Title: Decreasing waiting time for treatment before and during implementation of cancer patient pathways in Norway

Authors: Nilssen Yngvar[1], Brustugun Odd Terje[2], Eriksen Morten Tandberg[3,4], Gulbrandsen Johanne[1], Haug Erik Skaaheim[5,6], Naume Bjørn[4,7], Møller Bjørn[1]

Affiliations:

[1] Department of Registration, Cancer Registry of Norway, Oslo, Norway

[2] Section of Oncology, Drammen Hospital, Vestre Viken Hospital Trust, Drammen, Norway

[3] Division of Surgery, Inflammatory Diseases and Transplantation, Oslo University Hospital, Oslo, Norway

[4] Institute of Clinical Medicine, University of Oslo, Oslo, Norway

[5] Section of Urology, Vestfold Hospital Trust, Tønsberg, Norway

[6] Institute of Cancer Genomics and Informatics, Oslo University Hospital, Oslo, Norway

[7] Oslo University Hospital, Oslo, Norway

Corresponding author:

Yngvar Nilssen

Postboks 5313 Majorstuen

0304 Oslo

Norway

E-mail: yngvar.nilssen@kreftregisteret.no,

Phone: (+47) 22 92 87 03

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ABSTRACT

Background:

In 2015, Norway implemented cancer patient pathways to reduce waiting times for treatment. The aims of this paper were to describe patterns in waiting time and their association with patient characteristics for colorectal, lung, breast and prostate cancers.

Methods:

National, population-based data from 2007–2016 were used. A multivariable quantile regression examined the association between treatment period, age, stage, sex, place of residence, and median waiting times.

Results:

Reduction in median waiting times for radiotherapy among colorectal, lung and prostate cancer patients ranged from 14–50 days. Median waiting time for surgery remained approximately 21 days for both colorectal and breast cancers, while it decreased by 7 and 36 days for lung and prostate cancers, respectively. The proportion of lung and prostate cancer patients with metastatic disease at the time of diagnosis decreased, while the proportion of colorectal patients with localised disease and patients with stage I breast cancer increased ($p<0.001$). After adjusting for case-mix, a patient's place of residence was significantly associated with waiting time for treatment ($p<0.001$), however, differences in waiting time to treatment decreased over the study period.

Conclusions:

Between 2007 and 2016, Norway experienced improved stage distributions and consistently decreasing waiting times for treatment. While these improvements occurred gradually, no significant change was observed from the time of cancer patient pathway implementation.

INTRODUCTION

The diagnostic examination period for all cancer patients should be as efficient as possible. By avoiding unnecessary time delays, a patient's level of psychological stress, quality of life and prognosis could be improved. However, the time to diagnosis may be influenced by patient-, doctor- and system-related delays, where the longest delays may be attributable to the patient and the system [1, 2]. Increasing knowledge and awareness about cancer, including treatment possibilities and prognosis, may reduce a person's reluctance to seek a doctor, and affect patient-related delay. To reduce system-related delays, a number of initiatives have been implemented across Europe. In the early 2000s, urgent referral pathways in the UK and Cancer Fast-track Programme in Catalonia, Spain, were implemented, targeting an upper limit of two weeks from seeing a general practitioner (GP) to being referred to a specialist at a hospital [3, 4]. Denmark and Sweden implemented cancer patient pathways in 2007–2008 and 2015–2018, respectively, with an aim to reduce waiting times and related regional differences [5-7]. In Denmark, an additional aim was to improve cancer prognosis.

In 2010, the Norwegian Board of Health Supervision evaluated cancer care in Norway and found that unnecessary non-medical delay in the diagnostic period and a lack of continuity in treatment were two of the largest challenges that cancer patients were facing [8]. In 2012, Norway implemented a national cancer plan for 2013–2017 *"Together against cancer"* [9]. The aim of this plan was "to become a leading country with good cancer patient pathways" by focusing on better coordination and reduction of waiting times throughout the diagnostic period. Cancer patient pathways (CPP) in Norway can be described as a set of maximum days that patients should experience from when the hospital receives the referral to the first specialist visit, to a clinical decision and finally to the start of treatment. Initially, the overall goal was "that minimum 80% of all cancer patients should start their treatment within 20

working days after the hospital received the referral". However, prior to implementation, this goal was adjusted to be more clinically relevant to each type of cancer. Patients who are included in a CPP are assigned a coordinator that will function as a guide through the medical system. During the first four months of 2018, the proportion of cancer patients that were included in a CPP ranged from 82.1% (prostate) to 91.3% (breast) [10]. Norway implemented the first pathways in January 2015 for colorectal, lung, breast and prostate cancers. These four cancer sites represented approximately 50% of all new cases, as well as, half of all cancer-related mortality in 2016 [11].

