 10th, 25th, median, 75th and 90th percentile of the primary care and diagnostic interval by avoidable delay status.

2.3. Factors associated with risk of avoidable delay

We used two different logistic regression models, one for estimating associations between avoidable delay status ('yes/no') and compositional factors (case-mix variables such as age, sex and cancer type, which are deemed to be beyond the GPs direct control); and another for estimating associations between avoidable delay status and contextual factors (deemed to in principle be under the GP's control), adjusting for the case-mix of compositional factors. We describe those as the 'Compositional' Model' and the 'Compositional / Contextual Model').

The factors included in the Compositional Model were: age at diagnosis (0–24, 25–49, 50–64, 65–74, 75–84, 85+); sex; quintile of income deprivation (based on the index of multiple deprivation (IMD) of the patient's lower super output area of residence); ethnicity (white, non-white, not known); number of comorbidities (0, 1, 2, 3+, not known; Appendix A for further details); and presenting symptoms (non-alarm, alarm, not applicable, not known; alarm defined as any of: breast lump, post-menopausal bleeding, haematuria, haemoptysis, rectal bleeding, change in bowel habit (including diarrhoea and constipation), dysphagia, jaundice, weight loss, or lesions suspicious of melanoma) [23].

Additional variables included in the Compositional / Contextual Model were: use of primary care led investigation (no/not applicable, yes, not known); use of a safety netting (no, yes, not known); and referral type (2-week-wait (TWW), urgent – not for suspected cancer, routine, to private health care, emergency, other, not known). Safety netting denotes occurrences where the GP is uncertain about the diagnosis, and they have scheduled follow-up appointments or advice to the patient to seek an appointment if symptoms persist or evolve [24]. In England, when a primary care physician suspects the diagnosis of cancer, they can use a cancer-specific 'fast-track' referral (also known as TWW because referred patients have to be assessed at a specialist clinic within two weeks of referral from primary care).

2.4. Factors associated with the nature of avoidable delays

Lastly, among patients deemed to have experienced an avoidable delay (n = 3372), we examined associations between the patient case-mix variables (i.e. socio-demographic characteristics and cancer site) and the risk of three different outcomes (in separate models): setting category, phase category and likely attributable factor category.

Box 1
Avoidable delay classification.

NCDA question: *Was there an avoidable delay to this patient reaching their diagnosis? (We defined delay as an unnecessary prolongation of the time to reach a diagnosis that has potentially adverse consequences on outcomes). If there were multiple delays, please provide details for the delay you consider had the greatest impact on the time to reach a diagnosis.*

Possible answers: 'Yes'; 'No'; and 'Not known'

If 'Yes', the following supplementary questions were answered:

a) *Setting:* *If there was a potentially avoidable delay, in which health care setting did the delay chiefly originate?*

Possible answers: 'Pre-consultation'; 'Primary care'; 'Secondary or tertiary care'; and 'Not known'.

b) *Phase in the diagnostic pathway:* *If there was a potentially avoidable delay, to which stage in the diagnostic pathway do you chiefly attribute it?*

Possible answers: 'Help-seeking'; 'Clinical appraisal (primary, secondary care)'; 'Investigation (test request, test performance)'; 'Investigation (test result, reporting)'; 'Referral'; 'Appointment'; 'Delayed follow-up of abnormal investigation findings'; 'Not known'.

c) *Attributable factor:* *If there was a potentially avoidable delay, to whom or what is the delay chiefly attributable to?*

Possible answers: 'Patient'; 'Clinician (primary care, secondary care)'; 'Primary care system'; 'Secondary care system'; 'Tertiary care system'; 'The disease process'; and 'Not known'.

For the three known settings of avoidable delay, we carried out three binary logistic regression models, examining the odds of a delay occurring in a specific setting versus the 'other' two settings. 'Not known' cases were excluded from the models to prevent the assumption that all missing data were in the 'other' settings category.

