BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (http://bmjopen.bmj.com).

If you have any questions on BMJ Open's open peer review process please email editorial.bmjopen@bmj.com

BMJ Open

Assigning cancers into three groups to enable tailored care planning

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016797
Article Type:	Research
Date Submitted by the Author:	17-Mar-2017
Complete List of Authors:	McConnell, Hannah; Macmillan Cancer Support, Evidence Department White, Rachel; Macmillan Cancer Support, Evidence Department Maher, J; Macmillan Cancer Support; Mount Vernon Cancer Centre
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research
Keywords:	cancer, survivorship, personalised-care, quality of life, survival, cancer services

SCHOLARONE™
Manuscripts

For peer review only

Title: Assigning cancers into three groups to enable tailored care planning

Authors:

McConnell H[1], White R[2], Maher J[2, 3]

[1] Consultant c/o Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

[2] Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

[3] Mount Vernon Cancer Centre, Rickmansworth Road, Northwood, London HA6 2RN, UK.

Correspondence:

Rachel White

Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

Telephone: 0207 091 2002

E-mail: rwhite@macmillan.org.uk

Word count 4285 (excluding tables, figure, acknowledgments and notes)

peer review only

ABSTRACT

Objectives: The aim of this study is to categorise the 200 plus cancers into broad groups based on clusters of common experiences, treatment aims and outcomes and the common needs of people with different cancers. This framework will help to provide a high-level overview of care and support requirements for the whole cancer population.

Setting and Participants: Study target population: people ever diagnosed and still living with one of 20 common cancers in the UK.

Primary and secondary outcome measures: Data on the survival, prevalence and stage at diagnosis for common cancers in the UK were reviewed alongside clinically led assumptions to identify commonalities between different cancer types and cluster cancer into three groups. Incidence, prevalence and mortality data collected and reported by cancer registries across the UK were used to provide indicative estimates of the size of each group. The framework has been reviewed, validated and refined following consultation.

Results: One and five-year survival is highest for Group 1. For cancers in Group 2 one-year survival rates are over 50% and range from around 66% for metastatic breast cancer to 88% for colorectal stage 3. Five-year survival is moderate for cancers in Group 2. Group 3 cancers have poor survival and five-year survival is not more than 20% for any cancer in this group. We estimate that the majority of people living with cancer (20-year prevalence), nearly 1.2 million, have a cancer type in Group 1 'longer-term survival', but significant minorities of people have cancers in Group 2 'intermediate survival' (19%) and Group 3 'shorter-term survival' (10%).

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Conclusions: Stratifying cancers into this Three Cancer Groups model and highlighting the focus of care required for each provides a new high level view of potential care requirements and can be used to guide thinking for the development of more personalised care.

Keywords

Cancer, survivorship, personalised-care, survival, quality of life, cancer services (6 max)

Strengths and Limitations of this study

- Three Cancer Groups model provides a narrative that highlights the full spectrum of cancer journeys. This contributes towards planning for interventions as it ensures that sections of the cancer population are not forgotten. It also draws attention to the broad needs of each distinct section of the cancer population and their associated care requirements.
- The model has already influenced policy decisions as it is included in the English Cancer Strategy (Independent Cancer Taskforce, 2015)
- Our estimates of the proportion of patients in each group will stimulate future work to collect related quantitative data and be used to plan future services to meet the needs of these patients.
- The study used routinely available nationwide population-based data to stratify cancers into groups this makes it repeatable and open to further analysis by commissioners, policy makers and researchers.
- The identified groups resonate well with clinical practice.
- There are limited historical data on stage at diagnosis and, no routine data available on cancer progression or serious treatment related consequences for people living with cancer. This lack of data is a barrier to tailoring our categorisations more precisely or accurate

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

quantification. However the data available does give a strong impression of the variation in illness trajectories.

- Due to the complexity and diversity of some cancer pathways and small number of people diagnosed and living with some cancers not all cancers have been included in our stratification.

INTRODUCTION

The number of people diagnosed and living with cancer is increasing year on year. Recent research highlighted that people were twice as likely to survive at least 10 years after a cancer diagnosis in 2011 than they were in the early 1970s (Quaresma *et al*, 2014). Improved diagnoses and detection, a growing and ageing population along with improvements in treatment and survival mean it is estimated that 4 million people will have had and be living with a cancer diagnosis in the UK by 2030 (Maddams *et al*, 2012).

Over the decades since 1970 the implications of what a cancer diagnosis means, the story of cancer, has also changed. In the 1970s cancer was very much a taboo subject and associated with end of life and terminal illness. Today, although many people still do die from their cancer, death rates have been declining since the 1990s and are predicted to continue this downward trend as survival improves. With this improved survival the focus today is increasingly turning to, not if, but how people survive after cancer, that is, their quality of life and their ability to live well. This changed focus is recognised in the recent cancer strategies and plans from the nations of the UK which include a foci on quality and experience. Recognising the importance of life after cancer diagnosis and treatment, 'A strategy for England 2015-2020' noted:

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

> *We need to support people with cancer to return to as good a quality of life as possible after active treatment has ended, or support them to achieve their personal goals if they will be living with either primary or secondary cancer for some time.*
>
> (Independent Cancer Taskforce, 2015)

The perception of cancer as a death sentence remains amongst many, particularly in the public mind, because some cancers have seen little improvement in survival rates since the 1970s. On the other hand the idea that cancer is eliminated and life goes back to normal is also flawed. The experience of cancer is not binary: its outcome is not merely cure or death. The story of cancer now includes effects and consequences and in some cases the return of or a new cancer which makes for much more complex personal journeys and experiences.

What hasn't changed since the 1970s is the fact that cancer is not one disease but is made up of over 200 different types of cancer and, along with the hundreds of thousands of people diagnosed with cancer each year, each cancer is different, behaves differently, warrants different treatment and has different outcomes. Cancer research, genetics and treatment have all developed and there is an increasing move towards personalised medicine. Here we aim to consider cancer in the context of care and support. It is impractical to plan care and support requirements for all 200 plus cancers individually. We must find ways of identifying similar needs for groups of cancers and use this to guide our thinking about the interventions and conversations required to move towards more personalised care. For example, Deagle *et al* (2016) review the success of new roles piloted in Southampton to support people with active or advanced disease. Harley *et al* (2012) focused on the chronic cancer disease phase. They identified that care planning at the point of transition to chronic cancer should focus on evaluating patients' symptoms and need for psychological, social, and economic support and regular re-evaluation should follow.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Routine cancer incidence, mortality, survival and prevalence data are useful and essential for monitoring and planning but do not distinguish outcomes such as quality of life and needs. Previous work to divide cancer survivors into needs based segments with respect to their transitions into different phases of care (Yip *et al*, 2015) identified patterns for different cancer types. Here in order to aid the development of more personalised and tailored care we begin to use routinely collected data and clinical assumptions to segment the whole cancer population into clusters. We categorise cancers into broad groups based on clusters of common experiences, treatment aims and outcomes and the common needs of people with different cancers. This framework will help service planners identify the types of conversations and interventions required to facilitate better planning of care and support services to meet peoples' needs.

MATERIALS AND METHODS

Data on the survival, prevalence and stage at diagnosis for common cancers in the UK were reviewed alongside clinically led assumptions to identify commonalities between different cancer types. The commonalities included similar care pathways, needs and outcomes of people with those cancers. Survival was used as an initial proxy for those factors as it often has an impact on the types of care and support needed. This was refined by clinicians reviewing the most prevalent cancers to identify the impact stage has on treatment pathways and survival. Where the differences by stage were agreed to be most significant that cancer was considered separately by stage, for example organ confirmed prostate cancer and metastatic prostate cancer were considered separately.

Previous work (Yip *et al*, 2015) focused on specific cancer types and transition to different phases of care. Following this work we explored options to group all 200+ cancers in a more manageable way. We categorised cancers into three groups and indicative estimates are made to quantify the size of each of the groups. Where official statistics and England wide survival data exist we use these to categorise the common cancers in our model. We further use incidence, mortality and prevalence as

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

well as stage at diagnosis to estimate the number of people in each group. Where official statistics are not available we draw on the wider literature to provide estimates in particular for five-year survival by stage. We calculate weighted averages for survival where stage is grouped. There is little historical data split by stage at diagnosis and only recent data on survival by stage. Prevalence by stage is therefore crudely described based on stage at diagnosis, survival rates, and comparison of prevalence to cancer types with similar survival profiles. Mortality by stage is crudely estimated based on the distribution by stage at diagnosis in new diagnoses. Where necessary we assume stage at diagnosis and survival by stage rates are comparable across UK constituent countries and use England or localised data as a proxy to calculate data by stage for the UK where necessary. See Table 1 for more details.

The analysis included 20 common cancers (excluding non-melanoma skin cancer - ICD-10 C44) which account for the majority of people living with cancer in the UK (Macmillan/NCRAS, 2015). We exclude leukaemia (C91-95), head and neck (C00-14, C30-32), ill-defined, secondary and unspecified sites (C76-80) and some further rarer cancers as the highly diverse cancer care pathways and limited survival and stage data makes them difficult to stratify into the groups. These excluded cancers made up an estimated 13% of cancer incidence and 17% of mortality in 2014, and around 8% of 20-year prevalence as at the end of 2010. Our estimation of the total prevalence across the three groups is the sum of the count of first specific tumours based on Macmillan/NCRAS (2015). This means the sum will double count anybody who has more than one type of cancer within the 20 years follow up. The estimated total prevalence across the 3 groups includes ICD-10 D-codes in its categorisation of brain cancers. The denominator of the 8% of 20-year prevalence estimate (1.8 million) does not have any double counting as it is the person count with any cancer (ISD C00-C97 excluding C44).

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Table 1 describes the measures and data sources used within the estimates to quantify our Three Cancer Groups. We acknowledge variation in the quality of some of the data sources due to availability of data and we represent this in our results. In general we have higher confidence when the survival rates are based on England-level and lower confidence where the data are based on smaller populations or where we use a subset of a cancer as a proxy.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Table 1: Key data sources by measure, year and coverage

Measure	Time period	Year	Coverage	References
Prevalence	20-year prevalence	Up to end of 2010	UK	Macmillan/NCRAS, 2015
Incidence	Annual	2014	UK	ONS, 2016a; ISD, 2016; WCISU, 2016; NICR, 2016; CRUK, 2014
Incidence by stage at diagnosis	Annual	2014	England and N. Ireland (cervix)	NCIN, 2016; NICR, 2016
Mortality	Annual	2014 (N Ireland 2013)	UK	ONS, 2015; ISD, 2016; NICR, 2016
Survival all stages combined	One & five-year	Predicted for adults diagnosed in 2015	England	ONS, 2016b
Survival by stage	One-year	Diagnosed 2014 followed up to 2015 Diagnosed 2002-2009 (cervix)	England N Ireland	ONS, 2016c NICR, 2016
Survival by stage	Five-year	Diagnosed 2006-2010 (renal cell kidney cancer) Diagnosed 2002-2006 (prostate, breast and uterus) Diagnosed 2002-2009 (cervix) and 2005-2009 (colorectal)	England Former Anglia Cancer Network N Ireland	NCIN, 2014 CRUK, 2011 NICR, 2016

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

We then presented the categorisation at one of Macmillan's Clinical Advisory Board meetings which was attended by 15 health professionals to test and confirm general alignment of the groups with clinical practice. Macmillan's Clinical Advisory Board membership comprises of 25+ multi-disciplinary professionals and senior Macmillan directors including surgeons, oncologists, palliative care consultants, Allied Health Professionals and community nurses. The categorisation of the three groups was then presented and discussed in six workshops at a Macmillan conference of medical professionals across primary and secondary care in 2015 attended by 167 healthcare professionals and around 45 additional colleagues working within cancer. Macmillan GPs and GP Advisors made up the majority of healthcare professionals (136), with the remainder made up of consultants, practice nurses, primary care nurses and people affected by cancer. The Three Cancer Groups model was presented in the workshops and discussion focused on how primary and secondary care can work better together to enhance the experience of people with cancer. Workshop groups were asked to identify 'take-away ideas' on how members of the medical community could better support people within each of the Three Cancer Groups. Attendees at the workshops found the Three Cancer Groups and their assumptions resonated well with clinical practice and was a useful model to help to disentangle the complexity of care.

The Three Cancer Groups model was included in the English Cancer Strategy (Independent Cancer Taskforce, 2015), and we discussed the model at recent cancer conferences, particularly with cancer registration and analysis colleagues (European Network of Cancer Registries 2014, National Cancer Research Initiative 2015, World Cancer Congress 2016, Cancer data and outcomes conferences 2015 and 2016). Subsequently we validated and further refined the data used to categorise and quantify the three groups as new data became available in particular the stage data.

Assumptions

Every individual cancer journey is different and treatment and care should be personalised to individual needs. However, we aim to identify broad clusters of commonalities and categorise

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

cancers into three different groups according to treatment pathway, needs and outcomes to provide high-level overviews of care and support for the whole cancer population. The journey a patient has will be broadly influenced by outcomes (especially survival time), tumour type and needs and can be used to establish the demand for different levels of ongoing support. Here we describe our assumptions based on clinical knowledge of treatment pathways and likely outcomes for each group.

Group 1: Longer-term survival

For this group peoples' cancer is generally identified and treated successfully typically after an acute episode of care involving surgery, radiotherapy and or chemotherapy. The majority of this group of cancers include people who tend to live for the long-term – often more than a decade. Most localised breast and prostate cancer, most colorectal cancer at stage 1 and 2, and most stage 1 cervix and uterine cancers are included in this group. However, it is also believed many of this group will live with physical, practical, financial or emotional consequences of cancer or its treatment (Macmillan, 2012). Some people with cancers in this group could have long-term consequences of cancer or its treatment that appear many years after treatment, for example an increased risk of cardiac problems in breast cancer survivors.

Group 2: Cancer as a complex ongoing disease – Intermediate survival

Cancers in this group are often incurable but treatable from diagnosis, they may respond well to treatment initially but then relapse, recur or spread. There are two subsets in this group, firstly those cancers where a majority of people have an incurable but treatable illness from diagnosis. Secondly there are those with cancers from Group 1 where people have an apparently successful initial treatment, a gap of months or years and then metastatic disease develops e.g. hormone sensitive breast or prostate cancer. People with cancers in this group are likely to live more than a year but are less likely to live more than 5 years and typically have multiple lines of treatment. Ongoing

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

treatment or care is often required, survival is generally moderate and the acute effects and consequences of cancer and its treatment are likely to be prevalent in this group. This means that cancers in this group could be seen to be similar in behaviour and treatment requirements to a long-term condition. Myeloma, stages 2-4 uterus, cervix and kidney cancers, and metastatic breast and prostate cancer are in this group. Those who had a Group 1 cancer that developed into a Group 2 cancer cannot be easily identified in the current routine datasets.

Group 3: Shorter-term survival

For cancers in this group prognosis is typically poor with over half of people dying within a year of diagnosis. Acute cancer episodes, treatment and palliative care dominate in this group. Survival rates for these cancers are the lowest and some have seen little or no movement in recent decades. Lung, pancreas, metastatic colorectal cancer, brain and stomach cancer are in this group.

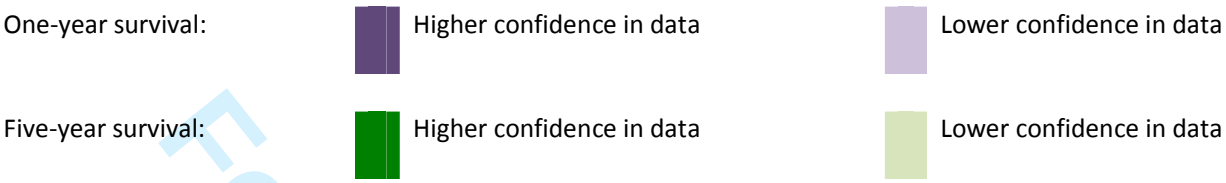
RESULTS

We review survival by cancer type using available data and allocate cancers into Three Cancer Groups based on our assumptions of treatment pathways and according to survival outcomes. Figure 1 shows the one and five-year survival rates for cancers included in the study and by stage for those cancers identified by clinicians as having a greater influence on treatment pathways. Where possible we report unstandardised net survival from the most reliable source as noted in Table 1. Figure 1 in its legend presents an assessment of the quality of the data used for each cancer and time period, for example where data are not sourced from England data or are estimated by proxy, such as from a subset of the cancer type we have less confidence in the data. It should be noted that survival rates by stage reported in Figure 1 come from multiple sources (see Table 1 for details). Caution should be taken when making comparisons.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Figure 1: One and five-year survival rates by cancer type, stage and group, England, up to 2011-15*

INSERT Figure 1



*Data are for England except cervix cancer by stage which is N Ireland data and five-year survival by stage which is regional data from the former Anglia Cancer Network or N Ireland data. The year of data varies with the earliest time period people were diagnosed as 2002-2006 followed up to 2011 for the five year survival by stage data and the latest as predicted survival for people diagnosed in 2015 for cancers with no stage split. See sources in Table 1 for more details.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

One-year survival is highest for Group 1 and ranges from 89% for Hodgkin's Lymphoma to 100% for early stage prostate cancer. Five-year survival is similarly high from 80% for Hodgkin's Lymphoma to over 100% for early stage prostate cancer. In general the difference between one and five-year survival is smallest within Group 1 compared to other groups in line with our assumption that people with cancers in this group are most likely to survive in the long-term.

For cancers in Group 2 one-year survival rates are over 50% and range from around 66% for metastatic breast cancer to 88% for colorectal stage 3. Five-year survival is moderate for cancers in Group 2 ranging from 15% for metastatic breast cancer to 66% for Non-Hodgkin lymphoma. The difference between one and five-year survival is much greater than that of Group 1 perhaps reflecting the increased complexity of cancer as an illness for people in this group. For metastatic breast and prostate cancer the difference between one and five-year survival appears to be particularly stark (over 50 percentage points). However, it should be noted that the data for five-year survival by stage availability and quality is limited (Cancer Research UK, 2011).

Group 3 cancers have poor survival with one-year survival ranging between 22% for pancreatic cancer and 44% for stomach cancer. Five-year survival is not more than 20% for any cancer in this group with mesothelioma lowest at just 4%, closely followed by pancreatic cancer and metastatic colorectal cancer both 6% (although not all sources are directly comparable).