The aims of this paper were to describe patterns in time from diagnosis to start of treatment between 2007 and 2016, and to study the importance of age, sex, stage and place of residence on time to treatment for colorectal, lung, breast and prostate cancers. In addition, the initial effect of the implementation of cancer patient pathways on stage distribution, as well as, the national and regional waiting times from diagnosis to treatment were explored.

MATERIAL AND METHODS

Cancer Registry of Norway

Since 1953, the Cancer Registry of Norway (CRN) has been collecting cancer notifications for the Norwegian population. It is estimated that the quality, comparability, completeness, validity, and timeliness of the CRN data are high, with 98.8% estimated completeness for all sites together [12]. The CRN annually obtains information regarding radiotherapy directly from the radiotherapy units. The personal identification number, assigned to all Norwegian citizens since 1964, enables linkage of information across institutions and databases. The CRN receives death certificates from the Cause of Death Registry, which are matched monthly against the National Population Register to ensure that vital status (death or emigration) is updated. Complete vital status information for the study was available until 31 December 2017.

Classification of variables

Stage of disease was grouped according to the condensed seventh version of the tumour, node, metastasis status as localised, regional, metastatic, or unknown [13]. For breast cancer, stage was classified as stage I-IV. For prostate cancer, a patient was categorised according to risk groups following the 2012 European Association of Urology (EAU) guidelines as low-risk, intermediate-risk and high-risk cancer [14]. Risk group information is dependent on the reporting of cT and PSA level by the clinicians, and in 2017 this was known for 63% of the patients [15]. Norway has 19 health trusts that are responsible for specialised health care in each of their catchment areas. The study variable denoting health trust was based on a patient's place of residence at the time of diagnosis, independent of where the patient was actually treated [16]. Information regarding a patient's stage and risk group was found within the diagnosis period (i.e., month of diagnosis plus an additional four months).

Date of diagnosis was defined as the date of the first histologically verified diagnosis registered at the CRN, which most often is based on a biopsy. Surgery refers to the radical removal of a tumor. Date of surgery refers to the date of the first notification indicating surgery registered at the CRN. For radiotherapy, only the first series of treatment where the intention was to cure the patient from the disease, i.e. curative, was included. Since information regarding chemotherapy was not available, "no treatment" refers to patients who neither underwent surgery nor received curative radiotherapy.

In the present analyses, the focus was on waiting times from the date of diagnosis to the date of surgery or curative radiotherapy, whichever occurred first. Therefore, only patients who started their treatments were included. The waiting time was calculated as the number of days from initial treatment and back to the date of diagnosis. This ensured that data on the most recently treated patients could be used. Since colon and rectum cancer patients share the same cancer patient pathway, they were grouped together.

Statistical analysis

Trends in waiting time were analysed using median waiting time with the respective standard error. To compare the level of regional variation in waiting times for treatment, the relative standard error, defined as standard error/median, was calculated. In order to account for changes in median over time the relative measure was preferred to the crude standard error. A multivariable quantile (median) regression of waiting time for treatment was used for each cancer site individually adjusted for treatment period, age and stage at diagnosis, sex and place of residence. In order to identify when the

slope of the (linear) trend in waiting times changed significantly, joinpoint regression analyses were performed. A Pearson chi-squared test was used to assess changes in stage distribution over time, and a Wald test was performed to check for regional variation. Multiple imputation, a statistical method that uses available data to model the likely distribution of missing data under the missing at random assumption, was used to handle incomplete data on stage [17]. Stage was imputed using a multinomial logistic regression model where year of diagnosis and the Nelson-Aalen estimate of the cumulative hazard were included as continuous variables, while sex, age group, the outcome indicator (dead/censored) and cancer site were included as categorical variables. Based on the recommendations by White et al. saying that the number of imputations should be approximately the same as the largest fraction of missing information, 15 datasets with imputed values of stage and risk group were created [17]. The number of imputations were then assessed checking the rule of thumb that all the degrees of freedom should be larger than 100.

