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Original Research

Emergency admission and survival from aggressive non-Hodgkin lymphoma: A report from the UK's population-based Haematological Malignancy Research Network



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KEYWORDS

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Abstract *Background:* Non-Hodgkin lymphoma (NHL) is often diagnosed after emergency presentation, a route associated with poor survival and an indicator of diagnostic delay. Accounting for around half of all NHLs, diffuse large B-cell lymphoma (DLBCL) is of particular interest since although it is potentially curable with standardised chemotherapy it can be challenging to identify at an early stage in the primary care setting.

Patients and methods: Set within a socio-demographically representative United Kingdom population of around 4 million people, data are from an established patient cohort. This report includes all patients (≥ 18 years) diagnosed with DLBCL 2004–2011 ($n = 1660$). Emergency admissions were identified via linkage to Hospital Episode Statistics using standard methods, and survival was examined using proportional hazards regression.

Results: Two out of every five patients were diagnosed following an emergency admission, and this was associated with advanced disease and poor survival ($p < 0.001$). Among the 80% of patients treated with curative chemotherapy, survival discrepancies emerged at the point of diagnosis; the adjusted hazard ratio (emergency versus non-emergency) at one month being 4.0 (95% confidence interval 1.9–8.2). No lasting impact was evident in patients who survived for 12 months or more.

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Conclusion: Emergency presentation impacts negatively on DLBCL survival; patients presenting via this route have significantly poorer outcomes than patients with similar clinical characteristics who present via other routes.

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1. Introduction

Cancer survival rates are reported to be poorer in Britain than many other European countries, resulting in an estimated 7000 avoidable premature deaths each year [1]. The evidence suggests that diagnostic delay is a major contributor to these differences, and hence the promotion of early diagnosis is being tackled through policy guidance and targets, with progress being audited nationally [2–6]. Nonetheless, despite some positive changes, there is considerable scope for improvement [7].

Emergency presentation is often considered a crude marker of diagnostic delay for cancers that commonly present with early signs and symptoms [8,9]; the analysis of routinely compiled health data confirming that this route to diagnosis is associated with long intervals and poorer outcomes [10]. Among haematological cancers (lymphomas, myelomas and leukaemias), emergency presentation is relatively common [10,11]. While this is clearly the appropriate route for conditions like the acute leukaemias, the reasons why a relatively large proportion of patients with non-Hodgkin lymphomas (NHL) present as an emergency and have poorer survival is less obvious.

As a group, NHLs are challenging to study since they comprise a heterogeneous spectrum of cancers with diverse patterns of onset, treatments and outcomes; the pathways of patients diagnosed with incurable but comparatively indolent subtypes, like follicular lymphoma and marginal zone lymphoma, tend to follow a remitting-relapsing course with periods of observation being interspersed with multiple lines of chemotherapy, whereas those of patients with more aggressive subtypes tend to dichotomise according to whether the cancer is potentially curable or not [12,13]. In this context, diffuse large B-cell lymphoma (DLBCL), which is the commonest haematological malignancy and accounts for around half of all NHLs, is of particular interest since although it is curable with standardised chemotherapy administered over a 6–8 month period, patients who present with advanced disease tend to do less well than those diagnosed at an earlier stage [14–17].

In the general patient population, DLBCL 5-year overall survival is now around 60%, disease/treatment-related deaths being highest in the first few months following diagnosis [14–16,18]. Focussing on deaths occurring within 3 years of diagnosis, the present report uses data from an established United Kingdom (UK)

patient cohort to examine the potential impact of emergency presentation on outcome in patients with DLBCL.

2. Methods

The study is set within the Haematological Malignancy Research Network (HMRN: www.hmrn.org), a population-based patient cohort instigated in 2004 to generate ‘real world’ evidence-based data for research and audit purposes [19]. HMRN’s catchment population of around 4 million is socio-demographically similar to that of the UK as a whole [20]. Patient care within HMRN is provided by 14 hospitals, clinical practice adheres to national guidelines and all diagnoses (over 2200 new patients annually) are made and coded to the latest World Health Organisation (WHO) classification [12,19,21] by clinical specialists at a single integrated haematopathology laboratory (the Haematological Malignancy Diagnostic Service: www.hmds.info); which was cited in the UK’s Cancer Reform Strategy as ‘the model for delivery of complex diagnostic services’ [2].