A similar approach was adopted for the seven phases of the diagnostic process that the avoidable delay occurred and six attributable factors. The models were adjusted as described for the Compositional Model only (i.e. fixed variables not under the control of the GP). Odds ratios (OR) and 95% confidence intervals are reported.

All analyses were carried out using R Studio v1.1453 and R v3.5.2.

3. Results

3.1. Construct validity

Among all analysed patients (n = 14,259), 3372 (24%) were deemed to have had an avoidable delay to their diagnosis (Appendix B). Being deemed to have had an avoidable delay substantially increased the median primary care interval from 2 to 22 days and the median diagnostic interval from 30 to 92 days. For patients who were reported to have had an avoidable delay, patients had a longer primary care interval if an avoidable delay had occurred in primary care (48 days) but not in pre-consultation (3 days) or secondary / tertiary care (8 days). Similarly, there were longer diagnostic intervals where a delay occurred in primary care (98 days) or secondary / tertiary care (110 days) but not pre-consultation (27 days). Further, there was a significantly greater median number of consultations in patients who had an avoidable delay (median 2, mean 3.2) compared to those who did not (median 1, mean 1.6). A summary showing the numbers of cases available for analysis is shown in Appendix C.

Among patients with primary care interval values longer than the 75th and 90th percentiles, 44% and 57% of patients respectively had an avoidable delay, i.e. around half of the patients with prolonged intervals were not deemed to have had an avoidable delay. For context, due to the skewed distribution of intervals, 29% of patients with an avoidable delay had a primary care interval longer than both the 10th and 25th percentile value of 0 days. A similar pattern was apparent for the diagnostic interval (Appendix D).

After adjusting for case-mix variables for patients with a valid diagnostic interval (12,862), avoidable diagnostic delays were associated with an additional 57 days to the median diagnostic interval and an additional 167 days at the 90th percentile (Table 1). Large though attenuated differences were also apparent after additional adjustments for contextual (i.e. beyond patient case-mix) variables, i.e. an additional 46 and 149 days at the median and 90th percentiles (Appendix E).

3.2. Predictors of avoidable delays

Considering case-mix factors (beyond the control of clinical care providers) in 14,259 patients with a known avoidable delay status, the odds of an avoidable delay increased with increasing number of comorbidities (test for trend $p < 0.001$; 3+ comorbidities vs no comorbidity: OR 1.43; 95% CI 1.25–1.63, Table 2). There was large (nearly five-fold) variation in the odds of avoidable delay by cancer site ($p < 0.001$). Compared to lung cancer, patients with breast cancer had the lowest (OR 0.34; 95% CI 0.28 to 0.42) and patients with stomach cancer the greatest odds of an avoidable delay (OR 1.72; 95% CI 1.30–2.26).

Further adjustment by contextual factors (deemed under the control of clinical care providers) showed that decisions by the GP to order investigations (OR 1.93; 95% CI 1.75–2.13) or employ safety netting (OR 1.19; 95% CI 1.08–1.30) were associated with an avoidable delay (Appendix F). Patients with urgent, routine or emergency referrals had significantly increased odds of an avoidable delay compared to those with TWW referrals (OR values of 2.21, 3.97 and 1.65 respectively).

Table 1
Associations of the diagnostic interval with avoidable delay status by quantile regression in all NCDA patients with a valid diagnostic interval (n = 12,862).

	Total[a] n (%)		Diagnostic interval[b] n (%)		Crude 50th percentile coefficient (95% CI)	Crude 90th percentile coefficient (95% CI)	Compositional Model adjusted 50th percentile coefficient (95% CI)	Compositional Model adjusted 90th percentile coefficient (95% CI)
Intercept (days)						32.4		92.2
Avoidable delay status								
No	10887	(76.4)	9147	(76.0)	Ref	Ref	Ref	Ref
Yes	3372	(23.6)	2885	(24.0)	**62 (57.9 to 66.1)**	**186 (169.6 to 202.4)**	**57.0 (52.2 to 61.8)**	**167.0 (150.6 to 183.4)**
Not known	1546		830		**20 (14.4 to 25.6)**	**123 (80.2 to 165.8)**	**15.6 (10.9 to 20.4)**	**98.5 (66.4 to 130.6)**