The statistical program Stata 15.1 was used for all analyses [18].

RESULTS

There were 235 971 patients identified with a diagnosis of colorectal (n=66 062), lung (n=45 112), breast (n=53 559) or prostate (n=71 238) cancer in the period 2000–2016 in Norway. The number of patients diagnosed per year increased markedly for all cancer sites (Figure 1). The proportion of patients who initially underwent surgery tripled for prostate cancer (10% in 2000 to 34% in 2015), remained around 90% for breast cancer, increased marginally for lung cancer (18% in 2000 to 20% in 2015) and decreased slightly for colorectal cancer (80% in 2000 to 75% in 2015). The proportion of patients who received radiotherapy as initial treatment more than doubled for colorectal cancer (4% in 2000 to 8% in 2015) and lung cancer (8% in 2000 to 17% in 2015), while a 50% increase was observed among patients with prostate cancer (12% in 2000 to 19% in 2015).

[Figure 1 here]

During the period 2007–2016, an overall tendency towards a lower proportion of patients diagnosed with metastatic cancer, was observed (Figure 2). For colorectal cancer, the proportion of patients diagnosed with regional or metastatic cancer declined, while the proportion of patients diagnosed with localised disease increased from 18.8% to 25.3% between 2007 and 2016. For lung and prostate cancers, the proportion of patients with metastatic cancer decreased from 51.7% to 44.7% and 13.7% to 9.2%, respectively between 2007 and 2016. The proportion diagnosed with stage I breast cancer slightly increased, while a slight decrease was observed among stage II patients over the same period. Comparing the last two periods (2013–2014 versus 2015–2016), statistically significant differences in stage distributions were observed across all four cancer sites ($p<0.001$ for all sites).

[Figure 2 here]

For the remainder of the paper, the study population contains all colorectal, lung, breast and prostate cancer patients who either received curative radiotherapy or surgery in 2007–2016 (n = 98 662). Patients registered with a date of treatment prior to, or on the same date as diagnosis were excluded due to the possibility of representing registration errors or emergency patients who do not follow the standardised cancer pathway (n=8 974). Finally, breast cancer patients who received radiotherapy as initial treatment or those diagnosed with stage IV were excluded due to low numbers (n=536). Therefore, 89 152 patients were eligible for analysis. Patient characteristics are shown in Table 1.

[Table 1 here]

The median waiting time from diagnosis to surgery was approximately three weeks for both colorectal and breast cancer patients (Figure 3). The waiting time for radiotherapy among colorectal cancer patients, and waiting time for surgery among breast cancer patients, began decreasing from 2011 and 2014, respectively. For lung cancer patients, marked changes in waiting times for both surgery and radiotherapy were observed from 2010–2011 onwards, with a decrease of more than 1 and 2 weeks, respectively. Similar patterns were observed for prostate cancer, where the waiting times for surgery and radiotherapy were reduced by 6 and 8 weeks starting from 2011 and 2013, respectively. For low-risk prostate cancer patients, waiting time for surgery increased by over 2 months over the study period.

[Figure 3 here]

For lung cancer patients, the waiting time for surgery increased with age ($p<0.001$). Male patients with colorectal cancer experienced a 1.2-day (95% confidence interval (CI) 0.8–1.5) increase in waiting time for surgery compared to females after controlling for case-mix (Table 2). No such difference was observed between male and female lung cancer patients. Compared to patients with stage I breast cancer, patients with stage III experienced an 9.0-day (95%CI: 7.3–10.7) increase in waiting time for surgery. Independent of a patient's age, sex, stage and place of residence, a significant reduction in waiting times for radiotherapy was observed for all cancer sites ($p<0.001$) (Table 3).

[Table 2, Table 3 here]

Statistically significant differences in waiting times existed between the 19 health trusts for all cancer sites ($p<0.001$). Figure 6 shows that lung cancer patients experienced the largest reduction in variation based on where they live, in terms of waiting time for treatment. Breast cancer patients had the smallest variation, which remained consistently low throughout the period.