HMRN operates with Section 251 support under the National Health Service (NHS) Act 2006, and all patients have prognostic, full treatment and outcome data collected to clinical trial standards. All HMRN patients are ‘flagged’ for death at the national Medical Research Information Service and are routinely linked to Hospital Episode Statistics Admitted Patient Care (HES-APC) data. Area-based population counts are sourced from the Office for National Statistics; with the income domain of the national index of deprivation being used as a marker of socio-economic status [15,22].

The present report focusses on patients aged 18 years or over who were newly diagnosed with *de novo* DLBCL between September 2004 and March 2011; all of whom were followed up for death for a minimum of 3 years. Primary source information on cancer stage, performance status, disease-associated systemic symptoms (B-symptoms), nodal status and treatment were obtained directly from medical records [15]. Following guidelines outlined by NHS Digital, hospital admissions were constructed from HES-APC. Using a similar approach to the Routes to Diagnosis initiative [10], emergency presentation was defined as an admission within 30 days of diagnosis directly from the accident and emergency (A&E) department (HES-APC admission method codes 21, 28), consultant-led outpatient clinic (code 24), bed

Table 1

Patient and disease characteristics distributed by presentation route: diffuse large B-cell lymphomas diagnosed Sept 2004 to Mar 2011 and followed for 3 years.