The Three Cancer Groups categorised by survival rates (Figure 1) give a good indication of the distinguishing features of the groups but key to assessing the need for population level care and support services is understanding the numbers of people stratified into each group. Figure 2 provides estimates of the number of people in each group using incidence, prevalence and mortality data.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

We estimate that the majority of people living with cancer (20-year prevalence), nearly 1.2 million, have a cancer type in Group 1 'longer-term survival', but significant minorities of people have cancers in Group 2 'intermediate survival' (19%) and Group 3 'shorter-term survival' (10%) (Figure 2). Group 1 is the largest group with the incidence as well as prevalence accounting for the largest proportions, as might be anticipated with most people with cancers in this group expected to survive in the longer-term. Cancer deaths in Group 1 are proportionally much lower than incidence and prevalence. In contrast Group 3, whose cancers have the poorest prognosis, had the highest proportion and number of cancer deaths and the lowest prevalence. Cancers in Group 2, although proportionally the smallest group in terms of incidence and mortality, have nearly twice the prevalence of Group 3 cancers and a significant number of people living with cancer – an estimated 342,000 at the end of 2010.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Figure 2: Proportion of people in each of the three cancer groups, estimates for the UK*

INSERT Figure 2

* Numbers do not add up to 100% for each column as some cancers have been excluded – see Methods and materials. These excluded cancers made up 13% of incidence, around 8% of prevalence and 17% of mortality in each respective year. See Table 1 for data sources. For prevalence and mortality no direct data for cancers by stage is available so some estimates rely on assumptions and simplifications.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

DISCUSSION

Cancer is made up of over 200 different types and even between the most common cancers variation in survival outcomes is large and we believe variation in need is likely to have a similar spread. In order to demonstrate the need for support and service configuration, establishing the demand for different levels of ongoing support in stratified groups is essential. Table 2 summarises the Three Cancer Groups in our model and notes the possible key concerns and interventions appropriate to support each group as informed by clinical input and the health professional's workshops.

Table 2: Summarising the features, needs and care requirements of the Three Cancer Groups

Group 1: Longer-term survival	Group 2: Intermediate survival	Group 3: Shorter-term survival
People with a Group 1 cancer typically have an early stage potentially curable cancer and a prognosis of a decade or more. Most people survive in the long-term, often in relatively good health (and many live for more than a decade)	*People with a Group 2 cancer often have incurable but treatable disease, typically having multiple lines of treatment. People experience cancer as a complex ongoing disease similar to a long-term condition.*	*People with a Group 3 cancer typically develop advanced disease and often have less than 12 months prognosis. Most people have relatively poor health and short-term survival*
Often face long-term consequences of their cancer and its treatment. May face recurrence even years after primary treatment	Often have a complex pathway, with multiple decision points, commonly experience relapse or recurrence	Often face short survival times, mostly incurable disease and complex, time sensitive decisions needed
Focus on recovery and long-term quality of life: · Reduce unnecessary over-treatment, focus on its impact on recovery and late effects · Management of comorbidities · Recovery Package, including Stratified Pathways and self-care with support and open access (NCSI, 2013)	Care must preserve quality of life through balance of: · acute intervention · chronic illness management · palliative care · shared care between patient and clinician (NCSI, 2013) · recognition when move to dying phase	Balance of anti-cancer treatment and palliative care to maintain quality of life. Focus care on: · early diagnosis · complex case management · good treatment and or supportive specialist palliative care

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

The majority of people living with cancer in this model have a Group 1 cancer, where most people will have one episode of treatment and a focus on managing the impact of treatment on recovery is key. The Recovery Package is an essential part of their care and support (NHS England, 2014) including practical, financial and emotional support, for example, to get back to work or an exercise programme. Some people with a Group 1 cancer with longer-term survival may have consequences of cancer or their treatment. There are limited data to quantify how many people this may affect but it is estimated around a quarter of all people living with cancer could have consequences (Macmillan, 2012). Patient reported outcome measures also highlight that people report consequences and issues which affect quality of life for years after initial diagnosis (NHS England, 2015). These people with later consequences may benefit from elements of care taken from the management of long-term conditions along with people with cancers in Group 2. Additionally there is a subset of people we are currently unable to quantify with a Group 1 cancer which develops and metastases months or years after initial diagnosis and so move to a Group 2 cancer.

Our model and provisional estimates suggest that around one in five cancer patients have a Group 2 cancer, the intermediate survival group. These people have ongoing disease, have more than one treatment episode with potentially complex care requirements. The large difference between one and five-year survival for Group 2 could be interpreted as a particular concern in terms of managing care whilst maintaining quality of life at such an unpredictable phase of disease. Group 2 can be seen as having similar needs to those with a long-term condition as they experience multiple episodes of care and monitoring of disease is required. Reed and Corner (2013), use the example of metastatic breast cancer, to predict that a model of care used to manage chronic illness could lead to more appropriate use of analgesics, anti-cancer treatments and hospital visits. The management of long-term conditions can include personalised treatment, care planning and supported self-management. For Group 2 a model of care used in long-term conditions incorporating supported self-management may be appropriate.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

For Group 3 many people die quickly and there should be a focus on improving diagnoses for late stage disease and managing a balance of anti-cancer treatment and palliative care well. Some people with a cancer in this group who do survive beyond a year may also benefit from a model of care similar to those with cancers in Group 2.

The Three Cancer Groups model and the focus of care required for each (Table 2) can be used to guide thinking for the development of more personalised care. The characteristics of individuals and their tumours taken alongside the focus of care for each group of cancers will help supportive conversations with patients and facilitate identification of more specific needs for personalised care and support. For example it is evident that cancer often co-exists with a wide range of other conditions or co-morbidities (Macmillan, 2015). This is particularly important to take into account in the understanding of care and support required to recover after treatment especially for people with a Group 1 cancer as well as when treatment decisions are made for all Groups.

Limitations

As noted the quality of data available to report on cancers by stage is limited although great gains have been made in recent years allowing us the confidence to report on our model here. Further data and research is needed to understand mortality, prevalence and longer-term survival by stage and to understand tumour progression in order to specify the cancers and people in each group more precisely. The data are also limited in that reported statistics do not identify if people have had a previous cancer diagnosis. At this initial stage of introducing our model we have not attempted to further sub-divide for simplicities sake. Current data and the small size of some tumour groups do not allow us to disaggregate within all tumours. As with any model not all individuals will fit perfectly into one of the groups and in reality people could move between groups. The model has also not been able to take into account serious treatment related consequences or the implications of

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

multiple morbidities on treatment and care due to limited data and evidence which could impact people in all groups. It is likely these groups would require care which would fall into Group 2 with people experiencing cancer as a complex ongoing disease.

The construct of our Three Cancer Groups model is new and so there are limited further data and research to explore in more depth the commonalities and distinctions between the groups of cancers and the people within these groups. In order to ensure that care and support meets patients' needs further research into the links between clinical care, treatment and quality of life as well as patient reported needs and outcomes in each of the groups would be beneficial. Further work to identify and test appropriate interventions for each of the Three Cancer Groups should be carried out with a focus on measuring which elements of care have an impact on quality of life. A recent study piloting new roles to deliver supportive care for cancer patients with active and advanced disease in Southampton shows promising results and found that more than 50% of patients were supported to be able to return to independence through self-management (Deagle *et al*, 2016). Such studies would benefit from reporting quality of life outcomes. Work in England, thanks to the recent Cancer Strategy (Independent Cancer Taskforce, 2014), is underway to develop a quality of life metric with the intention to monitor continuous improvement in long-term quality of life for people living with cancer. We hope to use the outcomes of this work to understand the groups in more detail in the future.

Conclusion

Every person with cancer is different and treatment and support should be personalised to individual needs. We believe personalised care is key to improving survival and quality of life and that a shared understanding of the aim of treatment is required between patients and health professionals in order to tailor care appropriately. We believe the Three Cancer Groups model provides a starting point for a broad framework and narrative that contributes towards personalising care through

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

better decision making and application of interventions to ensure people don't miss out on the care appropriate for them and their cancer.

Stratifying cancers in this way provides a new high level view of potential care requirements and will guide the thinking of planners and health professionals in order to personalise care. We aim to stimulate debate on this service challenge and shift perception from cancer as a binary life or death disease to that of the new reality, the new cancer story of three parts. Some cancers cannot be cured, some cancers keep coming back and most leave a lasting impact.

ACKNOWLEDGEMENTS

We thank Macmillan Cancer Support and the healthcare professionals who took part in discussion and workshops on the Three Cancer Groups model. Cancer registration and mortality data owners across the UK who collected and made much of these data available. Data are collated and presented from publicly available sources published by Office for National Statistics, Public Health England's National Cancer Registration and Analysis Service, the Welsh Cancer Intelligence and Surveillance Unit (Health Intelligence and Knowledge Management Division, Public Health Wales), the Scottish Cancer Registry (Information Services Division), the Northern Ireland Cancer Registry (Public Health Agency for NI) and Cancer Research UK.

FOOTNOTES

Contributors: Jane Maher was responsible for the development of the concept of the Three Cancer Groups and led on clinical engagement. Hannah McConnell and Rachel White were responsible for collating and analysing the data from across the UK and placing the topic within the wider cancer population narrative. All authors contributed to the first draft of the manuscript and have reviewed the final version before submission. Colleagues within Macmillan Cancer Support provided review of

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

draft papers. Further contributors provided data and clinical review are noted in the methods and acknowledgements.

Competing interests: None declared.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Data sharing statement: All data are described in Table 1. No additional data are available.

REFERENCES

Cancer Research UK (2011) Five-year relative survival by stage, adults (aged 15–99 years), Former Anglia Cancer Network, 2002–2006.

Cancer Research UK (2014) Mesothelioma incidence statistics (2014 data)

Deagle J, Richardson A, Fenlon D, Keen A (2016) Can a case management role in the community improve cancer care? Cancer Nursing Practice **18**(2): 22-27

Independent Cancer Taskforce. (2015) Achieving world-class cancer outcomes: a strategy for England 2015-2020

Information Services Division (ISD) (2016) Cancer incidence and mortality in Scotland by site/type of cancer, sex and year of diagnosis/registration of death: 2005-2014

Maddams J, Utley M, Møller H. (2012) Projections of cancer prevalence in the United Kingdom, 2010-2040. *Br J Cancer* **107**: 1195-1202, doi:10.1038/bjc.2012.366 (Projections scenario 1).

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Macmillan Cancer Support (2014) Routes from Diagnosis. The most detailed map of cancer survivorship yet

Macmillan Cancer Support (2012) Throwing light on cancer and the consequences of its treatment.

Macmillan Cancer Support (2015) Cancer in the context of other long-term conditions. Scoping evidence review and secondary data analysis

Macmillan Cancer Support/NCRAS (Public Health England's National Cancer Registration and Analysis Service) (2015) Macmillan-NCIN Cancer Prevalence Project: 20-year cancer prevalence in the UK by cancer site

NCIN (National Cancer Intelligence Network) (2014) Kidney cancer: survival report

NCRAS (Public Health England's National Cancer Registration and Analysis Service) (2016) TNM stage group by CCG by tumour type for 10+3 tumour types, 2014

NCSI (National Cancer Survivorship Initiative): Department of Health, Macmillan Cancer Support and NHS Improvement (2013) Living with & Beyond Cancer: Taking Action to Improve Outcomes

NICR (N Ireland Cancer Registry) (2016) Official Statistics: by site. Cancer incidence, prevalence and survival statistics for Northern Ireland: 1993-2014

NHS England (2014) Five Year Forward View

NHS England (2015) Quality of Life of Colorectal Cancer Survivors in England

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Office for National Statistics (2015) Deaths Registered in England and Wales: 2014

Office for National Statistics (2016a) Cancer Registration Statistics, England

Office for National Statistics (2016b) Cancer survival for adults in England: 2010 to 2014, followed up to 2015. Table 5

Office for National Statistics (2016c) One–year net cancer survival for Bladder, Breast, Colorectal, Kidney, Lung, Melanoma, Ovary, Prostate and Uterus, by stage at diagnosis

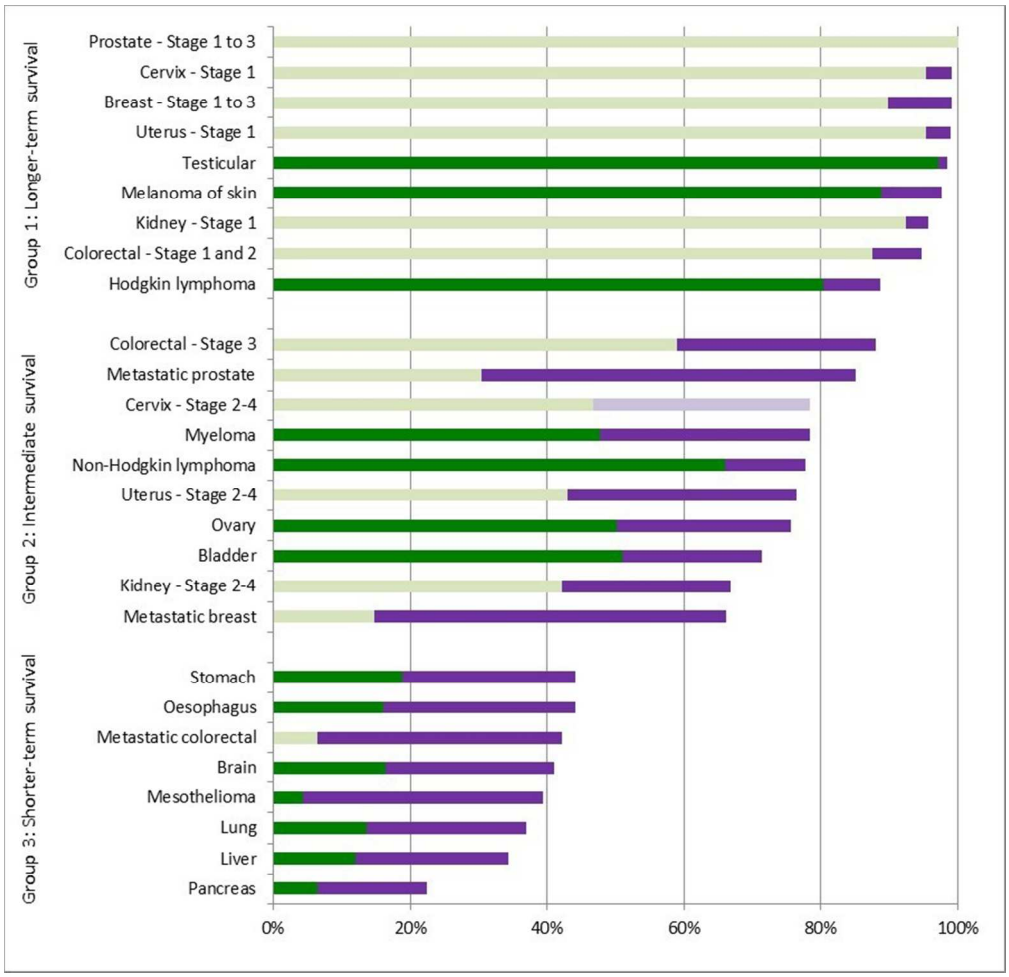
Quaresma M, Coleman MP and Rachet B (2014) 40 year trends in an index of survival for all cancers combined and survival adjusted for age and sex for each cancer in England and Wales, 1971- 2011: a population-based study. *Lancet* **385**: 1206-1218

Reed E and Corner J (2013) Defining the illness trajectory of metastatic breast cancer. *BMJ Support Palliat Care* **0**: 1–8, doi:10.1136/bmjspcare-2012-000415

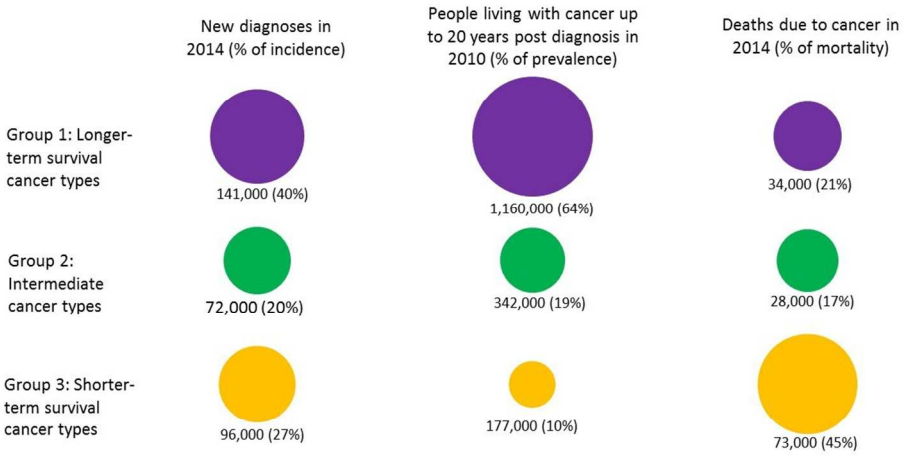
Welsh Cancer Intelligence and Surveillance Unit (2016) Cancer Incidence: Interactive Cancer Statistics Tool

Yip K, McConnell H, Alonzi R, Maher J (2015) Using routinely collected data to stratify prostate cancer patients into phases of care in the UK: implications for resource allocation and cancer survivorship *Br J Cancer* **112**: 1594–1602, doi:10.1038/bjc.2014.650

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml



189x183mm (120 x 120 DPI)



267x142mm (120 x 120 DPI)

For peer review only

BMJ Open

Assigning cancers into three groups and analysing cancer registration data in the UK to enable tailored care planning

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016797.R1
Article Type:	Research
Date Submitted by the Author:	28-Jun-2017
Complete List of Authors:	McConnell, Hannah; Macmillan Cancer Support, Evidence Department White, Rachel; Macmillan Cancer Support, Evidence Department Maher, J; Macmillan Cancer Support; Mount Vernon Cancer Centre
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research
Keywords:	cancer, survivorship, personalised-care, quality of life, survival, cancer services

SCHOLARONE™
Manuscripts

For peer review only

Title: Assigning cancers into three groups and analysing cancer registration data in the UK to enable tailored care planning

Authors:

McConnell H[1], White R[2], Maher J[2, 3]

[1] Consultant c/o Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

[2] Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

[3] Mount Vernon Cancer Centre, Rickmansworth Road, Northwood, London HA6 2RN, UK.

