Impact of Stage at Cancer Diagnosis on Total Healthcare Costs: A National Population-Based Study Using England Individual-Level Patient Data

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INTRODUCTION

- Cancer screening interventions aim to identify tumours before clinical presentation.
- Generally, cancers diagnosed at early stages (typically I or II) have substantially better survival than those diagnosed at late stages (typically III or IV)[1].
- Cancer stage at diagnosis is also a significant determinant of healthcare costs and the temporal distribution of these costs following diagnosis[2,3].
- Understanding the cost effectiveness of delivering benefits from screening interventions requires estimates of healthcare costs across different stages at diagnosis.
- Cancer care comprises 5% of total annual healthcare expenditure in England (approximately £11.7 billion)[4]; however, more detailed cancer healthcare cost data for England are currently limited[5].

OBJECTIVES

- To estimate the mean total pre-COVID National Health Service (NHS) hospital care costs per individual diagnosed with cancer in England from six months prior and up to six years after diagnosis, by stage at diagnosis and phase of care for eight specific cancer types.

METHODS

- This study used cancer registration data for England provided by the National Disease Registration Service (NDRS).
- The cancer registration data were linked to routine national healthcare datasets for hospital-based episodes of care (HES), diagnostic imaging (DID), systemic anti-cancer therapy (SACT), and radiotherapy (RTDS) (see Additional Information).
- The individuals in the cohort were those aged 50–79 years diagnosed with colorectal, head and neck, liver and bile duct, lung, lymphoma (any), oesophageal, ovarian, or pancreatic cancer in England between 1 Jan 2014 and 31 Dec 2017.
- All NHS hospital care events were extracted from six months before up to six years after diagnosis, censoring follow-up at death (from any cause) or 31 Dec 2019, whichever was earlier.
  - Healthcare events in this analysis were all-cause.
  - Healthcare events delivered in hospice/community settings, primary care and private healthcare were not captured.
- Records in the national healthcare datasets were merged and de-duplicated; Health Resource Group codes were assigned to each using the 2018/2019 NHS National Costs Grouper application (HRG4+), or, in the case of the SACT dataset, the National Tariff Chemotherapy Regimens List.
- Costs for each event were subsequently derived by mapping the HRG codes to the 2019/20 National schedule of NHS costs.
- Event costs were tabulated as mean NHS hospital care costs per patient by year of diagnosis (2014–2017), over the total available follow-up period.
- They were also tabulated as mean costs by phase of care per patient, in which costs of NHS hospital care were divided into four phases with the following priority:
  - Diagnosis (six months prior to the date of diagnosis);
  - End-of-life (up to one year prior to all-cause death, where applicable);
  - Initial treatment (the first year following the date of diagnosis); and
  - Continuing care (subsequent years after the initial treatment phase).

NHS HOSPITAL CARE COSTS WERE HIGHER IN STAGE IV VERSUS I FOR COLORECTAL, HEAD AND NECK, LYMPHOMA, AND OVARIAN CANCERS AND HIGHER IN STAGE I VERSUS IV FOR LIVER AND BILE DUCT, LUNG, OESOPHAGEAL, AND PANCREATIC CANCERS

Cohort Characteristics

		Colorectal	Head & Neck	Liver & Bile Duct	Lung	Lymphoma	Oesophageal	Ovarian	Pancreatic
Total (n)		**101,303**	**31,184**	**13,437**	**109,177**	**35,950**	**22,614**	**18,149**	**22,578**
Age (Mean)		67.6	64.3	67.6	68.6	67.0	67.6	65.6	68.2
Gender (%)	**Male**	59.1	71.5	69.7	53.5	56.4	73.3	0.0	54.4
	Female	40.9	28.5	30.3	46.5	43.6	26.7	100.0	45.6
Stage (%)	**0***	9.1	5.8	0.1	0.2	NA	5.5	0.8	0.6
	1	16.5	17.3	7.9	18.0	15.5	10.0	25.5	5.0
	2	21.0	10.5	9.2	7.6	11.5	12.4	5.9	13.3
	3	25.5	11.0	7.5	20.0	16.7	30.5	35.7	9.5
	4	20.6	45.0	28.3	48.3	39.4	31.3	19.9	53.1
	Missing/Unknown	7.2	10.4	46.9	5.8	16.9	10.1	12.2	18.5

*Carcinoma in situ.

Mean Total NHS Hospital Care Costs

- Two distinct patterns were found in mean total NHS hospital care costs per year by cancer type (data shown are for cancers diagnosed in 2014 only, but similar outcomes were demonstrated across all years):
  - NHS hospital care costs per patient were higher at stage IV than stage I for: colorectal (£42,452 vs £31,250, respectively), head and neck (£43,981 vs £32,095), lymphoma (£52,626 vs £38,420), and ovarian (£49,264 vs £26,651) cancers.
  - NHS hospital care costs per patient were higher at stage I than stage IV for: liver and bile duct (£48,612 vs £23,936 respectively), lung (£38,375 vs £22,429), oesophageal (£38,728 vs £23,149), and pancreatic (£39,555 vs £20,489) cancers.