[Figure 4 here]

DISCUSSION

Over the period 2007–2016, there was a slight shift towards a lower proportion of patients being diagnosed with metastatic cancer for colorectal, lung and prostate cancers. For breast cancer there was an increased proportion of patients diagnosed with stage I cancer, which was offset by a decrease in the proportion of patients diagnosed with stage II cancer. The waiting times for radiotherapy among colorectal and lung cancer patients decreased by more than two weeks, and for prostate cancer patients by more than six weeks. Colorectal and breast cancer patients did not experience any change in waiting times for surgery during this period.

The waiting time for curative radiotherapy for colorectal, lung and prostate cancer patients decreased significantly from 2011 to 2016. The number of radiotherapy units and machines in Norway increased from 20 in 2000 to 39 in 2010 [19]. Since the guidelines for post-operative radiotherapy for breast cancer changed in 2013–2014, recommending that patients undergo 15 instead of 25 fractions, the treatment period was reduced from five to three weeks [20]. Consequently, an increased capacity at the radiotherapy machines may have been beneficial for all cancer types. Rectal cancer patients account for approximately one-third of colorectal cancers in this study and preoperative radiotherapy (pRT) is used selectively only in rectal cancer patients. The proportion receiving pRT has increased dramatically during the period, from under 10% in 2000-2002 to 41% in 2009-2011, levelling off to between 30% and 40% after 2011 [21, 22]. This increase is also the most possible explanation for the slight reduction observed in the proportion of colorectal cancers receiving surgery, since patients with pRT and surgery were grouped as radiotherapy. For lung cancer there was a rapid increase in the proportion of patients receiving curative treatment (surgery, stereotactic radiotherapy and curatively fractionated radiotherapy) after 2010 [23]. Despite this increase in the proportion of curatively treated patients, the

waiting time for radiotherapy was reduced by over two weeks. As “waiting time” includes diagnostic work-up, examinations and preparatory activities, the time from diagnosis to treatment cannot and should not be zero.

For breast cancer, the waiting time for surgery and the level of regional variation in waiting time remained constant over the study period. This was expected as a national mammographic screening program has been well functioning for the past 20 years and breast diagnostic centres were implemented in Norway prior to the study period. These centres had preplanned pathways for the patients prior to 2007, and these can be considered as already implemented national patient pathways. However, it should be noted that a proportion of breast cancer patients did not enter a “quality-assured” breast diagnostic centre during the study period. A national Danish study also showed constant waiting time for breast cancer treatment around the implementation of CPPs. They argued that the lack of reduction in waiting time was due to the implementation of a national screening program [7]. Another aspect that may affect the time from diagnosis to surgery, as observed towards the end of the study period, is the growing awareness of the increased possibility for breast conservation surgery and reduced axillary surgery for subgroups using neoadjuvant treatment (and not only for locally advanced cases). The use of neoadjuvant treatment is expected to increase in the coming years, and may further affect the observed waiting time to surgery. Future analyses should consider information on the use systemic therapies prior to local treatment. The present analyses showed that stage III breast cancer patients experienced an 9.0-day longer waiting time to surgery than stage I patients. All stage I patients undergoing surgery were treated within 3 months of diagnosis. Information about neoadjuvant treatment was not available in this study and therefore it was not possible to separate the patients who received preoperative systemic treatment from those who did not. However, examining a histogram over waiting times to surgery for stage III patients, a clear bi-modal distribution was observed (data not

shown). The median waiting time was 21 and 198 days, respectively, for the first and second hump. Therefore, if information regarding patients who are likely to have been preoperatively treated (waiting time longer than 3 months) were excluded, the difference between stage I and stage III breast cancer patients would have disappeared.

In the period 2009–2016, the proportion of low-risk prostate cancer patients who underwent active surveillance increased from 20% to 75% [15]. Therefore, the observed two-month increase in median time from diagnosis to surgery for low-risk prostate cancer patients from 2007 to 2016, may reflect the increased use of active surveillance. These patients are likely to become intermediate- or high-risk patients when they undergo surgery. The waiting time for surgery is similar both in level and in development over time for patients with intermediate- and high-risk prostate cancer. These similarities are in accordance with clinical practice, as expected survival is long and a patient's risk group has traditionally not affected waiting time for surgery. It is important to note that prostate biopsies may cause local inflammation and therefore, surgeons may consider a time lag of up to 6 weeks before surgery. Traditionally stage has been available through digital rectal examination and lymph node dissection, but over the period, MRI has emerged as the dominant staging tool for prostate cancer patients. MRI tends to discover more locally advanced cancers which may explain the observed shift from localised to regional disease. Ad hoc screening (PSA testing) has resulted in more patients being diagnosed in an early stage, and because the absolute number of patients diagnosed with metastatic cancer was quite stable, the observed decrease in the proportion of metastatic cancers was expected. For the other cancer sites, as for prostate cancer, more advanced and improved staging options have become available, and hence the possibility that this has led to shifts in the stage distributions cannot be excluded. In a study from Denmark, CPP patients tended to be less frequently diagnosed in a localised stage compared to all patients diagnosed prior to the CPP implementation [24]. They argued that this