Correspondence:

Rachel White

Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

Telephone: 0207 091 2002

E-mail: rwhite@macmillan.org.uk

Word count 4755 (excluding the abstract, tables, figures, acknowledgments and notes)

For peer review only

ABSTRACT

Objectives: The aim of this study is to categorise cancers into broad groups based on clusters of common treatment aims, experiences and outcomes to provide a numerical framework for understanding services required to meet the needs of people with different cancers. This framework will enable a high-level overview of care and support requirements for the whole cancer population.

Setting and Participants: People in the UK with one of 20 common cancers; an estimated 309,000 diagnoses in 2014[9,10,11,12], 1,679,000 people diagnosed in a 20 year period and still living in 2010[14] and 135,000 cancer deaths in 2014[10,18,19].

Primary and secondary outcome measures: Survival and stage at diagnosis data were reviewed alongside clinically led assumptions to identify commonalities and cluster cancer types into three groups. The Three Cancer Groups were then described using incidence, prevalence and mortality data collected and reported by UK cancer registries. This was then reviewed, validated and refined following consultation.

Results: Group 1 includes cancers with the highest survival; five-year survival is over 80%. Group 3 cancers have shorter-term survival. Five-year survival is not more than 20% for any cancer in this group and many do not survive over a year. Group 2 includes cancers where people typically live more than a year but are less likely to live more than 5 years. We estimate that the majority (64%) of people living with cancer (20-year prevalence) have a cancer type in Group 1 'longer-term survival', but significant minorities of people have cancers in Group 2 'intermediate survival' (19%) and Group 3 'shorter-term survival' (10%).

Conclusions: Every person with cancer has unique needs shaped by a multitude of factors including co-morbidities, treatment regimens, patient preferences, needs, attitudes and behaviours. However,

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

to deliver personalised care there needs to be a high-level view of potential care requirements to support service planning.

Keywords

Cancer, survivorship, personalised-care, survival, quality of life, cancer services (6 max)

Strengths and Limitations of this study

- The Three Cancer Groups model provides a narrative that highlights the full spectrum of cancer journeys. This contributes towards planning for interventions as it ensures that sections of the cancer population are not forgotten. It also draws attention to the broad needs of each distinct section of the cancer population and their associated care requirements.
- The model has already influenced policy decisions as it is included in the English Cancer Strategy.[5]
- Our estimates of the proportion of people diagnosed with cancer in each group will stimulate future work to collect related quantitative data and be used to plan future services to meet the needs of these people.
- The study used routinely available, nationwide, population-based data to stratify cancers into groups. This makes it repeatable and open to further analysis by commissioners, policy makers and researchers.
- The identified groups resonate well with clinical practice.
- There are limited data on historical stage at diagnosis, cancer progression[41] or serious treatment-related consequences for people living with cancer. This lack of data is a barrier to tailoring our categorisations more precisely or providing more accurate quantification.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

However the data available does give a strong impression of the variation in illness trajectories.

- We are not able to include data on treatment regimens, patient preferences, needs, attitudes and behaviours in the description of the groups as this information is not routinely collected and linked to cancer registration data.
- Due to the complexity and diversity of some cancer pathways and the small number of people diagnosed and living with some cancers not all cancers have been included in our stratification.

INTRODUCTION

Recent research highlighted that people were twice as likely to survive at least 10 years after a cancer diagnosis in 2011 than they were in the early 1970s.[1] Given improved diagnoses and detection, a growing and ageing population, along with improvements in treatment and survival, it is estimated that 4 million people will have had and be living with a cancer diagnosis in the UK by 2030.[2]

Over the decades since 1970 the implications of what a cancer diagnosis means has also changed. In the 1970s cancer was often a taboo subject and associated with end of life and terminal illness.[3] Today, although many people still do die from their cancer, death rates have been declining since the 1990s and are predicted to continue this downward trend[4] as survival improves. With this improved survival the focus today is increasingly turning to how people survive after cancer, that is, their quality of life and their ability to live well. This changed focus is recognised in the recent cancer strategies and plans from the nations of the UK which include a foci on quality and experience. Recognising the importance of life after cancer diagnosis and treatment, 'A strategy for England 2015-2020' noted:

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

We need to support people with cancer to return to as good a quality of life as possible after active treatment has ended, or support them to achieve their personal goals if they will be living with either primary or secondary cancer for some time. [5]

The perception of cancer as a death sentence remains amongst many, particularly in the public mind, because some cancers have seen little improvement in survival rates since the 1970s. On the other hand the idea that cancer can be eliminated with life going back to normal is also flawed. The experience of cancer is not binary: its outcome is not merely cure or death. The story of cancer now includes effects and consequences and in some cases the return of or a new cancer which makes for much more complex personal journeys and experiences. Therefore, we need a new simple way to describe this complexity.

What hasn't changed since the 1970s is the fact that cancer is not one disease but is made up of many different types of cancer and, along with the hundreds of thousands of people diagnosed with cancer each year, each cancer is different, behaves differently, warrants different treatment and has different outcomes. Cancer research, genetics and treatment have all developed and there is an increasing move towards personalised medicine. Here we aim to consider cancer in the context of care and support. It is impractical to plan at a population level the care and support requirements for every cancer type and journey individually. We must find ways of identifying people with similar needs and use this to guide our thinking about the interventions and conversations required to move towards more personalised care. For example, Deagle *et al* review the success of new roles piloted in Southampton to support people with active or advanced disease.[6] Harley *et al* focused on the chronic cancer disease phase. They identified that care planning at the point of transition to chronic cancer should focus on evaluating symptoms and need for psychological, social, and economic support, and regular re-evaluation.[7]

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

In the face of all this complexity, for most monitoring and planning we only have routine cancer incidence, mortality, survival and prevalence data at a whole-population level. This does not in its current form describe the complexity in quality of life and needs. Previous work has aimed to draw out some of the complexity using routine cancer data by dividing cancer survivors into needs-based segments with respect to their transitions into different phases of care.[8] This identified patterns for different cancer types.

The aim of the current study is to identify a method to classify cancers types into groups that are associated with similar treatment aims, experiences and outcomes. The method needs to provide a numerical framework that allows researchers to estimate the size of each group in different populations. The aim is then to describe the size and characteristics of the Three Cancer Groups. Finally, this will lead to an exploration of how care varies between the groups and the implications for personalised care.

We started by categorising cancer types into broad groups based on clusters of common experiences, needs, treatment aims and outcomes. We identified that these groups of cancer types link to the typical survival times for each cancer. This grouping of cancer types also had the advantage that information on cancer types and survival is routinely published. Once the cancer types were grouped we could use routine cancer data to describe each group in more detail. This framework will help service planners identify the types of conversations and interventions required to facilitate better planning of care and support services to meet peoples' needs.

MATERIALS AND METHODS

Data on the survival, prevalence and stage at diagnosis for common cancers in the UK were reviewed alongside clinically led assumptions to identify commonalities between different cancer types. The commonalities included similar care pathways and the likely needs and outcomes of people with

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

those cancers. Survival was used as an initial proxy for those factors as it often has an impact on the types of care and support needed. England-wide survival data was used where this was available. This was refined by clinicians reviewing the most prevalent cancers to identify the impact stage has on treatment pathways and survival. Where the differences by stage were agreed to be most significant, that cancer was considered separately by stage, for example organ confined prostate cancer and metastatic prostate cancer were considered separately. The analysis of commonalities and possible groupings lead us to a categorisation defined using cancer types, stage and survival rates.

Once the Three Cancer Groups had been defined, indicative estimates are made to quantify the size of each of the groups. We further use incidence, mortality and prevalence as well as stage at diagnosis to describe the estimated number of people in each group. Where official statistics are not available we draw on the wider literature to provide estimates, in particular for five-year survival by stage. We calculate weighted averages for survival where stage is grouped.

For the numbers of people diagnosed with cancer we sum incidence in each of the countries in the UK in 2014 to get 357,000 diagnoses.[9,10,11,12] The incidence figures are then analysed by cancer type to calculate the total number of cancers diagnosed within each group. When cancers are separated by stage at diagnosis the incidence numbers are divided using proportions derived from stage at diagnosis data. Staging data for people diagnosed in England[13] was used apart from cervical cancer, which is not currently included in the England data, so was based on people diagnosed in Northern Ireland.[12] The proportions by stage at diagnosis exclude people with an unknown stage from the denominator.

The prevalence estimates are based on work conducted by Public Health England's National Cancer Registration and Analysis Service in partnership with Macmillan Cancer Support. It showed there

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

were 1.8 million people living up to 20 years after a cancer diagnosis in the UK in 2010.[14] This work aimed to quantify and characterise the UK cancer population in detail. It used cancer registration data to identify people with a cancer diagnosis between 1991 and 2010 who were still alive at 31 December 2010. The aims and methods are described in Macmillan/NCRAS.[15] There is little historical data split by stage at diagnosis and only recent data on survival by stage. Prevalence by stage is therefore indicative estimates crudely based on stage at diagnosis, survival rates, and comparison of prevalence to cancer types with similar survival profiles. Our estimation of the total prevalence across the Three Cancer Groups is based on the first diagnosis of each specific cancer. This means the sum will double count anybody who has more than one cancer at different sites within the 20 years follow up. The level of double counting varies by cancer type for example; almost 8% of first lung cancers were in people previously diagnosed with a cancer of a different site, within the 20-year period. By contrast only 1% of first cervical cancers are in people who have had a previous cancer outside of the cervix.[16,17] The estimated total prevalence across the Three Cancer Groups includes benign and uncertain behaviour brain and central nervous system tumours. The estimate of prevalence of cancers not included in the Three Cancer Groups is the difference between the sum of prevalence of the cancers in the Three Cancer Groups and the all cancer prevalence (1.8 million, ICD-10 C00-C97 excluding C44). The all cancer combined prevalence is a person count and does not double count people so the estimate of the prevalence of cancers not included in the Three Cancer Groups may be an underestimate.

The numbers dying due to cancer is the sum of mortality counts in each of the countries in the UK in 2014; 164,000 deaths.[10,18,19] The mortality figures are then analysed by the cancer type to calculate the sum of cancer deaths within each group. Mortality data is not published in the UK by stage at diagnosis. Therefore, we crudely estimate by dividing mortality by stage at diagnosis.[12,13] This is likely to overestimate the number of deaths where the cancer was first diagnosed at an early stage as a

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

larger proportion will ultimately die of non-cancer causes compared to those diagnosed with late stage disease.

Where necessary we assume stage at diagnosis and survival by stage are comparable across UK constituent countries and use England or localised data as a proxy to calculate data by stage for the UK. See Table 1 for more details.

The analysis included 20 common cancers (excluding non-melanoma skin cancer - ICD-10 C44) which account for the majority of people living with cancer in the UK.[14] We exclude leukaemia (C91-95), head and neck (C00-14, C30-32), ill-defined, secondary and unspecified sites (C76-80) and some further rarer cancers as the highly diverse cancer care pathways and limited survival and stage data makes them difficult to stratify into the groups. These excluded cancers made up an estimated 13% of cancer incidence and 17% of mortality in 2014, and around 8% of 20-year prevalence as at the end of 2010.

Table 1 describes the measures and data sources used within the estimates to quantify our Three Cancer Groups. We acknowledge variation in the quality of some of the data sources due to availability of data and we represent this in our results. In general we have higher confidence when the survival rates are based on England-level data and lower confidence where the data are based on smaller populations or where we use a subset of a cancer as a proxy.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Table 1: Key data sources by measure, year and coverage

Measure	Time period	Year	Coverage	References
Prevalence	20-year prevalence	Up to end of 2010	UK	Macmillan/NCRAS, 2015[14]
Incidence	Annual	2014	UK	ONS, 2016[9]; ISD, 2016[10]; WCISU, 2016[11]; NICR, 2016[12]; CRUK, 2014[20]
Incidence by stage at diagnosis	Annual	2014	England and N. Ireland (cervix)	NCRAS, 2016 [13]; NICR, 2016[12]
Mortality	Annual	2014 (N Ireland 2013)	UK	ONS, 2015[18]; ISD, 2016[10]; NICR, 2016[19]
Survival all stages combined	One & five-year	Predicted for adults diagnosed in 2015	England	ONS, 2016[21]
Survival by stage	One-year	Diagnosed 2014 followed up to 2015 Diagnosed 2002-2009 (cervix)	England N Ireland	ONS, 2016[22] NICR, 2016[12]
Survival by stage	Five-year	Diagnosed 2006-2010 (renal cell kidney cancer) Diagnosed 2002-2006 (prostate, breast and uterus) Diagnosed 2002-2009 (cervix) and 2005-2009 (colorectal)	England Former Anglia Cancer Network N Ireland	NCIN, 2014[23] CRUK, 2011[24] NICR, 2016[12]

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

After defining and describing the size of each group we then presented the categorisation at one of Macmillan's Clinical Advisory Board meetings. Macmillan's Clinical Advisory Board membership comprises of over 25 multi-disciplinary professionals and senior Macmillan directors including surgeons, oncologists, palliative care consultants, Allied Health Professionals and community nurses. At the Clinical Advisory Board there was agreement that the cancers groupings were in general alignment to clinical practice, the sizes of the groups were realistic and the description of likely needs in each group reflected their clinical experiences of tailored care. The categorisation and description of the Three Cancer Groups was then presented and discussed in six workshops at a Macmillan conference of medical professionals across primary and secondary care in 2015. This was attended by 167 healthcare professionals and around 45 additional colleagues working within cancer. Macmillan GPs and GP Advisors made up the majority of healthcare professionals (136), and the remainder consisted of consultants, practice nurses, primary care nurses and people affected by cancer. The Three Cancer Groups model was presented in the workshops and discussion focused on how primary and secondary care providers can work better together to enhance the experience of people with cancer. Workshop groups were asked to identify 'take-away ideas' on how members of the medical community could better support people within each of the Three Cancer Groups. Attendees at the workshops found the Three Cancer Groups and their assumptions resonated well with clinical practice and was a useful model to help to disentangle the complexity of care.

The Three Cancer Groups model was included in the English Cancer Strategy,[5] and we discussed the model at recent cancer conferences, particularly with cancer registration and analysis colleagues (European Network of Cancer Registries 2014, National Cancer Research Initiative 2015, World Cancer Congress 2016, Cancer data and outcomes conferences 2015 and 2016). Subsequently we validated and further refined the survival data used in the categorisation of cancers and incidence, mortality, prevalence and stage at diagnosis data used in quantifying and describing the Three Cancer Groups as new data became available, in particular the stage data.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Assumptions

Every individual cancer journey is different because of a multitude of factors including co-morbidities and treatment regimens, as well as psychosocial or holistic needs and preferences. This means treatment and care should be personalised to individual needs. However, we aim to identify broad clusters of commonalities and categorise cancers into three different groups to provide high-level overviews of care and support needed for the whole cancer population. The journey of someone living with cancer will be broadly influenced by outcomes (especially survival time) and cancer type and so can be used to establish the demand for different levels of ongoing support. Here we describe our assumptions based on clinical knowledge of treatment pathways and likely outcomes for each group.

Group 1: Longer-term survival

For this group peoples' cancer is generally identified and treated successfully, typically after an acute episode of care involving surgery, radiotherapy and/or chemotherapy. The majority of this group include people who tend to live long-term – often more than a decade. Most localised breast and prostate cancer, most colorectal cancer at stage 1 and 2, and most stage 1 cervix and uterine cancers are included in this group. However, many of this group will live with physical, practical, financial or emotional consequences of cancer or its treatment.[25,26] Some people with cancers in this group could have long-term consequences of cancer or its treatment that appear many years after treatment, for example an increased risk of cardiac problems in breast cancer survivors.

Group 2: Cancer as a complex ongoing disease – Intermediate survival

Cancers in this group are often treatable but not curable from diagnosis, and they may respond well to treatment initially but then relapse, recur or spread. There are two subsets in this group, firstly those cancers where a majority of people have a treatable but not curable illness from diagnosis.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Secondly there are those who are initially diagnosed with cancers from Group 1 where people have an apparently successful initial treatment, a gap of months or years and then metastatic disease develops e.g. some cases of hormone sensitive breast or prostate cancer. People with cancers in this group are likely to live more than a year but are less likely to live more than 5 years and typically have multiple lines of treatment. Ongoing treatment or care is often required, survival is generally moderate and the acute effects and consequences of cancer and its treatment are likely to be prevalent in this group. This means that cancers in this group could be seen to be similar in behaviour and treatment requirements to a long-term condition. Myeloma, stages 2-4 uterus, cervix and kidney cancers, and metastatic breast and prostate cancer are in this group. Those who had a Group 1 cancer that developed into a Group 2 cancer cannot be easily identified in the current routine datasets.

Group 3: Shorter-term survival

For cancers in this group prognosis is typically poor with over half of people dying within a year of diagnosis. Acute cancer episodes, treatment and palliative care dominate in this group. Survival rates for these cancers are the lowest and some have seen little or no movement in recent decades. Lung, pancreas, metastatic colorectal cancer, brain and stomach cancer are in this group.

RESULTS

We review survival by cancer type using available data and allocate cancers into Three Cancer Groups based on our assumptions of treatment pathways and according to survival outcomes. Figure 1 shows the one- and five-year survival rates for cancers included in the study and by stage for those cancers identified by clinicians as having a greater influence on treatment pathways. Where possible we report unstandardised net survival from the most reliable source as noted in Table 1. Figure 1 in its legend presents an assessment of the quality of the data used for each cancer and time period, for example where data are not sourced from England or are estimated by proxy, such as from a

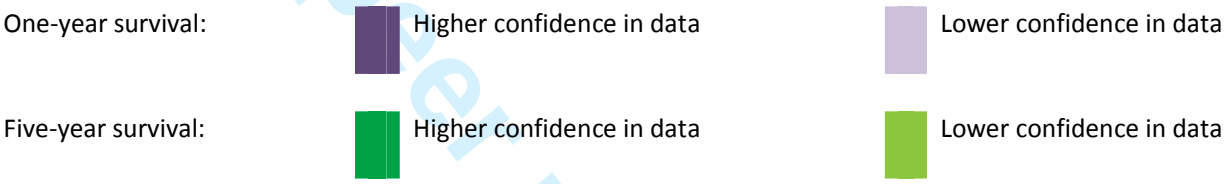
For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

subset of the cancer type for which we have less confidence in the data. It should be noted that survival rates by stage reported in Figure 1 come from multiple sources (see Table 1 for details) and so caution should be taken when making comparisons.