Crude and adjusted coefficients were determined for the 50th and 90th percentile of the diagnostic interval. Standard errors were bootstrapped with 200 replications to calculate the confidence intervals.
The diagnostic intervals were restricted to 0–730 days.
The Compositional Model was adjusted for avoidable delay, age at diagnosis, sex, ethnicity, number of comorbidities, IMD quintile, cancer site and symptoms at presentation. All coefficients for the Compositional Model, and the Compositional / Contextual Model with further adjustments for contextual variables, are shown in Appendix E.

[a] The total number of records in each category from the whole NCDA cohort.

[b] The number of records in each category that have a diagnostic interval.

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Table 2
Odds ratios of avoidable delay status with patient demographics, cancer site and symptoms at presentation by logistic regression (n = 14,259).

	Patients who had an avoidable delay n (%)	Patients who had no avoidable delay n (%)	Crude OR (95% CI)	Compositional Model adjusted OR (95% CI)	Joint Wald test P value
Total	3372 (23.6)	10887 (76.4)		Intercept = 0.23 days	
Age at diagnosis					
0-24	39 (23.1)	130 (76.9)	0.98 (0.67 to 1.40)	1.08 (0.72 to 1.57)	**0.005**
25-49	336 (22.8)	1138 (77.2)	0.97 (0.84 to 1.11)	**1.29 (1.10 to 1.51)**	
50-64	764 (23.5)	2493 (76.5)	1.00 (0.90 to 1.12)	1.07 (0.96 to 1.20)	
65-74	936 (23.4)	3061 (76.6)	Ref	Ref	
75-84	929 (25.1)	2776 (74.9)	1.09 (0.99 to 1.21)	1.06 (0.95 to 1.18)	
85+	368 (22.2)	1289 (77.8)	0.93 (0.81 to 1.07)	0.88 (0.77 to 1.02)	
Sex					
Male	1837 (24.4)	5685 (75.6)	Ref	Ref	
Female	1535 (22.8)	5202 (77.2)	**0.91 (0.85 to 0.99)**	**1.11 (1.01 to 1.22)**	**0.027**
Ethnicity					
White	2944 (23.6)	9536 (76.4)	Ref	Ref	
Non-white	165 (26.6)	455 (73.4)	1.17 (0.98 to 1.41)	1.19 (0.98 to 1.43)	0.168
Not known	263 (22.7)	896 (77.3)	0.95 (0.82 to 1.10)	0.96 (0.83 to 1.11)	
Number of comorbidities					
0	740 (21.1)	2765 (78.9)	Ref	Ref	
1	1020 (24.0)	3233 (76.0)	**1.18 (1.06 to 1.31)**	**1.21 (1.08 to 1.36)**	**< 0.001**
2	788 (23.3)	2596 (76.7)	**1.13 (1.01 to 1.27)**	**1.19 (1.05 to 1.35)**	