could be due to GPs referring more advanced cases through urgent referrals. Our results indicate that this may not be the case in Norway.

In June 2011, the Prime Minister of Norway announced a "waiting-time guarantee" stating that 80% of all cancer patients, independent of cancer site, should start their treatment within 20 days of diagnosis. The waiting times for cancer treatment decreased after 2011, making the observed data for 2015–2016 (post CPP implementation) just a continuation of an already ongoing trend. This may indicate that the real effect of CPPs started when the politicians actively started discussing and setting goals for waiting time, and not at the time of implementation. The attitude may have changed among medical staff around the implementation of CPPs as the focus on waiting times arose, leading to reductions in waiting times for surgery and radiotherapy. These tendencies were also seen in Denmark where the waiting time for treatment decreased significantly prior to, and continued to decrease after the implementation of CPPs [6, 7, 25].

This study has some limitations that are worth mentioning. First, as many patients will receive other treatments than surgery and curative radiotherapy, information about alternative treatments such as immunotherapy or chemotherapy would have provided a more complete picture of the treatment patterns in the Norwegian population. Second, information about socioeconomic status and whether or not a patient was included in a CPP, were not available in these data. As previous studies have shown significant socioeconomic differences in the likelihood of receiving treatment in Norway, further studies may indicate whether differences in waiting time based on socioeconomic status exist after the implementation of cancer patient pathways [26, 27]. In addition, linking data from the CRN with pathway-specific data from the Norwegian Patient Register may determine whether waiting times vary based on

a patient's inclusion in a CPP. Third, this paper does not address the clinical effectiveness in terms of patients' prognosis as it is beyond its scope. However, it should be considered in future research as more data after CPP implementation become available. Despite these limitations, this study provides unique and important information regarding development in stage distribution and waiting times for treatment for colorectal, lung, breast and prostate cancers using complete information about surgery and radiotherapy from the period before and during the implementation of CPPs in Norway. The study's population-based design and the use of national, comprehensive and high-quality data provide results that are widely representative.

In conclusion, this study showed an improved stage distribution, as well as, a clear reduction in waiting time especially for radiotherapy, but also for surgery, over the period 2007–2016 in Norway. Even if cancer patient pathways were implemented in 2015, the observed improvements seem to be part of a pattern starting prior to the implementation. More data after the implementation are needed to show the clinical effect of cancer patient pathways.

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FIGURE AND TABLE LEGENDS

Figure 1: The number of patients diagnosed and the proportion of patients treated with surgery and radiotherapy within one year of diagnosis in Norway between 2000 and 2015.

Figure 2: Stage distribution for patients diagnosed with colorectal, lung, breast and prostate cancers in Norway between 2007 and 2016.

Figure 3: Median waiting time (marked with crosses) from date of diagnosis to date of treatment (surgery or curative radiotherapy) for colorectal, lung, breast and prostate cancer patients after adjusting for case-mix (age, sex, stage and place of residence). Year represents the year of treatment (surgery or curative radiotherapy). The linear trend lines come from a joinpoint regression analysis, where the (potential) joinpoint indicates where there is a significant change in waiting time.

Figure 4: Relative standard error (standard error/ median) of median waiting time from date of diagnosis to treatment (surgery or radiotherapy) in Norway between 2007 and 2016.

Table 1: Patient characteristics for colorectal, lung, breast and prostate cancer patients treated with surgery or curative radiotherapy in 2007–2016 in Norway (n = 89 152).

Table 2: Univariable and multivariable quantile regression for waiting time to surgery for colorectal, lung, breast and prostate cancer patients in 2007–2016 in Norway.

Table 3: Univariable and multivariable quantile regression for waiting time to radiotherapy for colorectal, lung and prostate cancer patients in 2007–2016 in Norway.