Figure 1: One and five-year survival rates by cancer type, stage and group, England, up to 2011-15*

INSERT Figure 1

Legend:



*Data are for England except cervix cancer by stage which is Northern Ireland data and five-year survival by stage which is regional data from the former Anglia Cancer Network or Northern Ireland data. The year of data varies with the earliest time period people were diagnosed as 2002-2006 followed up to 2011 for the five year survival by stage data and the latest as predicted survival for people diagnosed in 2015 for cancers with no stage split. See sources in Table 1 for more details.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

One-year survival is highest for Group 1 and ranges from 89% for Hodgkin's lymphoma to over 100% for early stage prostate cancer. Five-year survival is similarly high from 80% for Hodgkin's lymphoma to over 100% for early stage prostate cancer. In general the difference between one and five-year survival is smallest within Group 1 compared to other groups in line with our assumption that people with cancers in this group are most likely to survive in the long-term.

For cancers in Group 2 one-year survival rates are over 50% and range from around 66% for metastatic breast cancer to 88% for colorectal stage 3. Five-year survival is moderate for cancers in Group 2 ranging from 15% for metastatic breast cancer to 66% for non-Hodgkin lymphoma. The difference between one and five-year survival is much greater than that of Group 1 perhaps reflecting the increased complexity of cancer as an illness for people in this group. For metastatic breast and prostate cancer the difference between one and five-year survival appears to be particularly stark (over 50 percentage points). However, it should be noted that there is limited data for five-year survival by stage available.[24]

Group 3 cancers have poor survival with one-year survival ranging between 22% for pancreatic cancer and 44% for stomach cancer. Five-year survival is not more than 20% for any cancer in this group with mesothelioma lowest at just 4%, closely followed by pancreatic cancer and metastatic colorectal cancer both 6% (although not all sources are directly comparable).

The Three Cancer Groups categorised by survival rates (Figure 1) give a good indication of the distinguishing features of the groups, but key to assessing the need for population level care and support services is understanding the numbers of people stratified into each group. Figure 2 provides estimates of the number of people in each group using incidence, prevalence and mortality data.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

We estimate that the majority of people living with cancer (20-year prevalence), nearly 1.2 million (64%), have a cancer type in Group 1 'longer-term survival', but significant minorities of people have cancers in Group 2 'intermediate survival' (19%) and Group 3 'shorter-term survival' (10%) (Figure 2). Group 1 is the largest group with incidence as well as prevalence accounting for the largest proportions, as might be anticipated with most people with cancers in this group expected to survive in the longer-term. Cancer deaths in Group 1 are proportionally much lower than incidence and prevalence. In contrast Group 3, whose cancers have the poorest prognosis, had the highest proportion and number of cancer deaths and the lowest prevalence. Cancers in Group 2, although proportionally the smallest group in terms of incidence and mortality, have nearly twice the prevalence of Group 3 cancers and a significant number of people living with cancer – an estimated 342,000 - at the end of 2010.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Figure 2: Proportion of people in each of the Three Cancer Groups, estimates for the UK

INSERT Figure 2

See Table 1 for data sources. For prevalence and mortality no direct data for cancers by stage is available so some estimates rely on assumptions and simplifications.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

DISCUSSION

Cancer is made up of many different types and even between the most common cancers variation in survival outcomes is large. We believe that variation in need is likely to have a similar spread. In order to demonstrate the need for support and service configuration, establishing the demand for different levels of ongoing support in stratified groups is essential. Table 2 summarises the Three Cancer Groups in our model and notes the possible key concerns and interventions appropriate to support each group as informed by clinical input and the health professional's workshops.

Table 2: Summarising the features, needs and care requirements of the Three Cancer Groups

Group 1: Longer-term survival	Group 2: Intermediate survival	Group 3: Shorter-term survival
People with a Group 1 cancer typically have an early stage, potentially curable cancer and a prognosis of a decade or more. Most people survive in the long-term, often in relatively good health (and many live for more than a decade)	*People with a Group 2 cancer often have treatable but not curable disease, typically having multiple lines of treatment. Most people experience cancer as a complex ongoing disease similar to a long-term condition*	*People with a Group 3 cancer typically develop advanced disease and often have less than 12 months prognosis. Most people have relatively poor health*
Often face long-term consequences of their cancer and its treatment. May face recurrence even years after primary treatment	Often have a complex pathway, with multiple decision points, commonly experience relapse or recurrence	Often face short survival times, mostly incurable disease and complex, time sensitive decisions needed
Focus on recovery and long-term quality of life: · reduce unnecessary over-treatment, focus on its impact on recovery and late effects[27] · Management of co-morbidities · Recovery Package, including Stratified Pathways and self-care with support and open access[28] · periodic monitoring of heath, for example for cardio function, fatigue[29]	Care must preserve quality of life through balance of: · acute intervention · chronic illness management[30] · palliative care principals[31] · shared care between patient and clinician[28] · acknowledgement that cancer is likely to be life-limiting · recognition when move to dying phase	Balance of anti-cancer treatment and palliative care to maintain quality of life. Focus care on: · complex case management · good treatment and supportive specialist palliative care[32] · early access to palliative care[33] · early diagnosis

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

The majority of people living with cancer in this model have a Group 1 cancer, where most people will have one episode of treatment and a focus on managing the impact of treatment on recovery is key. The Recovery Package is an essential part of their care and support [5,34] including practical, financial and emotional support, for example, to get back to work or an exercise programme. Some people with a Group 1 cancer with longer-term survival may have consequences of cancer or their treatment. For example, a study of women in America diagnosed with early-stage breast carcinoma who had not had a recurrence found that at 5-10 years post diagnosis 34% experienced significant fatigue. [35] There are limited data to quantify how many people consequences may affect overall but it is estimated around a quarter of all people living with cancer could have consequences.[25] Bower recommends adult cancer survivors should be evaluated for the presence of fatigue and then offered specific information and strategies for fatigue management.[29] The treatment strategies include physical activity interventions, psychosocial interventions, and mind-body interventions. Patient reported outcome measures also highlight that people report consequences and issues which affect quality of life for years after initial diagnosis.[36] These people with later consequences may benefit from elements of care taken from the management of long-term conditions along with people with cancers in Group 2. Additionally there is a subset of people we are currently unable to quantify with a Group 1 cancer which develops and metastases months or years after initial diagnosis and so move to a Group 2 cancer.

Our model and provisional estimates suggest that around one in five people living with a cancer diagnosis have a Group 2 cancer, the intermediate survival group. These people usually have ongoing disease, and will usually have more than one treatment episode with potentially complex care requirements. The large difference between one and five-year survival for Group 2 could be interpreted as a particular concern in terms of managing care whilst maintaining quality of life at such an unpredictable phase of disease. Group 2 can be seen as having similar needs to those with a long-term condition as they typically experience multiple episodes of care and monitoring of disease

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

is required. Reed and Corner use the example of metastatic breast cancer to predict that a model of care used to manage chronic illness could lead to more appropriate use of analgesics, anti-cancer treatments and hospital visits.[30] The management of long-term conditions can include personalised treatment, care planning and supported self-management. There is an increased recognition by specialist charities of the particular needs of people with cancers in Group 2 such Breast Cancer Care[37] and the Lymphoma Association.[38]

For Group 3 many people die quickly. While there must be a focus on improving diagnoses for late stage disease, it is also essential to have the right balance between anti-cancer treatment and palliative care. In the future as immunotherapy and targeted treatments emerge some Group 3 cancers have the potential to transform into Group 2 cancers.

The Three Cancer Groups model and the focus of care required for people in each group (Table 2) can be used to guide thinking for the development of more personalised care. The characteristics of individuals and their tumours taken alongside the focus of care for each group of cancers will help guide supportive conversations with people living with cancer and facilitate identification of specific needs for personalised care and support. For example it is evident that cancer often co-exists with a wide range of other conditions or co-morbidities.[39,40] This is particularly important to take into account in the understanding of care and support required to recover after treatment especially for people with a Group 1 cancer as well as when treatment decisions are made for all Groups.

Limitations

As noted the quality of data available to report on cancers by stage is limited, although great gains have been made in recent years allowing us the confidence to report on our model here. Further data and research is needed to understand mortality, prevalence and longer-term survival by stage and to understand tumour progression[41] in order to specify the cancers and people in each group

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

more precisely. The data are also limited in that reported statistics do not identify if people have had a previous cancer diagnosis.

At this initial stage of introducing our model we have not attempted to further sub-divide for simplicity's sake. Current data and the small size of some tumour groups do not allow us to disaggregate within all tumours. As with any model not all individuals will fit perfectly into one of the groups and in reality people could move between groups. The model has also not been able to take into account serious treatment-related consequences or the implications of multiple morbidities on treatment and care. This is due to limited data and evidence to show how this could impact people in all groups. The Three Cancer Groups are also not able to consider all aspects of patient profile. Alternative questionnaire-derived segmentations of people living with cancer around psychosocial factors, patient preferences, attitudes and behaviours are likely to find people clustered around attributes such self-efficacy rather than treatment or disease characteristics (such as Foster[42]). These alternative segmentations cannot easily be done systematically on the scale of all the UK and tend to highlight different aspects of diversity in people living with cancer.

The construct of our Three Cancer Groups model is new and so there are limited further data and research to explore in more depth the commonalities and distinctions between the groups of cancers and the people within these groups. In order to ensure that care and support meets the needs of people living with cancer, further research into the links between clinical care, treatment and quality of life as well as patient-reported needs and outcomes in each of the groups would be beneficial. This along with further testing of the concepts with people living with cancer, commissioners, policy makers and clinicians in a wide range of settings will help to further validate the Three Cancer Groups.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Once the Three Cancer Groups have been further developed and validated, further work to identify and test appropriate interventions for each of the Three Cancer Groups should be carried out with a focus on measuring which elements of care have an impact on quality of life. A recent study piloting new roles to deliver supportive care for people with active and advanced cancer in Southampton shows promising results and found that more than 50% of people were supported to be able to return to independence through self-management.[39] Work in England, thanks to the recent Cancer Strategy[5], is underway to develop a quality of life metric with the intention to monitor continuous improvement in long-term quality of life for people living with cancer. We hope to use the outcomes of this work to understand the groups in more detail in the future.

Conclusion

Every person with cancer is different, and treatment and support should be personalised to individual needs. We believe personalised care is key to improving survival and quality of life and that a shared understanding of the aim of treatment is required between people living with cancer and health professionals in order to tailor care appropriately. We believe the Three Cancer Groups model provides a starting point for a broad framework and narrative that contributes towards personalising care through better decision making and application of interventions to ensure people don't miss out on the care appropriate for them and their cancer.

Stratifying cancers as we have done provides a new high-level quantitative view of potential care requirements and can help guide the thinking of planners and health professionals in order to personalise care. We aim to stimulate debate on this service challenge and shift perception from cancer as a binary life or death disease to that of the new reality, the new cancer story of three parts. Some cancers cannot be cured, some cancers keep coming back and most leave a lasting impact.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

ACKNOWLEDGEMENTS

We thank Macmillan Cancer Support and the healthcare professionals who took part in discussion and workshops on the Three Cancer Groups model. Cancer registration and mortality data owners across the UK who collected and made much of these data available. Data are collated and presented from publicly available sources published by Office for National Statistics, Public Health England's National Cancer Registration and Analysis Service, the Welsh Cancer Intelligence and Surveillance Unit (Health Intelligence and Knowledge Management Division, Public Health Wales), the Scottish Cancer Registry (Information Services Division), the Northern Ireland Cancer Registry (Public Health Agency for NI) and Cancer Research UK.

FOOTNOTES

Contributors: Jane Maher was responsible for the development of the concept of the Three Cancer Groups and led on clinical engagement. Hannah McConnell and Rachel White were responsible for collating and analysing the data from across the UK and placing the topic within the wider cancer population narrative. All authors contributed to the first draft of the manuscript and have reviewed the final version before submission. Colleagues within Macmillan Cancer Support provided review of draft papers. Further contributors provided data and clinical review are noted in the methods and acknowledgements.

Competing interests: None declared.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Data sharing statement: All data are described in Table 1. No additional data are available.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

REFERENCES

1. Quaresma M, Coleman MP and Rachet B; 40 year trends in an index of survival for all cancers combined and survival adjusted for age and sex for each cancer in England and Wales, 1971- 2011: a population-based study. *Lancet;* 2014; **385**: 1206-1218

2. Maddams J, Utley M, Møller H.; Projections of cancer prevalence in the United Kingdom, 2010-2040. *Br J Cancer*; 2012; **107**: 1195-1202, doi:10.1038/bjc.2012.366 (Projections scenario 1).

3. Macmillan Cancer Support. Cancer: Then and now. 2016 http://www.macmillan.org.uk/documents/campaigns/cancer-then-now-report-final-online.pdf

4. Smittenaar CR, Petersen KA, Stewart K, Moitt N. Cancer Incidence and Mortality Projections in the UK until 2035. *Brit J Cancer*; 2016; 115(9): 1147-1155

5. Independent Cancer Taskforce; Achieving world-class cancer outcomes: a strategy for England 2015-2020; 2015 https://www.cancerresearchuk.org/sites/default/files/achieving_world-class_cancer_outcomes_-_a_strategy_for_england_2015-2020.pdf

6. Deagle J, Richardson A, Fenlon D, Keen A; Can a case management role in the community improve cancer care? *Cancer Nursing Practice;* 2016; **18**(2): 22-27

7. Harley C, Pini S, Bartlett YK, Velikova G; Defining chronic cancer: patient experiences and self-management needs *BMJ Support. Palliat. Care*; 2012; 2: 248–255

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

8. Yip K, McConnell H, Alonzi R, Maher J; Using routinely collected data to stratify prostate cancer patients into phases of care in the UK: implications for resource allocation and cancer survivorship *Br J Cancer;* 2015; **112**: 1594–1602, doi:10.1038/bjc.2014.650

9. Office for National Statistics; Cancer Registration Statistics, England; 2016; https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/cancerregistrationstatisticscancerregistrationstatisticsengland

10. Information Services Division Scotland (ISD); Cancer incidence and mortality in Scotland by site/type of cancer, sex and year of diagnosis/registration of death: 2005-2014; 2016; http://www.isdscotland.org/Health-Topics/Cancer/Cancer-Statistics/

11. Welsh Cancer Intelligence and Surveillance Unit; Cancer Incidence: Interactive Cancer Statistics Tool; 2016; http://www.wcisu.wales.nhs.uk/dashboard-data

12. NICR (N Ireland Cancer Registry); Official Statistics: by site. Cancer incidence, prevalence and survival statistics for Northern Ireland: 1993-2014; 2016; https://www.qub.ac.uk/research-centres/nicr/CancerInformation/official-statistics/BySite/

13. NCRAS (Public Health England's National Cancer Registration and Analysis Service); TNM stage group by CCG by tumour type for 10+3 tumour types, 2014; 2016; http://www.ncin.org.uk/publications/survival_by_stage

14. Macmillan Cancer Support/NCRAS (Public Health England's National Cancer Registration and Analysis Service); Macmillan-NCIN Cancer Prevalence Project: 20-year cancer prevalence in the UK; 2015; http://www.ncin.org.uk/view?rid=2954

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

15. Macmillan Cancer Support/NCRAS (Public Health England's National Cancer Registration and Analysis Service); Macmillan-NCIN Cancer Prevalence Project: Guidance and FAQs; 2015; http://www.ncin.org.uk/view?rid=2960

16. Macmillan Cancer Support/NCRAS (Public Health England's National Cancer Registration and Analysis Service); Macmillan-NCIN Cancer Prevalence Project: Cancer Prevalence UK Summary Data Table; 2015; http://www.ncin.org.uk/view?rid=2955

17. Jones S, McConnell H, White C, Huws D, Irvine L, Miller S.; Counting 20 year cancer prevalence in the UK A new way of counting cancer prevalence to understand the prevalence of multiple primaries in the UK. In: Cancer Outcomes Conference 2015: United Against Cancer. Belfast; 2015; http://www.macmillan.org.uk/documents/aboutus/research/researchandevaluationreports/ourresearchpartners/20yearcancerprevalenceposter.pdf

18. Office for National Statistics; Deaths Registered in England and Wales: 2014; 2015; https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsregistrationsummarytables/2015-07-15

19. NICR (N Ireland Cancer Registry) Official Statistics: by site. Mortality statistics: 1993-2014; 2016; https://www.qub.ac.uk/research-centres/nicr/CancerInformation/official-statistics/BySite/

20. Cancer Research UK; Mesothelioma incidence statistics (2014 data); 2014; http://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/mesothelioma

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

21. Office for National Statistics; Cancer survival for adults in England: 2010 to 2014, followed up to 2015. Table 5; 2016; https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/cancersurvivalinenglandadultsdiagnosed/2010and2014andfollowedupto2015/relateddata

22. Office for National Statistics; One–year net cancer survival for Bladder, Breast, Colorectal, Kidney, Lung, Melanoma, Ovary, Prostate and Uterus, by stage at diagnosis; 2016; https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/oneyearnetcancersurvivalforbladderbreastcolorectalkidneylungmelanomaovaryprostateanduterusbystageatdiagnosis

23. NCIN (National Cancer Intelligence Network); Kidney cancer: survival report; 2014; http://www.ncin.org.uk/view?rid=2676

24. Cancer Research UK; Five-year relative survival by stage, adults (aged 15–99 years), Former Anglia Cancer Network, 2002–2006.; 2011 http://www.cancerresearchuk.org/health-professional/cancer-statistics/survival

25. Macmillan Cancer Support; Throwing light on cancer and the consequences of its treatment.; 2012 http://www.macmillan.org.uk/documents/aboutus/research/researchandevaluationreports/throwinglightontheconsequencesofcanceranditstreatment.pdf

26. Stein K, Syrjala K, Andrykowski M; Physical and psychological long-term and late effects of cancer. *Cancer*; 2008; **112**: 2577–2592. doi:10.1002/cncr.23448

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

27. Donovan JL, Hamdy FC, Lane JA, et al.; Patient-Reported Outcomes after Monitoring, Surgery, or Radiotherapy for Prostate Cancer. *The New England journal of medicine*.; 2016; **375**(15):1425-1437. doi:10.1056/NEJMoa1606221.