		Diagnoses by presentation route			Chi-square ^b	Deaths by presentation route			Hazard ratio (95% confidence interval) ^b
		Diagnoses (%)	Non-emergency (%)	Emergency (%)		Deaths (% of all diagnoses)	Non-emergency (% of non-emergency presentations)	Emergency (% of emergency presentations)	
Sex	Total	1660 (100)	1007 (100)	653 (100)	p = 0.25	749 (45)	346 (34)	403 (62)	2.5 (2.2–2.9)
	Male	853 (51)	529 (53)	324 (50)		380 (45)	181 (34)	199 (61)	2.6 (2.1–3.2)
	Female	807 (49)	478 (47)	329 (50)		369 (46)	165 (35)	204 (62)	2.4 (2.0–3.0)
Age at diagnosis (years)	<50	214 (13)	125 (12)	89 (14)	p = 0.64	39 (18)	10 (8)	29 (33)	4.8 (2.4–9.9)
	50–74	873 (53)	538 (53)	335 (51)		345 (40)	155 (29)	190 (57)	2.7 (2.2–3.3)
	75+	573 (35)	344 (34)	229 (35)		365 (64)	181 (53)	184 (80)	2.6 (2.1–3.2)
	Median (IQR)	69.9 (59.2–78.1)	69.2 (59.2–77.9)	70.6 (58.9–78.4)		74.8 (65.6–81.6)	75.6 (65.8–82.1)	74.3 (65.1–81.4)	
Deprivation (quintile) ^a	1, Least deprived	352 (21)	234 (23)	118 (18)	p = 0.08	150 (43)	79 (34)	71 (60)	2.5 (1.8–3.5)
	2	386 (23)	221 (22)	165 (25)		163 (42)	65 (29)	98 (59)	2.8 (2.0–3.8)
	3	326 (20)	205 (20)	121 (19)		158 (48)	81 (40)	77 (64)	2.3 (1.7–3.2)
	4	292 (18)	175 (17)	117 (18)		140 (48)	63 (36)	77 (66)	2.6 (1.8–3.6)
	5, Most deprived	302 (18)	171 (17)	131 (20)		136 (45)	57 (33)	79 (60)	2.5 (1.8–3.5)
Patient's performance status ^a	0, Good	430 (26)	364 (36)	66 (10)	p < 0.001	79 (18)	60 (16)	19 (29)	1.9 (1.2–3.2)
	1	719 (43)	467 (46)	252 (39)		287 (40)	164 (35)	123 (49)	1.7 (1.3–2.1)
	2	335 (20)	133 (13)	202 (31)		230 (69)	88 (66)	142 (70)	1.3 (1.0–1.7)
	3 + 4 Poor	152 (9)	33 (3)	119 (18)		137 (90)	28 (85)	109 (92)	1.5 (1.0–2.3)
B-symptoms	Absent	919 (55)	610 (61)	309 (47)	p < 0.001	368 (40)	180 (30)	188 (61)	3.0 (2.4–3.6)
	Present	741 (45)	397 (39)	344 (53)		381 (51)	166 (42)	215 (62)	2.0 (1.7–2.5)
Nodal status	Nodal	441 (30)	325 (35)	116 (21)	p < 0.001	125 (28)	77 (24)	48 (41)	2.1 (1.4–3.0)
	Extranodal	281 (19)	163 (18)	118 (21)		112 (40)	52 (32)	60 (51)	1.9 (1.3–2.8)
	Nodal + extranodal	758 (51)	438 (47)	320 (58)		379 (50)	170 (39)	209 (65)	2.5 (2.0–3.0)
	Not assigned	180	81	99		133 (74)	47 (58)	86 (87)	2.7 (1.9–3.8)
Cancer stage	I	258 (17)	200 (22)	58 (10)	p < 0.001	51 (20)	35 (18)	16 (28)	1.7 (0.9–3.1)
	II	302 (20)	216 (23)	86 (15)		86 (28)	47 (22)	39 (45)	2.6 (1.7–4.0)
	III	233 (16)	169 (18)	64 (11)		88 (38)	55 (33)	33 (52)	2.1 (1.3–3.2)
	IV	702 (47)	342 (37)	360 (63)		406 (58)	163 (48)	243 (68)	2.0 (1.6–2.4)
	Not fully staged	165	80	85		118 (72)	46 (58)	72 (85)	2.4 (1.7–3.5)
International Prognostic Index (IPI)	Low	347 (26)	273 (33)	74 (15)	p < 0.001	52 (15)	40 (15)	12 (16)	1.1 (0.6–2.1)
	Low/intermediate	303 (23)	216 (26)	87 (18)		83 (27)	46 (21)	37 (43)	2.4 (1.5–3.7)
	Intermediate/high	318 (24)	200 (24)	118 (24)		135 (42)	78 (39)	57 (48)	1.4 (1.0–2.0)
	High	349 (26)	145 (17)	204 (42)		247 (71)	89 (61)	158 (77)	1.8 (1.4–2.4)
	Not known	343	173	170		232 (68)	93 (54)	139 (82)	2.6 (2.0–3.3)
1st line chemotherapy with curative intent	Yes	1346 (81)	883 (88)	463 (71)	p < 0.001	468 (35)	249 (28)	219 (47)	2.1 (1.7–2.5)
	No	314 (19)	124 (12)	190 (29)		281 (89)	97 (78)	184 (97)	2.5 (1.9–3.2)
	Palliative/supportive	217 (13)	67 (7)	150 (23)		217 (100)	67 (100)	150 (100)	2.1 (1.6–2.9)
	Localised disease	97 (6)	57 (6)	40 (6)		64 (66)	30 (53)	34 (85)	2.5 (1.5–4.0)

^a Not known: deprivation (n = 2), performance status (n = 24).^b Hazard ratios were estimated using Cox regression.

bureau (code 23) or following a request from a General Practitioner (GP) (code 22).