3+	782 (26.7)	2148 (73.3)	**1.36 (1.21 to 1.53)**	**1.43 (1.25 to 1.63)**	
Not known	42 (22.5)	145 (77.5)	1.08 (0.75 to 1.53)	1.06 (0.73 to 1.50)	
IMD quintile					
1 - least deprived	663 (21.8)	2381 (78.2)	Ref	Ref	
2	715 (22.8)	2417 (77.2)	1.06 (0.94 to 1.20)	1.04 (0.92 to 1.18)	0.189
3	737 (23.7)	2377 (76.3)	1.11 (0.99 to 1.25)	1.07 (0.95 to 1.21)	
4	672 (25.2)	1999 (74.8)	**1.21 (1.07 to 1.36)**	**1.16 (1.02 to 1.31)**	
5 - most deprived	585 (25.5)	1713 (74.5)	**1.23 (1.08 to 1.39)**	1.12 (0.98 to 1.28)	
Cancer site					
Breast	177 (10.3)	1536 (89.7)	**0.36 (0.30 to 0.44)**	**0.34 (0.28 to 0.42)**	**< 0.001**
Leukaemia	60 (14.7)	347 (85.3)	**0.55 (0.40 to 0.73)**	**0.61 (0.45 to 0.82)**	
Brain	38 (16.9)	187 (83.1)	**0.64 (0.44 to 0.91)**	**0.68 (0.46 to 0.97)**	
Melanoma	151 (18.9)	646 (81.1)	**0.74 (0.60 to 0.91)**	**0.76 (0.61 to 0.95)**	
Liver	47 (19.6)	193 (80.4)	0.77 (0.54 to 1.07)	0.82 (0.58 to 1.14)	
Endometrial	92 (24.3)	287 (75.7)	1.01 (0.78 to 1.31)	0.97 (0.74 to 1.26)	
Lung	446 (24.0)	1409 (76.0)	Ref	Ref	
Renal	110 (22.4)	382 (77.6)	0.91 (0.72 to 1.15)	1.00 (0.79 to 1.27)	
Prostate	428 (22.0)	1515 (78.0)	0.89 (0.77 to 1.04)	1.02 (0.87 to 1.20)	
Bladder	109 (24.4)	337 (75.6)	1.02 (0.80 to 1.30)	1.06 (0.83 to 1.36)	
Lymphoma	171 (26.4)	477 (73.6)	1.13 (0.92 to 1.39)	1.14 (0.92 to 1.40)	
Oesophageal	112 (27.6)	294 (72.4)	1.20 (0.94 to 1.53)	1.24 (0.96 to 1.58)	
Oral / Oropharyngeal	63 (28.5)	158 (71.5)	1.26 (0.92 to 1.71)	1.26 (0.91 to 1.71)	
Ovarian	89 (29.6)	212 (70.4)	**1.33 (1.01 to 1.73)**	1.27 (0.96 to 1.67)	
CUP	95 (28.5)	238 (71.5)	1.26 (0.97 to 1.63)	1.28 (0.98 to 1.66)	
Other	385 (29.0)	941 (71.0)	**1.29 (1.10 to 1.52)**	**1.29 (1.10 to 1.52)**	
Multiple myeloma	63 (27.5)	166 (72.5)	1.20 (0.88 to 1.62)	1.31 (0.95 to 1.78)	
Pancreatic	129 (31.6)	279 (68.4)	**1.46 (1.15 to 1.84)**	**1.46 (1.15 to 1.85)**	
Colon	337 (31.3)	738 (68.7)	**1.44 (1.22 to 1.70)**	**1.52 (1.28 to 1.80)**	
Rectal	177 (32.5)	368 (67.5)	**1.52 (1.23 to 1.87)**	**1.57 (1.26 to 1.96)**	
Stomach	93 (34.4)	177 (65.6)	**1.66 (1.26 to 2.18)**	**1.72 (1.30 to 2.26)**	