28. NCSI (National Cancer Survivorship Initiative): Department of Health, Macmillan Cancer Support and NHS Improvement; Living with & Beyond Cancer: Taking Action to Improve Outcomes; 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/181054/9333-TSO-2900664-NCSI_Report_FINAL.pdf

29. Bower J, Bak K, Berger A, et al. Screening, Assessment, and Management of Fatigue in Adult Survivors of Cancer: An American Society of Clinical Oncology Clinical Practice Guideline Adaptation. *Journal of Clinical Oncology;* 2014; **32**:17, 1840-1850

30. Reed E and Corner J; Defining the illness trajectory of metastatic breast cancer. *BMJ Support Palliative Care;* 2013; **0**: 1–8, doi:10.1136/bmjspcare-2012-000415

31. Park E, Rosenstein; Living with advanced cancer: unmet survivorship needs. North Carolina Medical Journal; 2014; 75(4), 279-282

32. Department of Health; What's important to me. A Review of Choice in End of Life Care; 2015; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407244/CHOICE_REVIEW_FINAL_for_web.pdf

33. Jennifer S. Temel, M.D., Joseph A. Greer, Ph.D., Alona Muzikansky, M.A., et al. Early Palliative Care for Patients with Metastatic Non–Small-Cell Lung Cancer;

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

N Engl J Med; 2010; 363:733-742; DOI: 10.1056/NEJMoa1000678

34. NHS England; Five Year Forward View; 2014; https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf

35. Bower J, Ganz P, Desmond K, et al.; Fatigue in long-term breast carcinoma survivors. *Cancer*, 2006; **106**: 751–758. doi:10.1002/cncr.21671

36. NHS England; Quality of Life of Colorectal Cancer Survivors in England; 2015; https://www.england.nhs.uk/wp-content/uploads/2015/03/colorectal-cancer-proms-report-140314.pdf

37. Breast Cancer Care. Secondary. Not second rate. Secondary breast cancer Part three: support and impact; 2017; https://www.breastcancercare.org.uk/sites/default/files/sbc_report_3_2017_final.pdf

38. Lymphoma Association. Understanding lymphoma as a cancer Patients' experiences of lymphoma diagnosis, treatment and aftercare Lymphoma Association survey 2016; 2017 https://www.lymphomas.org.uk/sites/default/files/pdfs/Understanding%20lymphoma%20as%20a%20cancer_Lymphoma%20Association%20FINAL%20REPORT.pdf

39. Macmillan Cancer Support; The burden of cancer and other long-term health conditions; 2015 http://www.macmillan.org.uk/documents/press/cancerandotherlong-termconditions.pdf

40. Nord C, Mykletun A, Thorsen L, Bjøro T,Fosså S; Self-reported health and use of health care services in long-term cancer survivors. *Int. J. Cancer*; 2005; **114**: 307–316. doi:10.1002/ijc.20713

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

41. Breast Cancer Care.2016. Secondary. Not second rate. Secondary breast cancer Part two: Who's counting? https://www.breastcancercare.org.uk/sites/default/files/secondary-breast-cancer-report-2.pdf

42. Foster C, Haviland J, Winter J, et al.; Pre-Surgery Depression and Confidence to Manage Problems Predict Recovery Trajectories of Health and Wellbeing in the First Two Years following Colorectal Cancer: Results from the CREW Cohort Study. Souglakos J, ed. *PLoS ONE*.; 2016; **11**(5):e0155434. doi:10.1371/journal.pone.0155434.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

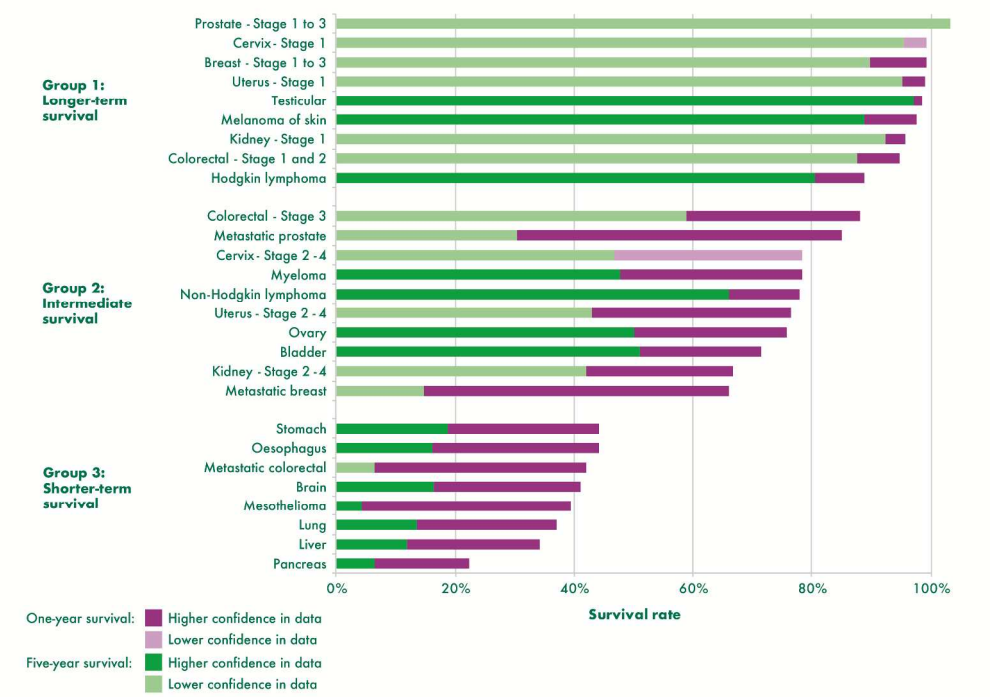


Figure 1: One and five-year survival rates by cancer type, stage and group, England, up to 2011-15* *Data are for England except cervix cancer by stage which is Northern Ireland data and five-year survival by stage which is regional data from the former Anglia Cancer Network or Northern Ireland data. The year of data varies with the earliest time period people were diagnosed as 2002-2006 followed up to 2011 for the five year survival by stage data and the latest as predicted survival for people diagnosed in 2015 for cancers with no stage split. See sources in Table 1 for more details.

297x210mm (300 x 300 DPI)

For peer review only

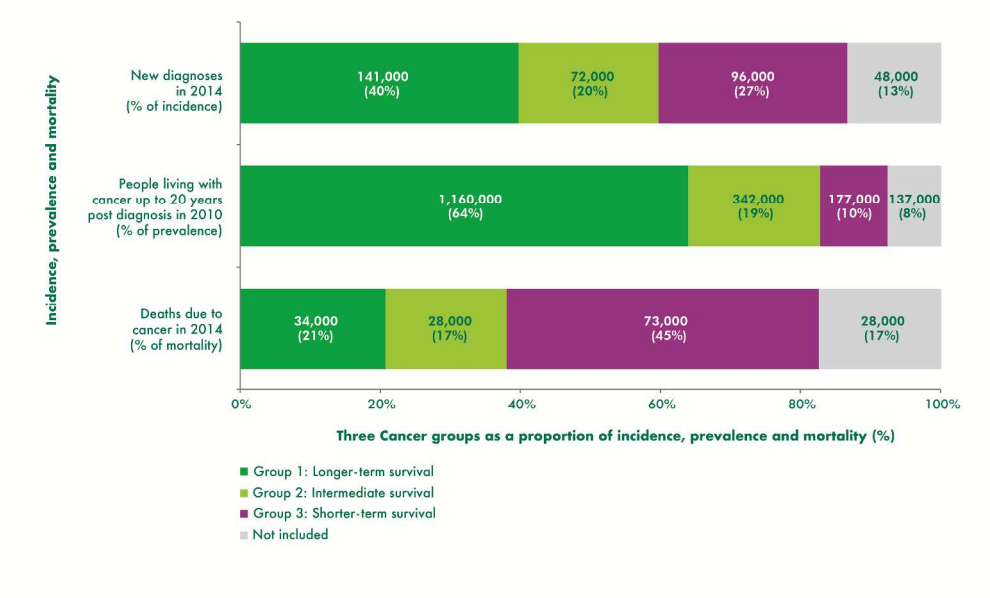


Figure 2: Proportion of people in each of the Three Cancer Groups, estimates for the UK See Table 1 for data sources. For prevalence and mortality no direct data for cancers by stage is available so some estimates rely on assumptions and simplifications.

297x210mm (300 x 300 DPI)

ew only

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	*(*a) Indicate the study's design with a commonly used term in the title or the abstract Title (page 1): Assigning cancers into three groups and analysing cancer registration data in the UK to enable tailored care planning. The main aspects of the design are a process of assigning and classification followed by a statistical description using secondary analysis.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Page 2 contains the abstract which explains what was done and found.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported In the introduction (page 4), we demonstrate that cancer has changed and the way cancer is perceived also needs to change to consider the diversity in the cancer population. To conceptualise this diversity and provide a numerical framework for understanding the cancer population we created the Three Cancer Groups.
Objectives	3	State specific objectives, including any prespecified hypotheses The aims are on page 6. The aim of this study is to categorise cancers into broad groups based on clusters of common treatment aims, experiences and outcomes. These groups should be defined in a way that creates a numerical framework that allows researchers to estimate the size of each group in different populations using routine data sets. We use this framework to describe the size and characteristics of the Three Cancer Groups. Finally, we aimed to explore how care varies between the groups and the implications for personalised care. We hypothesised that it is possible and useful for policy makers and service planners to use routine data to group cancers. We also hypothesised that considerable numbers of cancer patients would be in each Cancer Group so that services would be needed for each.
Methods		
Study design	4	Present key elements of study design early in the paper We defined the Three Cancer Groups by review and then statistically described the groups using secondary analysis of incidence, prevalence, mortality, survival and stage at diagnosis data (pages 7-9). This data was in most cases published by the Information Services Division Scotland which is part of NHS National Services Scotland, Public Health England's National Cancer Registration and Analysis Service,

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		the Office for National Statistics, Welsh Cancer Intelligence and Surveillance Unit and the Northern Ireland Cancer Registry. These bodies in general support public health across the UK and provide health intelligence and statistical services to help inform decision making about health services. The specific secondary analysis we conducted is not part of the standard use for these data sets but it is generally aligned to the aims of the data sets.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection The data used is described in Table 1 (page 10). This gives the year the data refers to, for example, the incidence data described cancers diagnosed in 2014. The table also gives the geographies, for example, mortality data covers all 4 nations in the UK. We use registration data, so in the geography column we are referring to all cancer patients diagnosed (or for mortality, dying) in that nation or region. Follow up time is described in the time period column in Table 1. For example, 5 year survival has 5 years real or modelled follow up.
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants The analysis included 20 common cancers (excluding non-melanoma skin cancer - ICD-10 C44) as displayed in Figure 1 (page 14). We exclude leukaemia (C91-95), head and neck (C00-14, C30-32), ill-defined, secondary and unspecified sites (C76-80) and some further rarer cancers (see page 9). The data covered patients living in the UK. The data was obtained though the bodies detailed in Table 1 (page 10).
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable The approach to define the Three Cancer Groups used mainly survival data and cancer type to allocate the groups. In some cases, this was divided additionally by cancer stage (see page 7). Statistical testing was not part of the study so there were no formal statistical

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		predictors or confounders. The limitations section (page 21) describes factors such as co-morbidities, patient profile and holistic needs which will impact the care requirement and experiences of patients within each of the Three Cancer Groups.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group A key variable was survival. As described in Table 1 (page 10) this is mainly statistics provided by the Office for National Statistics. The un-standardised survival rates are the predicted estimates of one-year, five-year net survival for adults (aged 15 to 99 years) that would be diagnosed in 2015 in England. Where survival is divided by stage it is mainly one–year net cancer survival for adults (aged 15 to 99 years), in England, in 2014 and followed up to 2015. Other sources are described and referenced in Table 1.
Bias	9	Describe any efforts to address potential sources of bias This is described in the limitations section (page 20). There is limited data available and so approximations and assumptions have been used to create estimates. The findings are presented as estimates and we appreciate that as more data becomes available the information can be refined. The main limitation is the lack of information about cancer stage at times other than diagnosis. This means there is likely to a high level of uncertainty in the estimate of the stage of long term survivors and a bias in the mortality figures (page 8)
Study size	10	Explain how the study size was arrived at Macmillan Cancer Support aims to reach and improve the lives of everyone living with cancer across the UK so we used UK wide data when this was available. The UK population also has the advantage that it is large enough that the cancer population is reasonably stable over time. The UK also has high quality registries covering all cancer patients in each country in the UK. As described in the materials and methods (page 9), when UK wide data was not available we used data on smaller populations such as England, Northern Ireland and Former Anglia Cancer Network.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why N/A
Statistical methods	12	*(*a) Describe all statistical methods, including those used to control for confounding The main method was aggregation of incidence, prevalence and mortality numbers across the UK and across cancer types. Additional assumptions and calculations were used to estimate group sizes by stage at diagnosis based on available data as described in the materials and methods section (page 7-8).

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

(*b*) Describe any methods used to examine subgroups and interactions

N/A

(*c*) Explain how missing data were addressed

We made simplifying assumptions, for example, cancer mortality is not available by stage at diagnosis so we assumed the same distribution as in stage at diagnosis (page 8). These simplifying assumptions are unlikely to be a fully robust reflection of reality, but we believe they are robust enough to draw conclusions about the general relative size of each of the Three Cancer Groups.

(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed
Case-control study—If applicable, explain how matching of cases and controls was addressed
Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy

N/A

(*e*) Describe any sensitivity analyses

N/A

Continued on next page

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed The study target population is people in the UK with one of 20 common cancers; an estimated 309,000 people diagnosed in 2014, 1,679,000 people diagnosed in a 20 year period and still living in 2010 and 135,000 who died due to cancer in 2014. These patients were described using published data so did not participate directly in the study.
		(b) Give reasons for non-participation at each stage N/A
		(c) Consider use of a flow diagram N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders The analysis covers cancer patients in the UK. The demographics of the cancer population are described by Information Services Division Scotland which is part of NHS National Services Scotland, Public Health England's National Cancer Registration and Analysis Service, the Office for National Statistics, Welsh Cancer Intelligence and Surveillance Unit and the Northern Ireland Cancer Registry.
		(b) Indicate number of participants with missing data for each variable of interest The cancer registries and death registrations include information on most cancer diagnoses and deaths across the UK. For details of the performance of the registry see http://www.ukiacr.org/kpis. The variable with the most missing data was stage at diagnosis. The numbers of missing cases are described in NCRAS (Public Health England's National Cancer Registration and Analysis Service); TNM stage group by CCG by tumour type for 10+3 tumour types, 2014; 2016. For example, for breast cancer 11% had unknown stage at diagnosis.
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) The one- and five-year survival for all cancers combined is based on follow up to 2015. To create predicted survival for diagnoses in 2015, a hybrid of the complete and period approaches is used (See Office for National Statistics; Cancer survival for adults in England: 2010 to 2014, followed up to 2015. Table 5; 2016). One year survival by stage is based on 2014 diagnosis followed up to 2015. 5-year survival by stage is based on a mixture of cohorts as described in table 1 on page 10.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		Prevalence in 2010 is based on diagnosis between 1991-2010 in England, Wales and Scotland and 1993-2010 in Northern Ireland (http://www.ncin.org.uk/view?rid=2960).
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure N/A
		Cross-sectional study—Report numbers of outcome events or summary measures N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included The results are the classification of cancers into each group (see Figure 1, page 14). We have highlighted in colour in Figure 1 where there is lower confidence in data. There is no formal measure of the precision of the classification; however, the classification was reported to and resonated well with clinical practice (page 11). As described the framework is a generalisation so it is appreciated that the generalisation will not fit all circumstances. Further results are shown in Figure 2 (page 17). It is not possible to conduct a formal measure of the precision but we do recognise the high level of uncertainty surrounding these estimates.
		(*b*) Report category boundaries when continuous variables were categorized N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses N/A
Discussion		
Key results	18	Summarise key results with reference to study objectives We aimed to identify a method to classify cancers into groups with similar needs and describe the size and characteristics of the groups. We found that 64% of people living with cancer have a Group 1 longer-term survival cancer, where most people will have one episode of treatment and a focus on managing the impact of treatment on recovery is key (page 19). We estimated that around one in five people living with a cancer diagnosis have a Group 2 cancer, the intermediate survival group. These people usually have ongoing disease, and will usually have more than one treatment episode with potentially complex care requirements (page 19-20). We also identified and estimated that 10% of people living with cancer are in the shorter-term survival Group 3. For these people there should be a focus and managing a balance of

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		anti-cancer treatment and palliative care (page 20).
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias See the limitations section (pages 21). We appreciate that incomplete data that will lead to imprecision in our estimates. The Three Cancer Groups are also not able to consider all aspects of holistic needs and patient profile. We aim to develop this understanding and further refine though further research into the links between clinical care, treatment and quality of life and further testing of the concepts with people living with cancer, commissioners, policy makers and clinicians.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence We conclude on page 22 that the Three Cancer Groups model provides a starting point for a broad framework and narrative that contributes towards personalising care through better decision making and application of interventions to ensure people don't miss out on the care appropriate for them and their cancer. This is a cautious conclusion as it appreciates the need for further refinement. We have also clearly set out the limitations (pages 20-22) in terms of both data and conclusions about the cancer population. We present in Table 2 (page 18) evidence from other studies on individual aspect of care that have been recommended for people living with cancer that we are able to apply to each of the Three Cancer Groups.
Generalisability	21	Discuss the generalisability (external validity) of the study results We have used population level data so believe our findings cover the picture for the majority of people living in each of the Three Cancer Groups, as shown in Table 1 (page 10). However, we appreciate there are exceptions to the generalisations such as those in the longer-term survival group who live with severe consequences of their cancer or its treatment and so may need some of the aspects of care for Group 2 cancers (page 19).
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors (page 23).