All analyses were conducted using standard methods in the statistical packages Stata 14.1 (StataCorp, Texas) and R 3.2.2 (R Core Team, Vienna). Three-year survival was examined using time-to-event analysis. Adjusted survival curves were produced using the average approach; using Cox proportional hazards regression, survival curves were estimated for all possible combinations of covariate values and a weighted mean of the curves was calculated to adjust the mix among patients presenting as an emergency to that of those presenting via other routes [23]. The adjusted curve weights were propensity scores; logistic regression, adjusting for all covariates and their statistically significant interactions, was used to predict each patient's probability of presenting as an emergency, before scaling the predicted probabilities to the proportion of patients in each group.

3. Results

Of the 1660 patients diagnosed with DLBCL during the study period, 653 (39%) presented as an emergency. No statistically significant differences between those who presented via this route and those who did not were evident for gender, age at diagnosis and deprivation (Table 1). However, scores for patient's performance status and symptom burden (B-symptoms), cancer stage and nodal status, as well as the composite prognostic index, were all significantly higher in the group that presented as an emergency than in the group that did not ($p < 0.001$). Assignment of nodal status and cancer stage in DLBCL usually requires a bone marrow biopsy as well as a computed tomography (CT) and/or positron-emission tomography (PET) scan. In our data, 180 (11%) patients did not have enough information to assign nodal status and 165 (10%) could not be assigned a cancer stage, the slightly lower number with missing stage reflected the fact that a few of the 180 patients were assigned to stage IV on the basis of biopsy detected bone marrow, liver or lung involvement. For both parameters, lack of assignment occurred more frequently in patients who presented via the emergency route than among those presenting via the non-emergency route; 15% and 8%, respectively, for nodal status, and 13% and 8% for stage.

The pronounced tendency for patients presenting via the emergency route to have more advanced disease impacted on whether or not they were fit enough to be treated with intensive chemotherapy with curative intent; 71% ($n = 463$) of those presenting as an emergency receiving such treatment, compared to 88% ($n = 883$) of those presenting via other routes ($p < 0.001$). Of the 1346 patients treated with potentially curative chemotherapy, 85% received standard R-CHOP (rituximab + cyclophosphamide, doxorubicin, vincristine and prednisone), and the remainder were mainly

treated with R-CVP (rituximab + cyclophosphamide, vincristine and prednisone) or R-CODOX-M/R-IVAC (rituximab + vincristine, doxorubicin, cyclophosphamide, cytarabine, etoposide, ifosfamide, mesna and methotrexate) [17]; no regimen differences were evident by route of presentation. The 314 (19%) of patients who were not treated intensively comprised a heterogeneous group; most ($n = 217/314$; 69%) were managed using a palliative/supportive approach, the remaining 97 had localised disease that was mainly treated with radiotherapy. The proportion of patients receiving palliative/supportive care was significantly higher among patients presenting via the emergency route (Table 1).

During the 3 years following diagnosis, 749 (45%) of the patients died. As might be expected, the cumulative incidence (risk) of death among patients who presented via the emergency route was almost twice (403/653, 62%) that of those who presented via other routes (346/1007; 34%). This survival difference, which is evident within all strata of Table 1, emerged at the point of diagnosis (Fig. 1) and yielded an overall unadjusted hazard ratio (HR) for the 3 year period of 2.5 (95% confidence interval [CI] 2.2–2.9) (Table 1). Interestingly, within age strata the strongest effect was seen among those who were diagnosed before the age of 50 years (HR 4.8, 95% CI 2.4–9.9).

The survival disparity between those who presented via the emergency route and those who did not is as evident among patients who were treated with intensive chemotherapy as it is among all patients combined (Fig. 1C and 1D). Table 2 presents conditional and cumulative survival estimates (adjusted for cancer stage and nodal involvement, patient's age, deprivation, performance status and B-symptoms) distributed by time since diagnosis; the 1-month (30 day) HRs for all patients ($n = 1660$; HR = 3.9, 95% CI 2.7–5.6), those treated with intensive chemotherapy ($n = 1346$; HR = 4.0, 95% CI 1.9–8.2), and those who were managed with supportive/palliative care ($n = 217$; HR = 3.8, 95% CI 2.3–6.1) are broadly similar. Among the 80% of patients who received intensive chemotherapy, this survival separation is retained throughout the treatment period; the conditional HR estimates show progressively smaller differences reaching 1.3 (95% CI 0.9–1.9) during the 6–12 month period. Importantly, however, mode of presentation had no lasting impact among patients who responded to chemotherapy and survived for 12 months or more; the conditional 12–24 year HRs being 1.0 (95% CI 0.7–1.5) for those treated with curative intent (Table 2).