(*continued on next page*)

Table 2 (*continued*)

	Patients who had an avoidable delay n (%)	Patients who had no avoidable delay n (%)	Crude OR (95% CI)	Compositional Model adjusted OR (95% CI)	Joint Wald test P value
Symptom group					
Alarm	1381 (23.0)	4628 (77.0)	Ref	Ref	**< 0.001**
Non-alarm	1668 (26.4)	4648 (73.6)	**1.20 (1.11 to 1.31)**	1.06 (0.96 to 1.16)	
Not applicable	277 (16.2)	1430 (83.8)	**0.65 (0.56 to 0.75)**	**0.58 (0.50 to 0.68)**	
Not known	46 (20.3)	181 (79.7)	0.85 (0.61 to 1.17)	0.76 (0.54 to 1.05)	

CUP – Cancer of Unknown Primary; IMD - Index of Multiple Deprivation.
Proportions shown for each variable are calculated by avoidable delay status.
The Compositional Model was adjusted for avoidable delay, age at diagnosis, sex, ethnicity, number of comorbidities, IMD quintile, cancer site and symptoms at presentation. The Compositional / Contextual Model with further adjustments for contextual variables is shown in Appendix F.

3.3. Setting

3.3.1. Nature of avoidable delay regarding setting, phase and attributable factor

Among 3273 patients with known location of avoidable delay, 13% were deemed to have occurred pre-consultation, 49% within primary care, and 38% within secondary care (Appendix G). Pre-consultation avoidable delays were more likely among breast cancer patients (OR vs lung cancer 3.55; 95% CI 2.23 to 5.68) (Fig. 1 and Appendix G). Primary care avoidable delays were more likely in patients with multiple myeloma (OR 2.04; 95% CI 1.14 to 3.76) and least likely in patients with breast, endometrial and renal cancer (OR 0.32, 0.40, 0.54 respectively). Secondary / tertiary care avoidable delays were more common in patients with prostate, colon, lymphoma, pancreatic, endometrial and renal cancers (OR range from 1.40 to 2.69).

3.4. Phase in diagnostic pathway

3.4.1. Nature of avoidable delay regarding setting, phase and attributable factor

Avoidable delays occurred at all phases of the diagnostic process and most commonly during test request / performance (25%, 827/3255). In patients living in areas of higher deprivation, there were higher odds of a delay in the help-seeking phase (OR quintile 5 vs 1: 1.66; 95% CI 1.18–2.35) (Appendix H). Patients with breast cancer had higher odds of an avoidable delay in the help-seeking, appointment and referral phases of the pathway (OR 3.17, 4.62 and 1.97 respectively) and lower odds in the clinical appraisal, test request/performance and test result/reporting (OR 0.46, 0.20 and 0.45 respectively), compared to lung cancer patients.

3.5. Attributable factor

3.5.1. Nature of avoidable delay regarding setting, phase and attributable factor

Avoidable delays were attributed to the primary or secondary care clinician, secondary care system or the patient in approximately equal percentages (28%, 27%, and 26% respectively; Appendix I). Most of avoidable delays pre-consultation were due to delayed help-seeking (74%, 306/414; Table 3). Avoidable delays in primary and secondary care settings had multifactorial reasons and were most commonly attributed to clinicians if occurring in a primary care setting (49%, 781/1608) or secondary healthcare system factors if occurring in secondary care setting (63%, 786/1251). Almost all the avoidable delays attributable to clinicians were located in primary care (87%, 781/900).

Increased odds of an avoidable delay attributable to the patient were seen for patients aged 85+ (OR 1.59; 95% CI 1.20–2.11), non-white patients (OR 1.63; 95% CI 1.13–2.32), the most deprived IMD quintile (OR 1.39; 95% CI 1.06–1.82) (n = 3215) (Appendix I).

4. Discussion

4.1. Main findings

We demonstrate that GP-assessed avoidable delays have construct validity, occur in a substantial proportion of patients (about a quarter), and are associated with an increase of the median diagnostic interval by two months. Greater number of comorbidities, certain cancer sites (pancreatic, colon, rectal, and stomach cancer), and management other than through 'suspected cancer' TWW referral were associated with greater risk of avoidable delay. Avoidable delays occurred along the diagnostic process and with similar frequency in primary and specialist care, though they were predominantly attributed to the clinician in the former setting and to the healthcare system in the latter. Most frequently, they occurred during the test request / performance phase of the diagnostic process, and in the context of primary care led