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

Categorising cancers to enable tailored care planning through a secondary analysis of cancer registration data in the UK

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-016797.R2
Article Type:	Research
Date Submitted by the Author:	30-Aug-2017
Complete List of Authors:	McConnell, Hannah; Macmillan Cancer Support, Evidence Department White, Rachel; Macmillan Cancer Support, Evidence Department Maher, J; Macmillan Cancer Support; Mount Vernon Cancer Centre
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research
Keywords:	cancer, survivorship, personalised-care, quality of life, survival, cancer services

SCHOLARONE™
Manuscripts

For peer review only

Title: Categorising cancers to enable tailored care planning through a secondary analysis of cancer registration data in the UK

Authors:

McConnell H[1], White R[2], Maher J[2, 3]

[1] Consultant c/o Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

[2] Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

[3] Mount Vernon Cancer Centre, Rickmansworth Road, Northwood, London HA6 2RN, UK.

Correspondence:

Rachel White

Macmillan Cancer Support, 89 Albert Embankment, London SE1 7UQ, UK.

Telephone: 0207 091 2002

E-mail: rwhite@macmillan.org.uk

Word count 4802 (excluding the abstract, tables, figures, acknowledgments and notes)

For peer review only

ABSTRACT

Objectives: The aim of this study is to categorise cancers into broad groups based on clusters of common treatment aims, experiences and outcomes to provide a numerical framework for understanding services required to meet the needs of people with different cancers. This framework will enable a high-level overview of care and support requirements for the whole cancer population.

Setting and Participants: People in the UK with one of 20 common cancers; an estimated 309,000 diagnoses in 2014, 1,679,000 people diagnosed in a 20 year period and still living in 2010 and 135,000 cancer deaths in 2014.

Primary and secondary outcome measures: Survival and stage at diagnosis data were reviewed alongside clinically led assumptions to identify commonalities and cluster cancer types into three groups. The Three Cancer Groups were then described using incidence, prevalence and mortality data collected and reported by UK cancer registries. This was then reviewed, validated and refined following consultation.

Results: Group 1 includes cancers with the highest survival; five-year survival is over 80%. Group 3 cancers have shorter-term survival. Five-year survival is not more than 20% for any cancer in this group and many do not survive over a year. Group 2 includes cancers where people typically live more than a year but are less likely to live more than 5 years. We estimate that the majority (64%) of people living with cancer (20-year prevalence) have a cancer type in Group 1 'longer-term survival', but significant minorities of people have cancers in Group 2 'intermediate survival' (19%) and Group 3 'shorter-term survival' (10%).

Conclusions: Every person with cancer has unique needs shaped by a multitude of factors including co-morbidities, treatment regimens, patient preferences, needs, attitudes and behaviours. However,

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

to deliver personalised care there needs to be a high-level view of potential care requirements to support service planning.

Keywords

Cancer, survivorship, personalised-care, survival, quality of life, cancer services (6 max)

Strengths and Limitations of this study

- The Three Cancer Groups model provides a narrative that highlights the full spectrum of cancer journeys. This contributes towards planning for interventions as it ensures that sections of the cancer population are not forgotten. It also draws attention to the broad needs of each distinct section of the cancer population and their associated care requirements.
- The model has already influenced policy decisions as it is included in the English Cancer Strategy.
- Our estimates of the proportion of people diagnosed with cancer in each group will stimulate future work to collect related quantitative data and be used to plan future services to meet the needs of these people.
- The study used routinely available, nationwide, population-based data to stratify cancers into groups. This makes it repeatable and open to further analysis by commissioners, policy makers and researchers.
- The identified groups resonate well with clinical practice.
- There are limited data on historical stage at diagnosis, cancer progression or serious treatment-related consequences for people living with cancer. This lack of data is a barrier to tailoring our categorisations more precisely or providing more accurate quantification.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

However the data available does give a strong impression of the variation in illness trajectories.

- We are not able to include data on treatment regimens, patient preferences, needs, attitudes and behaviours in the description of the groups as this information is not routinely collected and linked to cancer registration data.
- Due to the complexity and diversity of some cancer pathways and the small number of people diagnosed and living with some cancers not all cancers have been included in our stratification.

INTRODUCTION

Recent research highlighted that people were twice as likely to survive at least 10 years after a cancer diagnosis in 2011 than they were in the early 1970s.[1] Given improved diagnoses and detection, a growing and ageing population, along with improvements in treatment and survival, it is estimated that 4 million people will have had and be living with a cancer diagnosis in the UK by 2030.[2]

Over the decades since 1970 the implications of what a cancer diagnosis means has also changed. In the 1970s cancer was often a taboo subject and associated with end of life and terminal illness.[3] Today, although many people still do die from their cancer, death rates have been declining since the 1990s and are predicted to continue this downward trend[4] as survival improves. With this improved survival the focus today is increasingly turning to how people survive after cancer, that is, their quality of life and their ability to live well. This changed focus is recognised in the recent cancer strategies and plans from the nations of the UK which include a foci on quality and experience. Recognising the importance of life after cancer diagnosis and treatment, 'A strategy for England 2015-2020' noted:

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

We need to support people with cancer to return to as good a quality of life as possible after active treatment has ended, or support them to achieve their personal goals if they will be living with either primary or secondary cancer for some time. [5]

The perception of cancer as a death sentence remains amongst many, particularly in the public mind, because some cancers have seen little improvement in survival rates since the 1970s. On the other hand the idea that cancer can be eliminated with life going back to normal is also flawed. The experience of cancer is not binary: its outcome is not merely cure or death. The story of cancer now includes effects and consequences and in some cases the return of or a new cancer which makes for much more complex personal journeys and experiences. Therefore, we need a new simple way to describe this complexity.

What hasn't changed since the 1970s is the fact that cancer is not one disease but is made up of many different types of cancer and, along with the hundreds of thousands of people diagnosed with cancer each year, each cancer is different, behaves differently, warrants different treatment and has different outcomes. Cancer research, genetics and treatment have all developed and there is an increasing move towards personalised medicine. Here we aim to consider cancer in the context of care and support. It is impractical to plan at a population level the care and support requirements for every cancer type and journey individually. We must find ways of identifying people with similar needs and use this to guide our thinking about the interventions and conversations required to move towards more personalised care. For example, Deagle *et al* review the success of new roles piloted in Southampton to support people with active or advanced disease.[6] Harley *et al* focused on the chronic cancer disease phase. They identified that care planning at the point of transition to chronic cancer should focus on evaluating symptoms and need for psychological, social, and economic support, and regular re-evaluation.[7]

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

In the face of all this complexity, for most monitoring and planning we only have routine cancer incidence, mortality, survival and prevalence data at a whole-population level. This does not in its current form describe the complexity in quality of life and needs. Previous work has aimed to draw out some of the complexity using routine cancer data by dividing cancer survivors into needs-based segments with respect to their transitions into different phases of care.[8] This identified patterns for different cancer types.

The aim of the current study is to identify a method to classify cancer types into groups that are associated with similar treatment aims, experiences and outcomes. The method needs to provide a numerical framework that allows researchers to estimate the size of each group in different populations. The aim is then to describe the size and characteristics of the Three Cancer Groups. Finally, this will lead to an exploration of how care varies between the groups and the implications for personalised care.

We started by categorising cancer types into broad groups based on clusters of common experiences, needs, treatment aims and outcomes. We identified that these groups of cancer types link to the typical survival times for each cancer. This grouping of cancer types also had the advantage that information on cancer types and survival is routinely published. Once the cancer types were grouped we could use routine cancer data to describe each group in more detail. This framework will help service planners identify the types of conversations and interventions required to facilitate better planning of care and support services to meet peoples' needs.

MATERIALS AND METHODS

Data on the survival, prevalence and stage at diagnosis for common cancers in the UK were reviewed alongside clinically led assumptions to identify commonalities between different cancer types. The commonalities included similar care pathways and the likely needs and outcomes of people with

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

those cancers. Survival was used as an initial proxy for those factors as it often has an impact on the types of care and support needed. England-wide survival data was used where this was available. This was refined by clinicians reviewing the most prevalent cancers to identify the impact stage has on treatment pathways and survival. Where the differences by stage were agreed to be most significant, that cancer was considered separately by stage, for example organ confined prostate cancer and metastatic prostate cancer were considered separately. The analysis of commonalities and possible groupings lead us to a categorisation defined using cancer types, stage and survival rates.

Once the Three Cancer Groups had been defined, indicative estimates are made to quantify the size of each of the groups. We further use incidence, mortality and prevalence as well as stage at diagnosis to describe the estimated number of people in each group. Where official statistics are not available we draw on the wider literature to provide estimates, in particular for five-year survival by stage. We calculate weighted averages for survival where stage is grouped.

For the numbers of people diagnosed with cancer we sum incidence in each of the countries in the UK in 2014 to get 357,000 diagnoses.[9,10,11,12] The incidence figures are then analysed by cancer type to calculate the total number of cancers diagnosed within each group. When cancers are separated by stage at diagnosis the incidence numbers are divided using proportions derived from stage at diagnosis data. Staging data for people diagnosed in England[13] was used apart from cervical cancer, which is not currently included in the England data, so was based on people diagnosed in Northern Ireland.[12] The proportions by stage at diagnosis exclude people with an unknown stage from the denominator.

The prevalence estimates are based on work conducted by Public Health England's National Cancer Registration and Analysis Service in partnership with Macmillan Cancer Support. It showed there

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

were 1.8 million people living up to 20 years after a cancer diagnosis in the UK in 2010.[14] This work aimed to quantify and characterise the UK cancer population in detail. It used cancer registration data to identify people with a cancer diagnosis between 1991 and 2010 who were still alive on the 31st December 2010. The aims and methods are described in Macmillan/NCRAS.[15] There is little historical data split by stage at diagnosis and only recent data on survival by stage. Prevalence by stage is therefore crudely estimated based on stage at diagnosis proportions, survival rates, and a comparison of prevalence to cancer types with similar survival profiles. Our estimation of the total prevalence across the Three Cancer Groups is based on the first diagnosis of each specific cancer. This means the sum will double count anybody who has more than one cancer at different sites within the 20 years follow up. The level of double counting varies by cancer type for example; almost 8% of first lung cancers were in people previously diagnosed with a cancer of a different site, within the 20-year period. By contrast only 1% of first cervical cancers are in people who have had a previous cancer outside of the cervix.[16,17] The estimated total prevalence of the shorter-term survival group includes benign and uncertain behaviour brain and central nervous system tumours. The estimate of prevalence of cancers not included in the Three Cancer Groups is the difference between the sum of prevalence of the cancers in the Three Cancer Groups and the all cancer prevalence (1.8 million, ICD-10 C00-C97 excluding C44). The all cancer combined prevalence is a person count and does not double count people so the estimate of the prevalence of cancers not included in the Three Cancer Groups may be an underestimate.

The numbers dying due to cancer is the sum of mortality counts in each of the countries in the UK in 2014; 164,000 deaths.[10,18,19] The mortality figures are then analysed by the cancer type to calculate the sum of cancer deaths within each group. Mortality data is not published in the UK by stage at diagnosis. Therefore, we crudely estimate by dividing mortality by stage at diagnosis.[12,13] This is likely to overestimate the number of deaths where the cancer was first diagnosed at an early stage as a

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

larger proportion will ultimately die of non-cancer causes compared to those diagnosed with late stage disease.

Where necessary we assume stage at diagnosis and survival by stage are comparable across UK constituent countries and use England or localised data as a proxy to calculate data by stage for the UK. See Table 1 for more details.

The analysis included 20 common cancers (excluding non-melanoma skin cancer - ICD-10 C44) which account for the majority of people living with cancer in the UK.[14] We exclude leukaemia (C91-95), head and neck (C00-14, C30-32), ill-defined, secondary and unspecified sites (C76-80) and some rarer cancers as the highly diverse cancer care pathways and limited survival and stage data makes them difficult to stratify into the groups. These excluded cancers made up an estimated 13% of cancer incidence and 17% of mortality in 2014, and around 8% of 20-year prevalence as at the end of 2010.

Table 1 describes the measures and data sources used within the estimates to quantify our Three Cancer Groups. We acknowledge variation in the quality of some of the data sources due to availability of data and we represent this in our results. In general we have higher confidence when the survival rates are based on England-level data and lower confidence where the data are based on smaller populations or where we use a subset of a cancer as a proxy.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Table 1: Key data sources by measure, year and coverage

Measure	Time period	Year	Coverage	References
Prevalence	20-year prevalence	Up to end of 2010	UK	Macmillan/NCRAS, 2015[14]
Incidence	Annual	2014	UK	ONS, 2016[9]; ISD, 2016[10]; WCISU, 2016[11]; NICR, 2016[12]; CRUK, 2014[20]
Incidence by stage at diagnosis	Annual	2014	England and N. Ireland (cervix)	NCRAS, 2016 [13]; NICR, 2016[12]
Mortality	Annual	2014 (N Ireland 2013)	UK	ONS, 2015[18]; ISD, 2016[10]; NICR, 2016[19]
Survival all stages combined	One & five-year	Predicted for adults diagnosed in 2015	England	ONS, 2016[21]
Survival by stage	One-year	Diagnosed 2014 followed up to 2015 Diagnosed 2002-2009 (cervix)	England N Ireland	ONS, 2016[22] NICR, 2016[12]
Survival by stage	Five-year	Diagnosed 2006-2010 (renal cell kidney cancer) Diagnosed 2002-2006 (prostate, breast and uterus) Diagnosed 2002-2009 (cervix) and 2005-2009 (colorectal)	England Former Anglia Cancer Network N Ireland	NCIN, 2014[23] CRUK, 2011[24] NICR, 2016[12]

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

After defining and describing the size of each group we then presented the categorisation at one of Macmillan's Clinical Advisory Board meetings. Macmillan's Clinical Advisory Board membership comprises of over 25 multi-disciplinary professionals and senior Macmillan directors including surgeons, oncologists, palliative care consultants, Allied Health Professionals and community nurses. At the Clinical Advisory Board there was agreement that the cancers groupings were in general alignment to clinical practice, the sizes of the groups were realistic and the description of likely needs in each group reflected their clinical experiences of tailored care. The categorisation and description of the Three Cancer Groups was then presented and discussed in six workshops at a Macmillan conference of medical professionals across primary and secondary care in 2015. This was attended by 167 healthcare professionals and around 45 additional colleagues working within cancer. Macmillan GPs and GP Advisors made up the majority of healthcare professionals (136), and the remainder consisted of consultants, practice nurses, primary care nurses and people affected by cancer. The Three Cancer Groups model was presented in the workshops and discussion focused on how primary and secondary care providers can work better together to enhance the experience of people with cancer. Workshop groups were asked to identify 'take-away ideas' on how members of the medical community could better support people within each of the Three Cancer Groups. Attendees at the workshops found the Three Cancer Groups and their assumptions resonated well with clinical practice and was a useful model to help to disentangle the complexity of care.

The Three Cancer Groups model was included in the English Cancer Strategy,[5] and we discussed the model at recent cancer conferences, particularly with cancer registration and analysis colleagues (European Network of Cancer Registries 2014, National Cancer Research Initiative 2015, World Cancer Congress 2016, Cancer data and outcomes conferences 2015 and 2016). Subsequently we validated and further refined the survival data used in the categorisation of cancers and incidence, mortality, prevalence and stage at diagnosis data used in quantifying and describing the Three Cancer Groups as new data became available, in particular the stage data.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Assumptions

Every individual cancer journey is different because of a multitude of factors including co-morbidities and treatment regimens, as well as psychosocial or holistic needs and preferences. This means treatment and care should be personalised to individual needs. However, we aim to identify broad clusters of commonalities and categorise cancers into three different groups to provide high-level overviews of care and support needed for the whole cancer population. The journey of someone living with cancer will be broadly influenced by outcomes (especially survival time) and cancer type and so can be used to establish the demand for different levels of ongoing support. Here we describe our assumptions based on clinical knowledge of treatment pathways and likely outcomes for each group.

Group 1: Longer-term survival

For this group peoples' cancer is generally identified and treated successfully, typically after an acute episode of care involving surgery, radiotherapy and/or chemotherapy. The majority of this group include people who tend to live long-term – often more than a decade. Most localised breast and prostate cancer, most colorectal cancer at stage 1 and 2, and most stage 1 cervix and uterine cancers are included in this group. However, many of this group will live with physical, practical, financial or emotional consequences of cancer or its treatment.[25,26] Some people with cancers in this group could have long-term consequences of cancer or its treatment that appear many years after treatment, for example an increased risk of cardiac problems in breast cancer survivors.

Group 2: Cancer as a complex ongoing disease – Intermediate survival

Cancers in this group are often treatable but not curable from diagnosis, and they may respond well to treatment initially but then relapse, recur or spread. There are two subsets in this group, firstly those cancers where a majority of people have a treatable but not curable illness from diagnosis.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Secondly there are those who are initially diagnosed with cancers from Group 1 where people have an apparently successful initial treatment, a gap of months or years and then metastatic disease develops e.g. some cases of hormone sensitive breast or prostate cancer. People with cancers in this group are likely to live more than a year but are less likely to live more than 5 years and typically have multiple lines of treatment. Ongoing treatment or care is often required, survival is generally moderate and the acute effects and consequences of cancer and its treatment are likely to be prevalent in this group. This means that cancers in this group could be seen to be similar in behaviour and treatment requirements to a long-term condition. Myeloma, stages 2-4 uterus, cervix and kidney cancers, and metastatic breast and prostate cancer are in this group. Those who had a Group 1 cancer that developed into a Group 2 cancer cannot be easily identified in the current routine datasets.

Group 3: Shorter-term survival

For cancers in this group prognosis is typically poor with over half of people dying within a year of diagnosis. Acute cancer episodes, treatment and palliative care dominate in this group. Survival rates for these cancers are the lowest and some have seen little or no movement in recent decades. Lung, pancreas, metastatic colorectal cancer, brain and stomach cancer are in this group.

RESULTS

We review survival by cancer type using available data and allocate cancers into Three Cancer Groups based on our assumptions of treatment pathways and according to survival outcomes. Figure 1 shows the one- and five-year survival rates for cancers included in the study and by stage for those cancers identified by clinicians as having a greater influence on treatment pathways. Where possible we report unstandardised net survival from the most reliable source as noted in Table 1. Figure 1 in its legend presents an assessment of the quality of the data used for each cancer and time period, for example where data are not sourced from England or are estimated by proxy, such as from a

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

subset of the cancer type for which we have less confidence in the data. It should be noted that survival rates by stage reported in Figure 1 come from multiple sources (see Table 1 for details) and so caution should be taken when making comparisons.