The contribution of potentially confounding prognostic factors (cancer stage, nodal status, age, performance status, B-symptoms and deprivation) to the survival dichotomy seen even among patients treated curatively who present via different routes is demonstrated in Fig. 2. Clearly, whilst such established risk

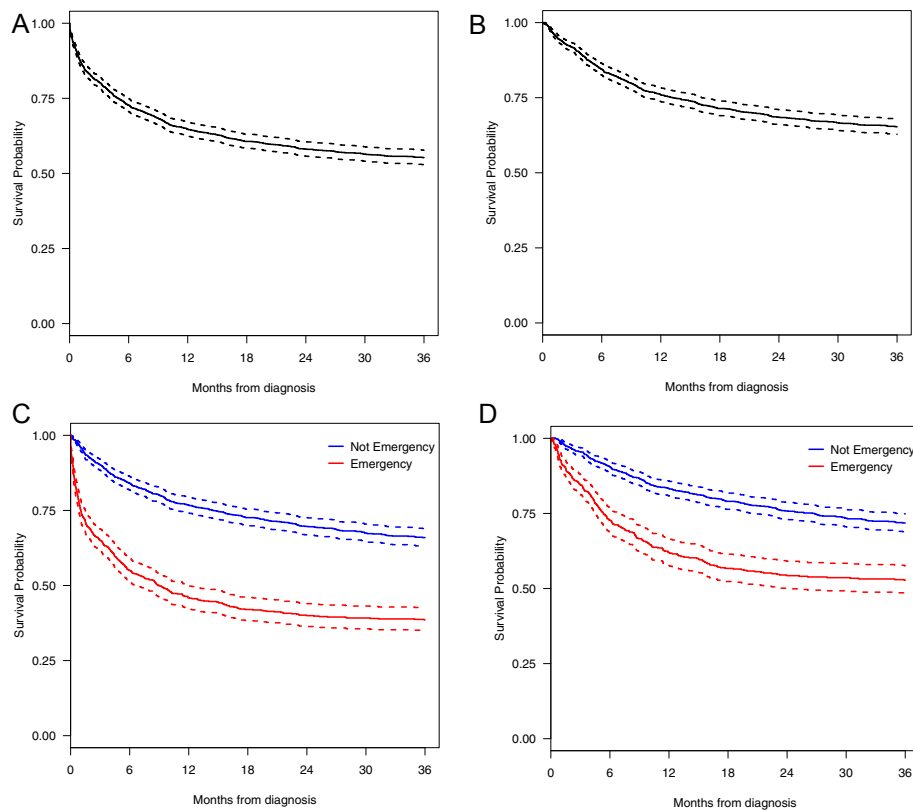


Fig. 1. Kaplan–Meier survival curves and 95% confidence intervals (dotted lines) for patients with diffuse large B-cell lymphoma: total patients (A), patients treated with curative intent (B), total patients stratified by mode of presentation (C) and curatively treated patients stratified by mode of presentation (D).

factors explain some of the variation seen in the initial months following diagnosis, they do not account for it all.

4. Discussion

Survival of patients diagnosed with DLBCL who presented via the emergency route was significantly worse than that of patients who presented via other routes. Whilst emergency presentation is the appropriate route for several conditions and illnesses, including the acute leukaemias, for the majority of cancers it is considered to be a proxy for advanced disease and delayed diagnosis [8,9]. Two out of 5 patients in our population-based cohort were diagnosed via this route and the survival disparity, which emerged at the point of diagnosis, was not wholly explained by stage of disease, performance status, symptom burden and area-based deprivation. In this context, although our findings for DLBCL confirm the association between emergency presentation, advanced disease and outcome, they also suggest that other unmeasured factors may have a role to play. Importantly, however, the survival difference, which was as striking among the 80% of patients who were treated with intensive chemotherapy as among the total patient group, did not extend beyond the first year.

This is the first population-based study to examine the potential impact of emergency presentation on

survival among an unselected group of patients diagnosed with DLBCL, the commonest of the NHLs. The paucity of ‘real-world’ information on clinically meaningful NHL subtypes is primarily due to the complexity of disease classification [12,24]; which means that national data are often reported for all NHL subtypes combined. In England, for example, the Routes to Diagnosis initiative found that around one in four NHLs were diagnosed via the emergency route, which is fewer than the two in five observed here for DLBCL [10]. This difference is likely to reflect the heterogeneity of NHLs which, in addition to aggressively presenting cancers like DLBCL, Burkitt lymphoma and mantle cell lymphoma, include incurable but comparatively indolent subtypes such as follicular lymphoma and marginal zone lymphoma, which tend to present less acutely [13].

That advanced disease is a poor prognostic factor for most cancers, including DLBCL [16], is well established; and as such, earlier diagnosis has been identified as key to improving cancer outcomes in the UK [6,25]. In this context, the National Cancer Patient Experience Survey reported that around a third of patients with NHL (aggressive and indolent subtypes combined) had three or more pre-referral GP consultations; and many patients have expressed general frustrations with the diagnostic process [4,26–28]. Such difficulties are generally attributed to the symptoms of lymphoma, which can be vague,

which will not. In this context, whilst socio-economic patterning is frequently detected in cancers with strong environmental/life-style risk factors and/or screening programmes, relationships with haematological cancers are less clear-cut. Within our UK population of 4 million, no socio-economic associations with incidence for any haematological malignancy subtype have been observed [20]; and although variations with area-based measure of deprivation and survival have been detected for chronic myeloid leukaemia (a long-term condition controlled with daily oral therapy) [33], no evidence of socio-economic patterning for DLBCL incidence or outcome have been found [15]. Nonetheless other factors, such as travelling distance to hospital and the presence of existing co-morbidities, may well have had an important role to play in the findings presented in this report [34]. Furthermore, it is important to note that, in common with the national Routes to Diagnosis study [10,32], emergency admissions from several sources have been grouped together. In our data, around 30% of emergency admissions to hospital were directly requested by GPs, and a further 40% occurred via A&E department; the latter comprising a complex mix of self-presentations, as well as A&E referrals initiated by GPs. In this context, the ability to link to primary care databases would enable more effective pathway mapping. Such routine linkage, which should be possible in the future, could lead to increased understanding and better strategies to support earlier cancer diagnosis.

In summary, patients diagnosed with DLBCL after an emergency admission had poorer levels of fitness, more advanced stage disease, and were less likely to be treated with curative intent. Among the 80% of patients treated curatively, the survival of those presenting via an emergency route was significantly poorer than that of patients with similar clinical characteristics who presented via other routes. This survival disparity emerged at the point of diagnosis, but did not extend beyond the first year. Given the curable nature of this cancer, strategies to support earlier diagnosis should be considered, since even minor improvements in time to diagnosis could lead to significant survival benefits in the longer term.

Contributors

DH, RP, ER and AS had the idea for the study. EK carried out the analysis in collaboration with SC, AS and ER; DH, EK and ER drafted the manuscript and RP and CB commented on the clinical aspects. All authors commented on and approved the final draft.

Conflict of interest statement

None declared.

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Ethics statement

The Haematological Malignancy Research Network (HMRN) has ethical approval (REC 04/01205/69) from Leeds West Research Ethics Committee, R&D approval from each Trust, and exemption from Section 251 (formally Section 60) of the Health and Social Care Act (2001) (PIAG 1-05(h)/2007). Hospital Episode Statistics—Admitted Patient Care data for 2004–2011 are reused with permission from NHS Digital (formerly the Health and Social Care Information Centre).

References

- [1] Abdel-Rahman M, Stockton D, Rachet B, Hakulinen T, Coleman MP. What if cancer survival in Britain were the same as in Europe: how many deaths are avoidable? *Br J Cancer* 2009;101: S115–24.
- [2] Department of Health. Cancer reform strategy. London, UK; 2007.
- [3] Department of Health. Improving outcomes: a strategy for cancer. London, UK; 2011. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/213785/dh_123394.pdf.
- [4] NICE. Improving outcomes in haematological cancers: the manual. London, UK: Department of Health; 2003.
- [5] NICE. Suspected cancer: recognition and referral. London, UK; 2015. <https://www.nice.org.uk/guidance/ng12/resources/suspected-cancer-recognition-and-referral-1837268071621> [Accessed 21 April 2016].
- [6] Thomson CS, Forman D. Cancer survival in England and the influence of early diagnosis: what can we learn from recent EUROcare results? *Br J Cancer* 2009;101(Suppl. 2):S102–9.
- [7] Department of Health, NHS England, Public Health England. Progress in improving cancer services and outcomes in England. National Audit Office; 2015. <https://www.nao.org.uk/wp-content/uploads/2015/01/Progress-improving-cancer-services-and-outcomes-in-England.pdf>.
- [8] Hamilton W. Emergency admissions of cancer as a marker of diagnostic delay. *Br J Cancer* 2012;107:1205–6.
- [9] Abel GA, Shelton J, Johnson S, Elliss-Brookes L, Lyratzopoulos G. Cancer-specific variation in emergency presentation by sex, age and deprivation across 27 common and rarer cancers. *Br J Cancer* 2015;112:S129–36.
- [10] Elliss-Brookes L, McPhail S, Ives A, Greenslade M, Shelton J, Hiom S, et al. Routes to diagnosis for cancer – determining the patient journey using multiple routine data sets. *Br J Cancer* 2012; 107:1220–6.
- [11] Howell D, Smith A, Appleton S, Bagguley T, Macleod U, Cook G, et al. Multiple myeloma: routes to diagnosis, clinical characteristics and survival findings from a UK population-based study. *Br J Cancer* 2017;177:67–71.
- [12] Smith A, Crouch S, Lax S, Li J, Painter D, Howell D, et al. Lymphoma incidence, survival and prevalence 2004–2014: sub-

- type analyses from the UK's Haematological Malignancy Research Network. *Br J Cancer* 2015;112:1575–84.
- [13] Swerdlow SH, Campo E, Pileri SA, Harris NL, Stein H, Siebert R, et al. The 2016 revision of the World Health Organization (WHO) classification of lymphoid neoplasms. *Blood* 2016. <http://dx.doi.org/10.1182/blood-2016-01-643569>. published online March 15.
- [14] Tilly H, Gomes da Silva M, Vitolo U, Jack A, Meignan M, Lopez-Guillermo A, et al. Diffuse large B-cell lymphoma (DLBCL): ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol* 2015;26:v116–25.
- [15] Smith A, Crouch S, Howell D, Burton C, Patmore R, Roman E. Impact of age and socioeconomic status on treatment and survival from aggressive lymphoma: a UK population-based study of diffuse large B-cell lymphoma. *Cancer Epidemiol* 2015;39:1103–12.
- [16] Vaidya R, Witzig TE. Prognostic factors for diffuse large B cell lymphoma in the R(X)CHOP era. *Ann Oncol* 2014. <http://dx.doi.org/10.1093/annonc/mdu109>. published online March 13.
- [17] NICE. Non-Hodgkin's lymphoma: diagnosis and management: guidance and guidelines. 2016. <https://www.nice.org.uk/guidance/ng52?unlid=88910979820161130132913> [Accessed 13 December 2016].
- [18] Sehn LH, Donaldson J, Chhanabhai M, Fitzgerald C, Gill K, Klasa R, et al. Introduction of combined CHOP plus rituximab therapy dramatically improved outcome of diffuse large B-cell lymphoma in British Columbia. *J Clin Oncol* 2005;23:5027–33.
- [19] Smith A, Roman E, Howell D, Jones R, Patmore R, Jack A. The Haematological Malignancy Research Network (HMRN): a new information strategy for population based epidemiology and health service research. *Br J Haematol* 2010;148:739–53.
- [20] Smith A, Howell D, Patmore R, Jack A, Roman E. Incidence of haematological malignancy by sub-type: a report from the Haematological Malignancy Research Network. *Br J Cancer* 2011;105:1684–92.
- [21] Campo E, Swerdlow SH, Harris NL, Pileri S, Stein H, Jaffe ES. The 2008 WHO classification of lymphoid neoplasms and beyond: evolving concepts and practical applications. *Blood* 2011;117:5019–32.
- [22] Department for Communities and Local Government. The English indices of deprivation 2007. 2008. published online March 28, <http://www.communities.gov.uk/publications/communities/indicesdeprivation07> [Accessed 16 February 2011].
- [23] Cole SR, Hernán MA. Adjusted survival curves with inverse probability weights. *Comput Methods Programs Biomed* 2004;75:45–9.
- [24] Teras LR, DeSantis CE, Cerhan JR, Morton LM, Jemal A, Flowers CR. 2016 US lymphoid malignancy statistics by World Health Organization subtypes. *CA Cancer J Clin* 2016. <http://dx.doi.org/10.3322/caac.21357>. published online Sept 12.
- [25] Neal RD, Tharmanathan P, France B, Din NU, Cotton S, Fallon-Ferguson J, et al. Is increased time to diagnosis and treatment in symptomatic cancer associated with poorer outcomes? Systematic review. *Br J Cancer* 2015;112(Suppl. 1):S92–107.
- [26] NICE. Improving outcomes in haematological cancers: research evidence. London: Department of Health; 2003.
- [27] Lyratzopoulos G, Neal RD, Barbiere JM, Rubin GP, Abel GA. Variation in number of general practitioner consultations before hospital referral for cancer: findings from the 2010 National Cancer Patient Experience Survey in England. *Lancet Oncol* 2012;13:353–65.
- [28] Lyratzopoulos G, Abel GA, McPhail S, Neal RD, Rubin GP. Measures of promptness of cancer diagnosis in primary care: secondary analysis of national audit data on patients with 18 common and rarer cancers. *Br J Cancer* 2013. <http://dx.doi.org/10.1038/bjc.2013.1>. published online Feb 7.
- [29] Howell DA, Smith AG, Roman E. Help-seeking behaviour in patients with lymphoma. *Eur J Cancer Care (Engl)* 2008;17:394–403.
- [30] Nikonova A, Guirguis HR, Buckstein R, Cheung MC. Predictors of delay in diagnosis and treatment in diffuse large B-cell lymphoma and impact on survival. *Br J Haematol* 2015;168:492–500.
- [31] Howell DA, Smith AG, Jack A, Patmore R, Macleod U, Mironska E, et al. Time-to-diagnosis and symptoms of myeloma, lymphomas and leukaemias: a report from the Haematological Malignancy Research Network. *BMC Hematol* 2013;13:9.
- [32] Public Health England. Routes to diagnosis 2006–2013, preliminary results. National Cancer Intelligence Network Short Report; 2015.
- [33] Smith AG, Painter D, Howell DA, Evans P, Smith G, Patmore R, et al. Determinants of survival in patients with chronic myeloid leukaemia treated in the new era of oral therapy: findings from a UK population-based patient cohort. *BMJ Open* 2014;4:e004266.
- [34] Louwman WJ, Aarts MJ, Houterman S, van Lenthe FJ, Coebergh JWW, Janssen-Heijnen MLG. A 50% higher prevalence of life-shortening chronic conditions among cancer patients with low socioeconomic status. *Br J Cancer* 2010;103:1742–8.