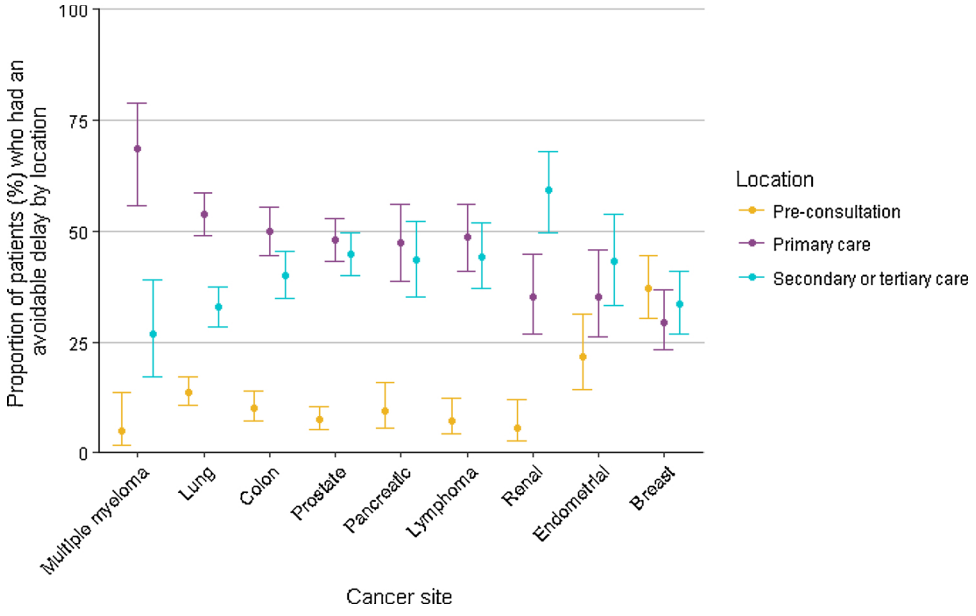

Fig. 1. Graph showing the proportion of patients who had an avoidable delay by setting for cancer sites which had a significantly different odds ratio to lung cancer. There are 3 main observations / patterns. First, in patients subsequently diagnosed with multiple myeloma and lung, when avoidable delays are deemed to have occurred, they are more likely to have occurred in primary care. Second, in general avoidable delays during the pre-consultation (patient) phase are rare, except in women subsequently diagnosed with breast and endometrial cancer. Third, in all other cancers substantial proportions of delays in both primary and post-primary care are observed, with a degree of variability in the post-primary care component in particular. The error bars show the 95% confidence intervals.

investigations. More deprived patients were at greater risk of avoidable delay due to delayed help-seeking and at lower risk due to the test request/performance phase of the pathway. About half of patients who experienced a prolonged primary care or diagnostic interval were not deemed by the GP to have had an avoidable delay.

4.2. Comparison with existing literature

In general it is difficult to measure safety incidents relating to diagnostic accuracy and timeliness [25] and a range of approaches and definitions has been employed [26]. Our taxonomy was derived iteratively from analysis of free text comments by participants in the National Audit of Cancer Diagnosis in Primary Care [27]. More recently the Institute of Medicine has defined diagnostic error as 'the failure to (a) establish an accurate and timely explanation of the patient's health problem(s) or (b) communicate that explanation to the patient' [12]. We used retrospective record review by GPs to identify avoidable delays, an approach that has been utilised elsewhere [28,29]. Others have identified diagnostic safety incidents using routinely coded data: this approach, however, is predicated on the ability to operationally define such events and is therefore limited to a small range of pre-defined scenarios (e.g. failure to follow-up an abnormal laboratory test) [30]. Using complaints or medico-legal cases to identify avoidable delays or diagnostic errors has merit but lacks a denominator group to help understand patient groups at greater risk [7,31].

On average, patients with an avoidable delay experienced diagnostic intervals prolonged by two months, a finding comparable to a Danish study, reporting 1228 GP-reported (diagnostic) 'quality deviations' in 4034 patients and a prolongation of 41 days among patients with a 'quality deviation' [32]. Further, the distribution of odds of avoidable delay across cancer sites was broadly similar [32] and to the spectrum of diagnostic difficulty that we have previously described [33]. The odds of an avoidable delay were significantly higher for patients with comorbidities and varied by cancer site. We have previously reported that 76% of patients in the NCDA had at least one comorbidity and a fifth had 3 or more [15]. Multi-morbidity is associated with greater risk of urgent or emergency presentation of cancer [34,35], a lesser degree of care continuity [36] and has been previously identified as causing delay [37].

4.3. Strengths and limitations

This study included 3372 patients with avoidable delays which is considerably larger than any comparable studies of diagnostic error to date. The study population is representative of incident cancer cases and the characteristics of participating practices are similar to non-participating ones [15]. It is likely therefore that the results can be generalised to the wider population. The study period (2014) precedes the publication of the 2015 NICE guidance for recognition and referral of patients with suspected cancer [38] which is likely to have led to secular changes in clinical practice. Recent cancer policy is also changing the availability and use of diagnostic services [39]. Our findings provide a historical picture of clinical practice and identify areas for quality improvement; continuous monitoring of avoidable delays in future waves of audit of cancer diagnosis in primary care will be useful. The elapse of 2 years between diagnosis and audit would mean that on the one hand our data are likely to have a consistent basis; on the other, the recall of unrecorded contextual issues may be missing. Additional information from patients and secondary care physicians would give further insights into avoidable delays, however, this was out of the scope of the NCDA project.

Avoidable delay as assessed by the GP contains a degree of subjectivity as they may be more likely to report avoidable delay in primary care, the phase in the diagnostic process more 'visible' to them. However, they may also be more willing to report avoidable delay occurring in secondary care or pre-presentation. We used GP-reported data; these can be considered the 'gold standard' method for eliciting GP perceptions of avoidable diagnostic delay, but those accounts might differ from the patients' own perceptions of avoidable delay. A prior study from Denmark examined the degree of agreement between patients and GPs regarding 'quality deviations' in the diagnostic process (a concept similar to that of avoidable diagnostic delays used in our study) and found that in spite of poor concordance between the two sources, GP-reported 'quality deviations' had good construct validity against observed prolonged interval length [40]. Relatedly, prior evidence examining agreement between patient- and GP-reported diagnostic intervals (i.e. not considering whether delays were avoidable or not) also indicates at best moderate only agreement [41,42]. It is not possible to 'arbitrate' as to whether doctors or patients report the length of the diagnostic intervals, and avoidable delays, more accurately than the other; rather it is likely that both, correctly, interpret and report on different aspects of the diagnostic process [40].

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Table 3
Cross tabulation of the number of avoidable delays by phase in the diagnostic pathway that the delay occurred and the attributable factor, for each setting of the avoidable delay, for patients who had a GP-assessed avoidable delay (n = 3372).

	Attributable factor							
Phase in pathway where avoidable delay occurred	Patient	Clinician[c]	Primary care system	Secondary care system	Tertiary care system	The disease process	Not known	Total
Setting: Pre-consultation								
Help-seeking	306	3	2	2	0	8	5	326
Appointment	6	0	0	5	0	1	0	12
Clinical appraisal[a]	0	4	0	3	0	5	1	13
Test request / performance	11	3	0	5	0	2	3	24
Test result / reporting	1	2	1	2	0	0	1	7
Delayed follow-up[b]	7	0	0	0	1	0	0	8
Referral	9	1	2	0	0	1	0	13
Not known	6	0	0	0	0	4	1	11
Total	346	13	5	17	1	21	11	414
Setting: Primary care								
Help-seeking	106	3	8	2	0	5	5	129
Appointment	21	4	6	3	0	0	2	36
Clinical appraisal[a]	17	280	40	5	0	88	15	445
Test request / performance	44	160	58	18	0	45	21	346
Test result / reporting	11	28	21	10	0	10	7	87
Delayed follow-up[b]	10	40	19	2	0	1	7	79
Referral	64	264	56	18	1	38	15	456
Not known	4	2	4	1	0	16	3	30
Total	277	781	212	59	1	203	75	1608
Setting: Secondary care								
Help-seeking	21	0	0	4	0	0	1	26
Appointment	45	2	0	112	3	6	8	176
Clinical appraisal[a]	11	42	0	79	1	34	4	171
Test request / performance	53	30	0	289	4	52	19	447
Test result / reporting	5	9	0	119	1	22	11	167
Delayed follow-up[b]	14	9	0	104	5	3	9	144
Referral	6	3	0	53	2	3	1	68
Not known	3	1	0	26	1	15	6	52
Total	158	96	0	786	17	135	59	1251
Setting: Not known								
Help-seeking	21	0	0	0	0	0	0	21
Appointment	9	0	0	1	0	0	4	14
Clinical appraisal[a]	1	5	0	1	0	5	1	13
Test request / performance	3	2	0	2	0	3	0	10
Test result / reporting	1	2	0	2	0	3	0	8
Delayed follow-up[b]	0	0	0	0	0	1	0	1
Referral	3	0	0	2	0	1	2	8
Not known	6	1	0	0	0	12	5	24
Total	44	10	0	8	0	25	12	99
Grand total	825	900	217	870	19	384	157	3372

[a] Clinical appraisal could be from primary or secondary care.
[b] Delayed follow up is of abnormal investigation findings.
[c] Clinician could be from primary or secondary care.

We were not able to consider the consequences of avoidable delay beyond their impact on diagnostic timeliness outcomes. Few studies have identified the harms that may result from diagnostic error, though one study has estimated that one half of such errors could be potentially harmful [8].

4.4. Interpretation of findings

Because diagnostic delays increase the risk of adverse patient outcomes, understanding their nature and frequency is essential for quality improvement initiatives [43].

Routine self-assessment of these delays by GPs through the ongoing NCDA, or other tools, would allow them to be recognised and consequent action to be pursued. The multifaceted nature of avoidable delay demonstrated here suggests that multiple approaches should be taken to reduce the number of avoidable delays to diagnosis. The 'Safer Dx Framework' [26] recognises this complexity and provides a model within which quality improvement can occur. For patients with comorbidities, the underlying causes of avoidable delays need to be better understood and remedied, recognising that the goals and treatment preferences of these patients may differ from those without comorbidities [44]. Avoidable delays attributed to patient factors occurring after presentation may benefit from improved safety netting or communication to patients, and again the exact mechanism should be further studied.

Avoidable delays specifically attributable to diagnostic testing in primary care are likely to reflect the alacrity with which those tests are scheduled and reported by test providers (usually located in secondary care). System processes in secondary care should be readily amenable to quality improvement using transformational change techniques such as 'Lean production' [45,46]. However, delays in scheduling patient review in primary care once investigations have been completed cannot be discounted and in the UK the Royal College of General Practitioners has a major programme to support practices in Quality Improvement initiatives [47].

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5. Conclusion

Avoidable delays occur in about a quarter of cancer diagnoses and where they do occur, the median diagnostic interval is increased by approximately two months. GP-identified instances of avoidable delay have construct validity with regard to diagnostic timeliness, suggesting that it represents a useful tool for guiding quality improvements, over and above the measurement of diagnostic interval without characterising whether delays were avoidable. The patient characteristics and aspects of the diagnostic process that are most likely to be associated with these instances are also described. Whilst the causes of diagnostic delays in cancer are multifactorial and occur in different health care settings and phases of the diagnostic process, their analysis can inform targeted quality improvement initiatives and enable future epidemiological research examining their prognostic implications.

Ethical approval

The study was exempt from gaining individual consent having obtained Section 251 approval from the UK Patient Information Advisory Group (PIAG) (now the Confidentiality Advisory Group, CAG), under Section 251 of the NHS Act 2006 (PIAG 03(a)/2001).

Author's contributions

RS, GL, GR, SM made substantial contributions to the conception and design of the study

RS conducted the data analysis with support from SM and GL

GR provided clinical guidance

All authors made substantial contributions to the interpretation of the findings

All authors contributed to drafting and revising the manuscript for intellectual content, and approved the final version for submission.

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Declaration of Competing Interest

The authors declare no competing interests.

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Data for this study is based on patient-level information collected by the NHS, as part of the care and support of cancer patients. The data are collated, maintained and quality assured by the National Cancer Registration and Analysis Service, which is part of Public Health England (PHE).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.canep.2019.101617.

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