Mean NHS Hospital Care Costs by Phase of Care

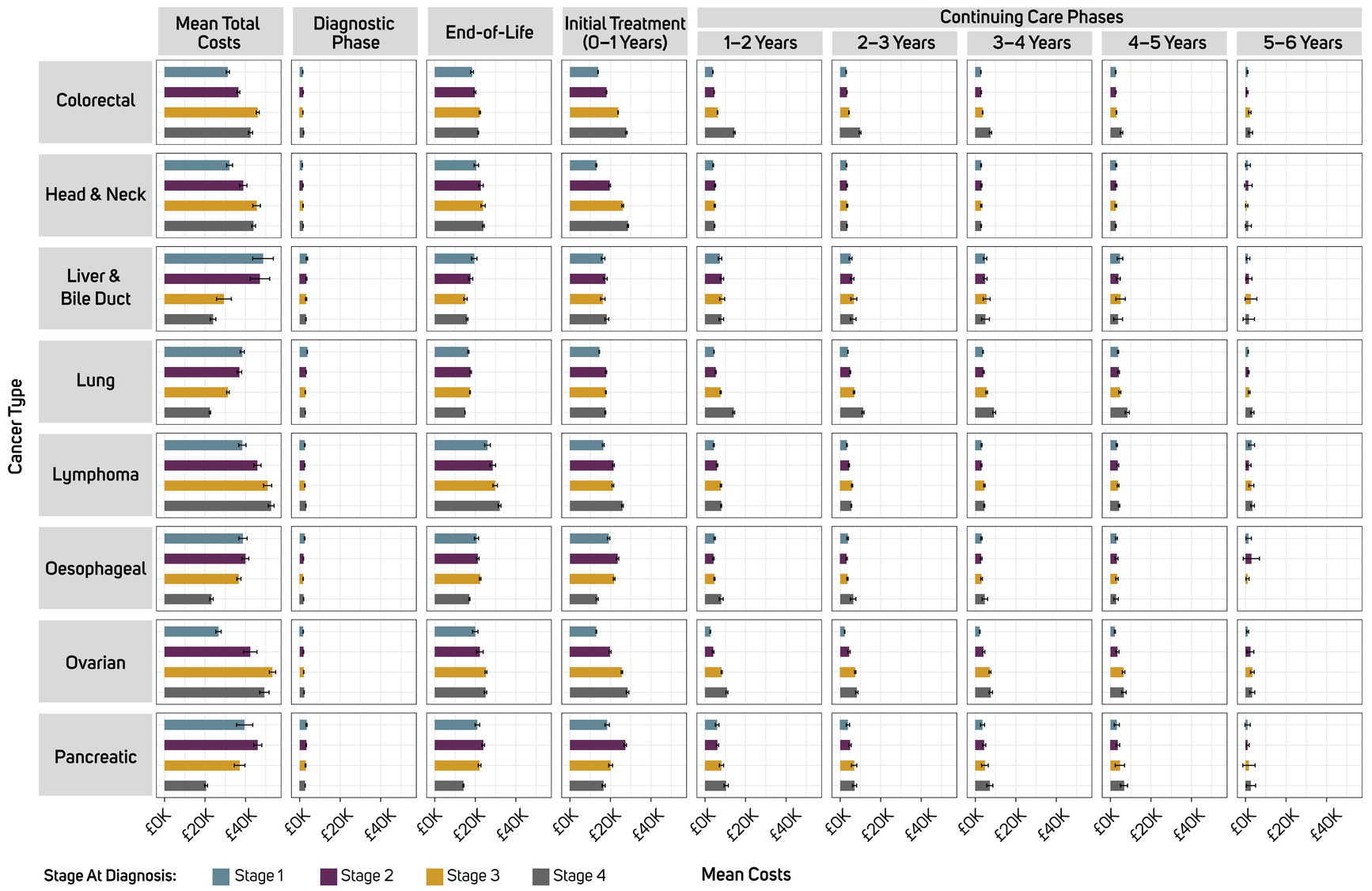

Figure 1. Mean NHS hospital care costs per patient per phase of care by cancer type and stage.

- The initial treatment and end-of-life phases were associated with the highest mean NHS hospital care total costs per patient across all cancer types and stages (**Figure 1**).
  - In the initial treatment phase, stage IV cancers had the highest mean costs for colorectal (£27,862), head and neck (£28,655), liver (£18,212), lymphoma (£25,933), and ovarian (£28,435) cancers; for lung, oesophageal, and pancreatic cancers, stage II cancers had the highest mean costs (£17,870, £23,521, and £27,281, respectively).
- In the diagnostic phase, costs were low and relatively similar across all stages for all cancer types.
- In the end-of-life phase, costs for lymphoma were notably higher across all stages than for all other cancer types; conversely, costs for lung and liver and bile duct cancers were generally lower across all stages than for other cancer types.
- In the continuing care phases, mean NHS hospital care costs per patient were generally higher for cancers diagnosed at stage III and IV than at I and II across all cancer types.

Additional Information

The full titles of the routine national healthcare datasets used in this analysis are as follows: DID, Diagnostic Imaging Dataset; HES, Hospital Episode Statistics; RTDS, Radiotherapy Dataset; and SACT, Systemic Anti-Cancer Therapy.

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Disclosures

D.A.J. and S.H. are employees of GRAIL Bio UK, Ltd., and hold stock in GRAIL, Inc. E.G. was previously employed by GRAIL Bio UK, Ltd. G.B., R.C., S.J., C.P., B.R., and K.S. have nothing to disclose.

CONCLUSIONS

- The cancer stage with the highest mean NHS hospital care costs varied by cancer type and phase of care, likely because NHS hospital care standards and options also vary according to these factors.
- Earlier diagnosis from screening may thus reduce costs for some cancer types, but for others, the benefit may be better prognosis for patients rather than lower costs for the National Health Service.
- Initial cancer treatment and end-of-life care phases had the highest total mean healthcare costs.
- Since the end of the study period, advances in cancer care have likely had notable impacts on costs that are not reflected in our study, including:
  - national rollout of curative stereotactic radiotherapy for lung cancer[6]
  - increasing use of targeted therapies and immunotherapy[7]
- Some limitations of this analysis are that some costs are likely not captured in the data sets used in our study, and the data are not the most currently available, though this was to avoid the COVID pandemic period.
- This work is ongoing, and future analyses will explore the estimated costs of cancer-specific healthcare.