Figure 1: One and five-year survival rates by cancer type, stage and group, England, up to 2011-15*

INSERT Figure 1

*Data are for England except cervix cancer by stage which is Northern Ireland data and five-year survival by stage which is regional data from the former Anglia Cancer Network or Northern Ireland data. The year of data varies with the earliest time period people were diagnosed as 2002-2006 followed up to 2011 for the five year survival by stage data and the latest as predicted survival for people diagnosed in 2015 for cancers with no stage split. See sources in Table 1 for more details.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

One-year survival is highest for Group 1 and ranges from 89% for Hodgkin's lymphoma to over 100% for early stage prostate cancer. Five-year survival is similarly high from 80% for Hodgkin's lymphoma to over 100% for early stage prostate cancer. In general the difference between one and five-year survival is smallest within Group 1 compared to other groups in line with our assumption that people with cancers in this group are most likely to survive in the long-term.

For cancers in Group 2 one-year survival rates are over 50% and range from around 66% for metastatic breast cancer to 88% for colorectal stage 3. Five-year survival is moderate for cancers in Group 2 ranging from 15% for metastatic breast cancer to 66% for non-Hodgkin lymphoma. The difference between one and five-year survival is much greater than that of Group 1 perhaps reflecting the increased complexity of cancer as an illness for people in this group. For metastatic breast and prostate cancer the difference between one and five-year survival appears to be particularly stark (over 50 percentage points). However, it should be noted that there is limited data for five-year survival by stage available.[24]

Group 3 cancers have poor survival with one-year survival ranging between 22% for pancreatic cancer and 44% for stomach cancer. Five-year survival is not more than 20% for any cancer in this group with mesothelioma lowest at just 4%, closely followed by pancreatic cancer and metastatic colorectal cancer both 6% (although not all sources are directly comparable).

The Three Cancer Groups categorised by survival rates (Figure 1) give a good indication of the distinguishing features of the groups, but key to assessing the need for population level care and support services is understanding the numbers of people stratified into each group. Figure 2 provides estimates of the number of people in each group using incidence, prevalence and mortality data.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

We estimate that the majority of people living with cancer (20-year prevalence), nearly 1.2 million (64%), have a cancer type in Group 1 'longer-term survival', but significant minorities of people have cancers in Group 2 'intermediate survival' (19%) and Group 3 'shorter-term survival' (10%) (Figure 2). Group 1 is the largest group with incidence as well as prevalence accounting for the largest proportions, as might be anticipated with most people with cancers in this group expected to survive in the longer-term. Cancer deaths in Group 1 are proportionally much lower than incidence and prevalence. In contrast Group 3, whose cancers have the poorest prognosis, had the highest proportion and number of cancer deaths and the lowest prevalence. Cancers in Group 2, although proportionally the smallest group in terms of incidence and mortality, have nearly twice the prevalence of Group 3 cancers and a significant number of people living with cancer – an estimated 342,000 - at the end of 2010.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Figure 2: Proportion of people in each of the Three Cancer Groups, estimates for the UK

INSERT Figure 2

See Table 1 for data sources. For prevalence and mortality no direct data for cancers by stage is available so some estimates rely on assumptions and simplifications.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

DISCUSSION

Cancer is made up of many different types and even between the most common cancers variation in survival outcomes is large. We believe that variation in need is likely to have a similar spread. In order to demonstrate the need for support and service configuration, establishing the demand for different levels of ongoing support in stratified groups is essential. Table 2 summarises the Three Cancer Groups in our model and notes the possible key concerns and interventions appropriate to support each group as informed by clinical input and the health professional's workshops.

Table 2: Summarising the features, needs and care requirements of the Three Cancer Groups

Group 1: Longer-term survival	Group 2: Intermediate survival	Group 3: Shorter-term survival
People with a Group 1 cancer typically have an early stage, potentially curable cancer and a prognosis of a decade or more. Most people survive in the long-term, often in relatively good health (and many live for more than a decade)	*People with a Group 2 cancer often have treatable but not curable disease, typically having multiple lines of treatment. Most people experience cancer as a complex ongoing disease similar to a long-term condition*	*People with a Group 3 cancer typically develop advanced disease and often have less than 12 months prognosis. Most people have relatively poor health*
Often face long-term consequences of their cancer and its treatment. May face recurrence even years after primary treatment	Often have a complex pathway, with multiple decision points, commonly experience relapse or recurrence	Often face short survival times, mostly incurable disease and complex, time sensitive decisions needed
Focus on recovery and long-term quality of life: · Reduce unnecessary over-treatment, focus on its impact on recovery and late effects[27] · Management of co-morbidities · Recovery Package, including Stratified Pathways and self-care with support and open access[28] · Periodic monitoring of heath, for example for cardio function, fatigue[29]	Care must preserve quality of life through balance of: · Acute intervention · Chronic illness management[30] · Palliative care principals[31] · Shared care between patient and clinician[28] · Acknowledgement that cancer is likely to be life-limiting · Recognition when move to dying phase	Balance of anti-cancer treatment and palliative care to maintain quality of life. Focus care on: · Complex case management · Good treatment and supportive specialist palliative care[32] · Early access to palliative care[33] · Early diagnosis

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

The majority of people living with cancer in this model have a Group 1 cancer, where most people will have one episode of treatment and a focus on managing the impact of treatment on recovery is key. The Recovery Package is an essential part of their care and support [5,34] including practical, financial and emotional support, for example, to get back to work or an exercise programme. Some people with a Group 1 cancer with longer-term survival may have consequences of cancer or their treatment. For example, a study of women in America diagnosed with early-stage breast carcinoma who had not had a recurrence found that at 5-10 years post diagnosis 34% experienced significant fatigue. [35] There are limited data to quantify how many people consequences may affect overall but it is estimated around a quarter of all people living with cancer could have consequences.[25] Bower recommends adult cancer survivors should be evaluated for the presence of fatigue and then offered specific information and strategies for fatigue management.[29] The treatment strategies include physical activity interventions, psychosocial interventions, and mind-body interventions. Patient reported outcome measures also highlight that people report consequences and issues which affect quality of life for years after initial diagnosis.[36] These people with later consequences may benefit from elements of care taken from the management of long-term conditions along with people with cancers in Group 2. Additionally there is a subset of people we are currently unable to quantify with a Group 1 cancer which develops and metastases months or years after initial diagnosis and so move to a Group 2 cancer.

Our model and provisional estimates suggest that around one in five people living with a cancer diagnosis have a Group 2 cancer, the intermediate survival group. These people usually have ongoing disease, and will usually have more than one treatment episode with potentially complex care requirements. The large difference between one and five-year survival for Group 2 could be interpreted as a particular concern in terms of managing care whilst maintaining quality of life at such an unpredictable phase of disease. Group 2 can be seen as having similar needs to those with a long-term condition as they typically experience multiple episodes of care and monitoring of disease

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

is required. Reed and Corner use the example of metastatic breast cancer to predict that a model of care used to manage chronic illness could lead to more appropriate use of analgesics, anti-cancer treatments and hospital visits.[30] The management of long-term conditions can include personalised treatment, care planning and supported self-management. There is an increased recognition by specialist charities of the particular needs of people with cancers in Group 2 such Breast Cancer Care[37] and the Lymphoma Association.[38]

For Group 3 many people die quickly. While there must be a focus on improving diagnoses for late stage disease, it is also essential to have the right balance between anti-cancer treatment and palliative care. In the future as immunotherapy and targeted treatments emerge some Group 3 cancers have the potential to transform into Group 2 cancers.

The Three Cancer Groups model and the focus of care required for people in each group (Table 2) can be used to guide thinking for the development of more personalised care. The Three Cancer Groups are not designed to be directly discussed with people living with cancer or dictate the care each person must receive. Instead it provides a numerical framework to support service planning. In addition, healthcare professionals can use the characteristics of individuals and their tumours alongside the focus of care for each group of cancers to anticipate the needs of their patients. This alongside other techniques could guide supportive conversations with people living with cancer. Consideration of characteristics other than the Three Cancer Groups are critical, for example it is evident that cancer often co-exists with a wide range of other conditions or co-morbidities.[39,40] This is particularly important to take into account in the understanding of care and support required to recover after treatment, especially for people with a Group 1 cancer as well as when treatment decisions are made for all Groups.

Limitations

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

As noted the quality of data available to report on cancers by stage is limited, although great gains have been made in recent years allowing us the confidence to report on our model here. Further data and research is needed to understand mortality, prevalence and longer-term survival by stage and to understand tumour progression[41] in order to specify the cancers and people in each group more precisely. The data are also limited in that reported statistics do not identify if people have had a previous cancer diagnosis.

At this initial stage of introducing our model we have not attempted to further sub-divide for simplicity's sake. Current data and the small size of some tumour groups do not allow us to disaggregate within all tumours. As with any model not all individuals will fit perfectly into one of the groups and in reality people could move between groups. The model has also not been able to take into account serious treatment-related consequences or the implications of multiple morbidities on treatment and care. This is due to limited data and evidence to show how this could impact people in all groups. The Three Cancer Groups are also not able to consider all aspects of patient profile. Alternative questionnaire-derived segmentations of people living with cancer around psychosocial factors, patient preferences, attitudes and behaviours are likely to find people clustered around attributes such self-efficacy rather than treatment or disease characteristics (such as Foster[42]). These alternative segmentations cannot easily be done systematically on the scale of all the UK and tend to highlight different aspects of diversity in people living with cancer.

The construct of our Three Cancer Groups model is new and so there are limited further data and research to explore in more depth the commonalities and distinctions between the groups of cancers and the people within these groups. In order to ensure that care and support meets the needs of people living with cancer, further research into the links between clinical care, treatment and quality of life as well as patient-reported needs and outcomes in each of the groups would be beneficial. This along with further testing of the concepts with people living with cancer,

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

commissioners, policy makers and clinicians in a wide range of settings will help to further validate the Three Cancer Groups.

Once the Three Cancer Groups have been further developed and validated, further work to identify and test appropriate interventions for each of the Three Cancer Groups should be carried out with a focus on measuring which elements of care have an impact on quality of life. A recent study piloting new roles to deliver supportive care for people with active and advanced cancer in Southampton shows promising results and found that more than 50% of people were supported to be able to return to independence through self-management.[39] Work in England, thanks to the recent Cancer Strategy[5], is underway to develop a quality of life metric with the intention to monitor continuous improvement in long-term quality of life for people living with cancer. We hope to use the outcomes of this work to understand the groups in more detail in the future.

Conclusion

Every person with cancer is different, and treatment and support should be personalised to individual needs. We believe personalised care is key to improving survival and quality of life and that a shared understanding of the aim of treatment is required between people living with cancer and health professionals in order to tailor care appropriately. We believe the Three Cancer Groups model provides a starting point for a broad framework and narrative that contributes towards personalising care through better decision making and application of interventions to ensure people don't miss out on the care appropriate for them and their cancer.

Stratifying cancers as we have done provides a new high-level quantitative view of potential care requirements and can help guide the thinking of planners and health professionals in order to personalise care. We aim to stimulate debate on this service challenge and shift perception from cancer as a binary life or death disease to that of the new reality, the new cancer story of three

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

parts. Some cancers cannot be cured, some cancers keep coming back and most leave a lasting impact.

ACKNOWLEDGEMENTS

We thank Macmillan Cancer Support and the healthcare professionals who took part in discussion and workshops on the Three Cancer Groups model. Cancer registration and mortality data owners across the UK who collected and made much of these data available. Data are collated and presented from publicly available sources published by Office for National Statistics, Public Health England's National Cancer Registration and Analysis Service, the Welsh Cancer Intelligence and Surveillance Unit (Health Intelligence and Knowledge Management Division, Public Health Wales), the Scottish Cancer Registry (Information Services Division), the Northern Ireland Cancer Registry (Public Health Agency for NI) and Cancer Research UK.

FOOTNOTES

Contributors: Jane Maher was responsible for the development of the concept of the Three Cancer Groups and led on clinical engagement. Hannah McConnell and Rachel White were responsible for collating and analysing the data from across the UK and placing the topic within the wider cancer population narrative. All authors contributed to the first draft of the manuscript and have reviewed the final version before submission. Colleagues within Macmillan Cancer Support provided review of draft papers. Further contributors provided data and clinical review are noted in the methods and acknowledgements.

Competing interests: None declared.

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Data sharing statement: All data are described in Table 1. No additional data are available.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

REFERENCES

1. Quaresma M, Coleman MP and Rachet B; 40 year trends in an index of survival for all cancers combined and survival adjusted for age and sex for each cancer in England and Wales, 1971- 2011: a population-based study. *Lancet;* 2014; **385**: 1206-1218

2. Maddams J, Utley M, Møller H.; Projections of cancer prevalence in the United Kingdom, 2010-2040. *Br J Cancer*; 2012; **107**: 1195-1202, doi:10.1038/bjc.2012.366 (Projections scenario 1).

3. Macmillan Cancer Support. Cancer: Then and now. 2016 http://www.macmillan.org.uk/documents/campaigns/cancer-then-now-report-final-online.pdf

4. Smittenaar CR, Petersen KA, Stewart K, Moitt N. Cancer Incidence and Mortality Projections in the UK until 2035. *Brit J Cancer*; 2016; 115(9): 1147-1155

5. Independent Cancer Taskforce; Achieving world-class cancer outcomes: a strategy for England 2015-2020; 2015 https://www.cancerresearchuk.org/sites/default/files/achieving_world-class_cancer_outcomes_-_a_strategy_for_england_2015-2020.pdf

6. Deagle J, Richardson A, Fenlon D, Keen A; Can a case management role in the community improve cancer care? *Cancer Nursing Practice;* 2016; **18**(2): 22-27

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

7. Harley C, Pini S, Bartlett YK, Velikova G; Defining chronic cancer: patient experiences and self-management needs *BMJ Support. Palliat. Care*; 2012; 2: 248–255

8. Yip K, McConnell H, Alonzi R, Maher J; Using routinely collected data to stratify prostate cancer patients into phases of care in the UK: implications for resource allocation and cancer survivorship *Br J Cancer;* 2015; **112**: 1594–1602, doi:10.1038/bjc.2014.650

9. Office for National Statistics; Cancer Registration Statistics, England; 2016; https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/cancerregistrationstatisticscancerregistrationstatisticsengland

10. Information Services Division Scotland (ISD); Cancer incidence and mortality in Scotland by site/type of cancer, sex and year of diagnosis/registration of death: 2005-2014; 2016; http://www.isdscotland.org/Health-Topics/Cancer/Cancer-Statistics/

11. Welsh Cancer Intelligence and Surveillance Unit; Cancer Incidence: Interactive Cancer Statistics Tool; 2016; http://www.wcisu.wales.nhs.uk/dashboard-data

12. NICR (N Ireland Cancer Registry); Official Statistics: by site. Cancer incidence, prevalence and survival statistics for Northern Ireland: 1993-2014; 2016; https://www.qub.ac.uk/research-centres/nicr/CancerInformation/official-statistics/BySite/

13. NCRAS (Public Health England's National Cancer Registration and Analysis Service); TNM stage group by CCG by tumour type for 10+3 tumour types, 2014; 2016; http://www.ncin.org.uk/publications/survival_by_stage

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

14. Macmillan Cancer Support/NCRAS (Public Health England's National Cancer Registration and Analysis Service); Macmillan-NCIN Cancer Prevalence Project: 20-year cancer prevalence in the UK; 2015; http://www.ncin.org.uk/view?rid=2954

15. Macmillan Cancer Support/NCRAS (Public Health England's National Cancer Registration and Analysis Service); Macmillan-NCIN Cancer Prevalence Project: Guidance and FAQs; 2015; http://www.ncin.org.uk/view?rid=2960

16. Macmillan Cancer Support/NCRAS (Public Health England's National Cancer Registration and Analysis Service); Macmillan-NCIN Cancer Prevalence Project: Cancer Prevalence UK Summary Data Table; 2015; http://www.ncin.org.uk/view?rid=2955

17. Jones S, McConnell H, White C, Huws D, Irvine L, Miller S.; Counting 20 year cancer prevalence in the UK A new way of counting cancer prevalence to understand the prevalence of multiple primaries in the UK. In: Cancer Outcomes Conference 2015: United Against Cancer. Belfast; 2015; http://www.macmillan.org.uk/documents/aboutus/research/researchandevaluationreports/ourresearchpartners/20yearcancerprevalenceposter.pdf

18. Office for National Statistics; Deaths Registered in England and Wales: 2014; 2015; https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsregistrationsummarytables/2015-07-15

19. NICR (N Ireland Cancer Registry) Official Statistics: by site. Mortality statistics: 1993-2014; 2016; https://www.qub.ac.uk/research-centres/nicr/CancerInformation/official-statistics/BySite/

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

20. Cancer Research UK; Mesothelioma incidence statistics (2014 data); 2014; http://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/mesothelioma

21. Office for National Statistics; Cancer survival for adults in England: 2010 to 2014, followed up to 2015. Table 5; 2016; https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/cancersurvivalinenglandadultsdiagnosed/2010and2014andfollowedupto2015/relateddata

22. Office for National Statistics; One–year net cancer survival for Bladder, Breast, Colorectal, Kidney, Lung, Melanoma, Ovary, Prostate and Uterus, by stage at diagnosis; 2016; https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/datasets/oneyearnetcancersurvivalforbladderbreastcolorectalkidneylungmelanomaovaryprostateanduterusbystageatdiagnosis

23. NCIN (National Cancer Intelligence Network); Kidney cancer: survival report; 2014; http://www.ncin.org.uk/view?rid=2676

24. Cancer Research UK; Five-year relative survival by stage, adults (aged 15–99 years), Former Anglia Cancer Network, 2002–2006.; 2011 http://www.cancerresearchuk.org/health-professional/cancer-statistics/survival

25. Macmillan Cancer Support; Throwing light on cancer and the consequences of its treatment.; 2012

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

http://www.macmillan.org.uk/documents/aboutus/research/researchandevaluationreports/throwinglightontheconsequencesofcanceranditstreatment.pdf

26. Stein K, Syrjala K, Andrykowski M; Physical and psychological long-term and late effects of cancer. *Cancer*; 2008; **112**: 2577–2592. doi:10.1002/cncr.23448

27. Donovan JL, Hamdy FC, Lane JA, et al.; Patient-Reported Outcomes after Monitoring, Surgery, or Radiotherapy for Prostate Cancer. *The New England journal of medicine*.; 2016; **375**(15):1425-1437. doi:10.1056/NEJMoa1606221.

28. NCSI (National Cancer Survivorship Initiative): Department of Health, Macmillan Cancer Support and NHS Improvement; Living with & Beyond Cancer: Taking Action to Improve Outcomes; 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/181054/9333-TSO-2900664-NCSI_Report_FINAL.pdf

29. Bower J, Bak K, Berger A, et al. Screening, Assessment, and Management of Fatigue in Adult Survivors of Cancer: An American Society of Clinical Oncology Clinical Practice Guideline Adaptation. *Journal of Clinical Oncology;* 2014; **32**:17, 1840-1850

30. Reed E and Corner J; Defining the illness trajectory of metastatic breast cancer. *BMJ Support Palliative Care;* 2013; **0**: 1–8, doi:10.1136/bmjspcare-2012-000415

31. Park E, Rosenstein; Living with advanced cancer: unmet survivorship needs. North Carolina Medical Journal; 2014; 75(4), 279-282

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

32. Department of Health; What's important to me. A Review of Choice in End of Life Care; 2015; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407244/CHOICE_REVIEW_FINAL_for_web.pdf

33. Jennifer S. Temel, M.D., Joseph A. Greer, Ph.D., Alona Muzikansky, M.A., et al. Early Palliative Care for Patients with Metastatic Non–Small-Cell Lung Cancer; *N Engl J Med*; 2010; 363:733-742; DOI: 10.1056/NEJMoa1000678

34. NHS England; Five Year Forward View; 2014; https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf

35. Bower J, Ganz P, Desmond K, et al.; Fatigue in long-term breast carcinoma survivors. *Cancer*, 2006; **106**: 751–758. doi:10.1002/cncr.21671

36. NHS England; Quality of Life of Colorectal Cancer Survivors in England; 2015; https://www.england.nhs.uk/wp-content/uploads/2015/03/colorectal-cancer-proms-report-140314.pdf

37. Breast Cancer Care. Secondary. Not second rate. Secondary breast cancer Part three: support and impact; 2017; https://www.breastcancercare.org.uk/sites/default/files/sbc_report_3_2017_final.pdf

38. Lymphoma Association. Understanding lymphoma as a cancer Patients' experiences of lymphoma diagnosis, treatment and aftercare Lymphoma Association survey 2016; 2017 https://www.lymphomas.org.uk/sites/default/files/pdfs/Understanding%20lymphoma%20as%20a%20cancer_Lymphoma%20Association%20FINAL%20REPORT.pdf

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

39. Macmillan Cancer Support; The burden of cancer and other long-term health conditions; 2015 http://www.macmillan.org.uk/documents/press/cancerandotherlong-termconditions.pdf

40. Nord C, Mykletun A, Thorsen L, Bjøro T,Fosså S; Self-reported health and use of health care services in long-term cancer survivors. *Int. J. Cancer*; 2005; **114**: 307–316. doi:10.1002/ijc.20713

41. Breast Cancer Care.2016. Secondary. Not second rate. Secondary breast cancer Part two: Who's counting? https://www.breastcancercare.org.uk/sites/default/files/secondary-breast-cancer-report-2.pdf

42. Foster C, Haviland J, Winter J, et al.; Pre-Surgery Depression and Confidence to Manage Problems Predict Recovery Trajectories of Health and Wellbeing in the First Two Years following Colorectal Cancer: Results from the CREW Cohort Study. Souglakos J, ed. *PLoS ONE*.; 2016; **11**(5):e0155434. doi:10.1371/journal.pone.0155434.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

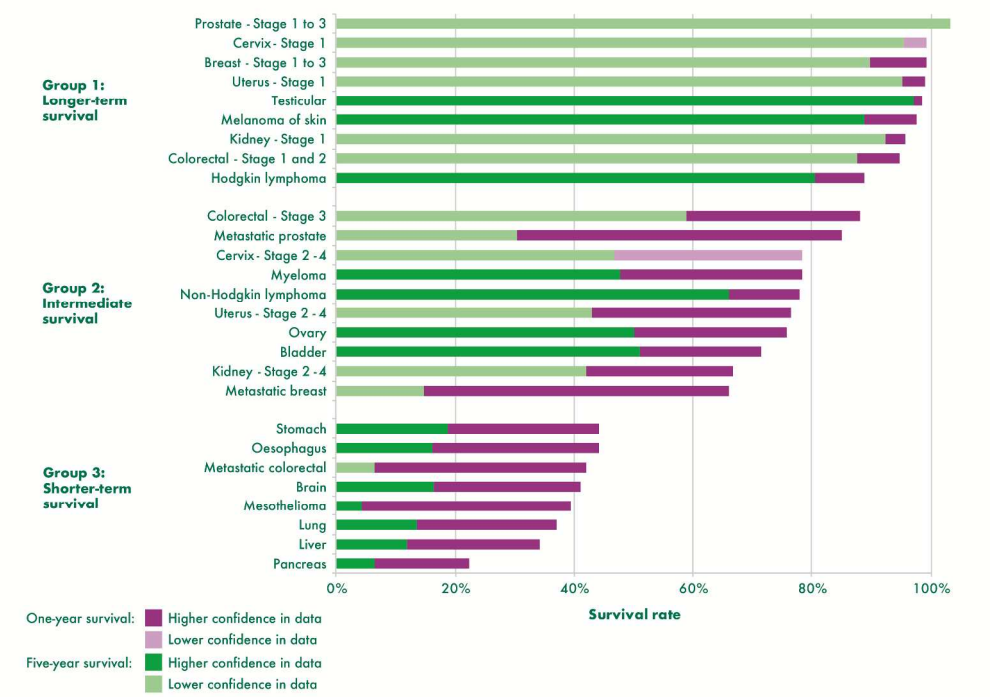


Figure 1: One and five-year survival rates by cancer type, stage and group, England, up to 2011-15* *Data are for England except cervix cancer by stage which is Northern Ireland data and five-year survival by stage which is regional data from the former Anglia Cancer Network or Northern Ireland data. The year of data varies with the earliest time period people were diagnosed as 2002-2006 followed up to 2011 for the five year survival by stage data and the latest as predicted survival for people diagnosed in 2015 for cancers with no stage split. See sources in Table 1 for more details.

297x210mm (300 x 300 DPI)

For peer review only

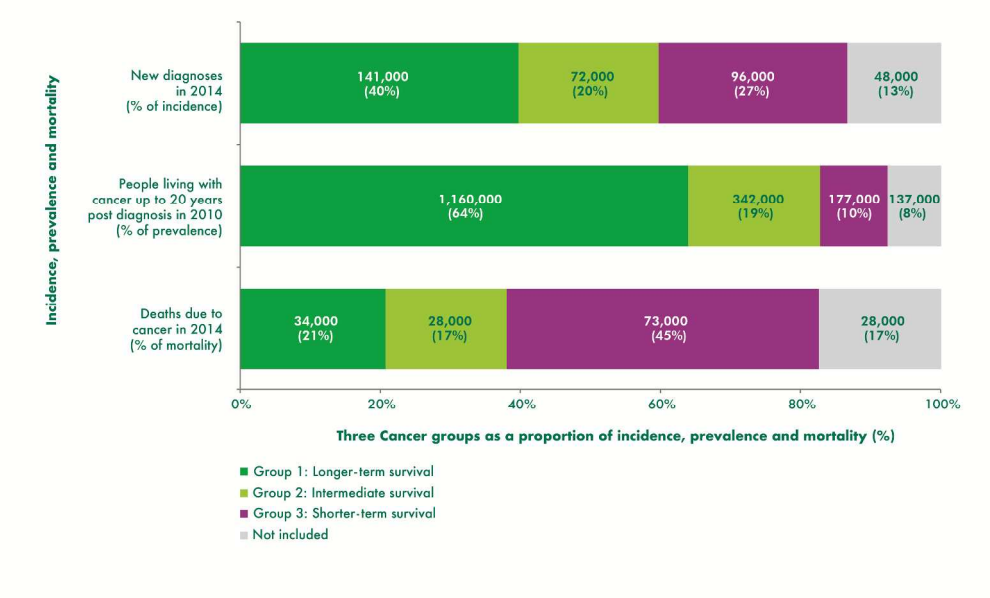


Figure 2: Proportion of people in each of the Three Cancer Groups, estimates for the UK See Table 1 for data sources. For prevalence and mortality no direct data for cancers by stage is available so some estimates rely on assumptions and simplifications.

297x210mm (300 x 300 DPI)

ew only

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	*(*a) Indicate the study's design with a commonly used term in the title or the abstract Title (page 1): Assigning cancers into three groups and analysing cancer registration data in the UK to enable tailored care planning. The main aspects of the design are a process of assigning and classification followed by a statistical description using secondary analysis.
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Page 2 contains the abstract which explains what was done and found.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported In the introduction (page 4), we demonstrate that cancer has changed and the way cancer is perceived also needs to change to consider the diversity in the cancer population. To conceptualise this diversity and provide a numerical framework for understanding the cancer population we created the Three Cancer Groups.
Objectives	3	State specific objectives, including any prespecified hypotheses The aims are on page 6. The aim of this study is to categorise cancers into broad groups based on clusters of common treatment aims, experiences and outcomes. These groups should be defined in a way that creates a numerical framework that allows researchers to estimate the size of each group in different populations using routine data sets. We use this framework to describe the size and characteristics of the Three Cancer Groups. Finally, we aimed to explore how care varies between the groups and the implications for personalised care. We hypothesised that it is possible and useful for policy makers and service planners to use routine data to group cancers. We also hypothesised that considerable numbers of cancer patients would be in each Cancer Group so that services would be needed for each.
Methods		
Study design	4	Present key elements of study design early in the paper We defined the Three Cancer Groups by review and then statistically described the groups using secondary analysis of incidence, prevalence, mortality, survival and stage at diagnosis data (pages 7-9). This data was in most cases published by the Information Services Division Scotland which is part of NHS National Services Scotland, Public Health England's National Cancer Registration and Analysis Service,

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		the Office for National Statistics, Welsh Cancer Intelligence and Surveillance Unit and the Northern Ireland Cancer Registry. These bodies in general support public health across the UK and provide health intelligence and statistical services to help inform decision making about health services. The specific secondary analysis we conducted is not part of the standard use for these data sets but it is generally aligned to the aims of the data sets.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection The data used is described in Table 1 (page 10). This gives the year the data refers to, for example, the incidence data described cancers diagnosed in 2014. The table also gives the geographies, for example, mortality data covers all 4 nations in the UK. We use registration data, so in the geography column we are referring to all cancer patients diagnosed (or for mortality, dying) in that nation or region. Follow up time is described in the time period column in Table 1. For example, 5 year survival has 5 years real or modelled follow up.
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants The analysis included 20 common cancers (excluding non-melanoma skin cancer - ICD-10 C44) as displayed in Figure 1 (page 14). We exclude leukaemia (C91-95), head and neck (C00-14, C30-32), ill-defined, secondary and unspecified sites (C76-80) and some further rarer cancers (see page 9). The data covered patients living in the UK. The data was obtained though the bodies detailed in Table 1 (page 10).
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable The approach to define the Three Cancer Groups used mainly survival data and cancer type to allocate the groups. In some cases, this was divided additionally by cancer stage (see page 7). Statistical testing was not part of the study so there were no formal statistical

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		predictors or confounders. The limitations section (page 21) describes factors such as co-morbidities, patient profile and holistic needs which will impact the care requirement and experiences of patients within each of the Three Cancer Groups.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group A key variable was survival. As described in Table 1 (page 10) this is mainly statistics provided by the Office for National Statistics. The un-standardised survival rates are the predicted estimates of one-year, five-year net survival for adults (aged 15 to 99 years) that would be diagnosed in 2015 in England. Where survival is divided by stage it is mainly one–year net cancer survival for adults (aged 15 to 99 years), in England, in 2014 and followed up to 2015. Other sources are described and referenced in Table 1.
Bias	9	Describe any efforts to address potential sources of bias This is described in the limitations section (page 20). There is limited data available and so approximations and assumptions have been used to create estimates. The findings are presented as estimates and we appreciate that as more data becomes available the information can be refined. The main limitation is the lack of information about cancer stage at times other than diagnosis. This means there is likely to a high level of uncertainty in the estimate of the stage of long term survivors and a bias in the mortality figures (page 8)
Study size	10	Explain how the study size was arrived at Macmillan Cancer Support aims to reach and improve the lives of everyone living with cancer across the UK so we used UK wide data when this was available. The UK population also has the advantage that it is large enough that the cancer population is reasonably stable over time. The UK also has high quality registries covering all cancer patients in each country in the UK. As described in the materials and methods (page 9), when UK wide data was not available we used data on smaller populations such as England, Northern Ireland and Former Anglia Cancer Network.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why N/A
Statistical methods	12	*(*a) Describe all statistical methods, including those used to control for confounding The main method was aggregation of incidence, prevalence and mortality numbers across the UK and across cancer types. Additional assumptions and calculations were used to estimate group sizes by stage at diagnosis based on available data as described in the materials and methods section (page 7-8).

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

(*b*) Describe any methods used to examine subgroups and interactions

N/A

(*c*) Explain how missing data were addressed

We made simplifying assumptions, for example, cancer mortality is not available by stage at diagnosis so we assumed the same distribution as in stage at diagnosis (page 8). These simplifying assumptions are unlikely to be a fully robust reflection of reality, but we believe they are robust enough to draw conclusions about the general relative size of each of the Three Cancer Groups.

(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed
Case-control study—If applicable, explain how matching of cases and controls was addressed
Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy

N/A

(*e*) Describe any sensitivity analyses

N/A

Continued on next page

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed The study target population is people in the UK with one of 20 common cancers; an estimated 309,000 people diagnosed in 2014, 1,679,000 people diagnosed in a 20 year period and still living in 2010 and 135,000 who died due to cancer in 2014. These patients were described using published data so did not participate directly in the study.
		(b) Give reasons for non-participation at each stage N/A
		(c) Consider use of a flow diagram N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders The analysis covers cancer patients in the UK. The demographics of the cancer population are described by Information Services Division Scotland which is part of NHS National Services Scotland, Public Health England's National Cancer Registration and Analysis Service, the Office for National Statistics, Welsh Cancer Intelligence and Surveillance Unit and the Northern Ireland Cancer Registry.
		(b) Indicate number of participants with missing data for each variable of interest The cancer registries and death registrations include information on most cancer diagnoses and deaths across the UK. For details of the performance of the registry see http://www.ukiacr.org/kpis. The variable with the most missing data was stage at diagnosis. The numbers of missing cases are described in NCRAS (Public Health England's National Cancer Registration and Analysis Service); TNM stage group by CCG by tumour type for 10+3 tumour types, 2014; 2016. For example, for breast cancer 11% had unknown stage at diagnosis.
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) The one- and five-year survival for all cancers combined is based on follow up to 2015. To create predicted survival for diagnoses in 2015, a hybrid of the complete and period approaches is used (See Office for National Statistics; Cancer survival for adults in England: 2010 to 2014, followed up to 2015. Table 5; 2016). One year survival by stage is based on 2014 diagnosis followed up to 2015. 5-year survival by stage is based on a mixture of cohorts as described in table 1 on page 10.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		Prevalence in 2010 is based on diagnosis between 1991-2010 in England, Wales and Scotland and 1993-2010 in Northern Ireland (http://www.ncin.org.uk/view?rid=2960).
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure N/A
		Cross-sectional study—Report numbers of outcome events or summary measures N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included The results are the classification of cancers into each group (see Figure 1, page 14). We have highlighted in colour in Figure 1 where there is lower confidence in data. There is no formal measure of the precision of the classification; however, the classification was reported to and resonated well with clinical practice (page 11). As described the framework is a generalisation so it is appreciated that the generalisation will not fit all circumstances. Further results are shown in Figure 2 (page 17). It is not possible to conduct a formal measure of the precision but we do recognise the high level of uncertainty surrounding these estimates.
		(*b*) Report category boundaries when continuous variables were categorized N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses N/A
Discussion		
Key results	18	Summarise key results with reference to study objectives We aimed to identify a method to classify cancers into groups with similar needs and describe the size and characteristics of the groups. We found that 64% of people living with cancer have a Group 1 longer-term survival cancer, where most people will have one episode of treatment and a focus on managing the impact of treatment on recovery is key (page 19). We estimated that around one in five people living with a cancer diagnosis have a Group 2 cancer, the intermediate survival group. These people usually have ongoing disease, and will usually have more than one treatment episode with potentially complex care requirements (page 19-20). We also identified and estimated that 10% of people living with cancer are in the shorter-term survival Group 3. For these people there should be a focus and managing a balance of

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

		anti-cancer treatment and palliative care (page 20).
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias See the limitations section (pages 21). We appreciate that incomplete data that will lead to imprecision in our estimates. The Three Cancer Groups are also not able to consider all aspects of holistic needs and patient profile. We aim to develop this understanding and further refine though further research into the links between clinical care, treatment and quality of life and further testing of the concepts with people living with cancer, commissioners, policy makers and clinicians.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence We conclude on page 22 that the Three Cancer Groups model provides a starting point for a broad framework and narrative that contributes towards personalising care through better decision making and application of interventions to ensure people don't miss out on the care appropriate for them and their cancer. This is a cautious conclusion as it appreciates the need for further refinement. We have also clearly set out the limitations (pages 20-22) in terms of both data and conclusions about the cancer population. We present in Table 2 (page 18) evidence from other studies on individual aspect of care that have been recommended for people living with cancer that we are able to apply to each of the Three Cancer Groups.
Generalisability	21	Discuss the generalisability (external validity) of the study results We have used population level data so believe our findings cover the picture for the majority of people living in each of the Three Cancer Groups, as shown in Table 1 (page 10). However, we appreciate there are exceptions to the generalisations such as those in the longer-term survival group who live with severe consequences of their cancer or its treatment and so may need some of the aspects of care for Group 2 cancers (page 19).
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors (page 23).

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml