Emerging issues in cancer control

The ability to better characterize cancer cases can help guide the improvement of prevention, screening, patient care and treatment. This chapter presents two emerging issues related to the increasing complexity of care for cancer patients: cancer comorbidities and wait time to treatment. They are important in the context of describing the burden of cancer because they can help inform improvements in the cancer system.

Part 1:

Comorbidity and cancer

Comorbidities are conditions or diseases outside of the cancer of interest but which exist simultaneously alongside it. Comorbidities are not adverse effects of cancer treatment, but exist at the time of the cancer diagnosis. The presence of other illnesses may require more complex care or lengthier treatment, and may also increase the length of time spent waiting for treatment. As such, information on comorbidity can be valuable in understanding the full burden of disease because it is an indicator of the general health of the patient—and thus an important prognostic factor for survival. Information on comorbidity is collected from Canadian hospitals through the Discharge Abstract Database (DAD) and the National Ambulatory Care Reporting System (NACRS).[1, 2]

Information on comorbidity can be valuable in understanding the full burden of cancer as it is an indicator of general health—and thus an important prognostic factor for survival.

Some comorbid conditions (such as obesity or acquired or inherited immunosuppression) may in themselves be risk factors for cancer. At the same time, some medications used to treat comorbid conditions (such as anti-inflammatories, statins or antibiotics) may decrease the risk of cancer or improve cancer prognosis.[3–5] Comorbid conditions can also have an impact on the selection of treatment type and make some treatments prohibitive.[6–8] For example, lung cancer patients with severe chronic obstructive pulmonary disease (COPD) are not good candidates for resection and therefore have a reduced chance of survival.[9, 10]

Previous findings from other jurisdictions have shown poorer survival among cancer patients with comorbidities.[11] In addition, improvements in cancer survival observed over the past few decades have not been matched among patients with comorbid conditions.[12] Comorbidity can impact survival through a number of mechanisms, including generally higher mortality among those with concurrent chronic conditions, the effect of simultaneous treatment for the comorbidity and the cancer, the likelihood of less aggressive treatment among those with a comorbidity and the impact of the comorbid condition itself on the progression of the cancer.[11, 13]

This section presents statistics on the presence of comorbidities for cancer cases diagnosed from 2011 to 2015 for seven cancer types:

- bladder
- breast
- colorectal
- kidney
- lung
- melanoma
- pancreas

While statistics presented for years beyond 2013 in other chapters of this report are based on projected data, in this chapter actual (non-projected) data were used for all analyses.

Comorbidity by cancer type

The presence of comorbidities varied by cancer type. Of the seven cancer types examined, the cancer type with the greatest proportion of patients with no comorbidity (as measured by the Charlson Comorbidity Index [CCI]) was female breast cancer, with 89.7% of patients having a CCI score of zero (Table 3.1). In contrast, pancreatic cancer had the lowest proportion of patients with no comorbidity at 52.0%.

Among those with comorbidity, patients can be divided into those with moderate comorbidities (CCI score of one or two) and those with severe comorbidities (CCI score of three or more). In summary:

- While the majority of bladder cancer patients had no comorbidities, 27.4% had moderate comorbidities and 9.5% had severe comorbidities.
- Almost 90% of female breast cancer patients had no comorbidities, 8.8% had moderate comorbidities and 1.4% had severe comorbidities.
- Among colorectal cancer patients, 67.9% had no comorbidities, 25.2% had moderate comorbidities and 7.0% had severe comorbidities.
- The majority of kidney cancer patients had no comorbidities (64.8%), 26.5% had moderate comorbidities and 8.6% had severe comorbidities.
- Of the cancers examined, lung cancer patients were among the most likely to have at least one comorbidity (43.2% of patients had a CCI score of at least one) while 10.3% had severe comorbidities.
- The vast majority of melanoma patients had no comorbidities (87.7%), with only 2.5% having severe comorbidities.
- Pancreatic cancer patients were the most likely, of the cancers examined, to have severe comorbidities, with 13.3% of patients having a CCI score of at least three.

These findings are in line with research in the United States that found that comorbidity was more common in lung cancer patients than colorectal cancer patients and more common in colorectal cancer patients than breast cancer patients.[14] However, the prevalence of comorbidities found in that study was higher than in our analysis, particularly for colorectal and lung cancers, despite the fact that we included more comorbid conditions in our modified CCI index.

The variation in the prevalence of comorbidity by cancer type is partially explained by risk factors.[15] Cancers such as lung and bladder that have risk factors in common with chronic conditions (e.g., tobacco use) are more often associated with comorbidity. Conversely, cancers that are not strongly related to such risk factors (e.g., breast, melanoma) are less likely to be associated with comorbidity.[15] In addition, comorbidity prevalence tends to increase with age, meaning patients with cancers more often diagnosed at younger ages (e.g., melanoma, breast) are less likely to have comorbidity.

Cancers more often associated with comorbidity tend to have risk factors in common with other chronic conditions.

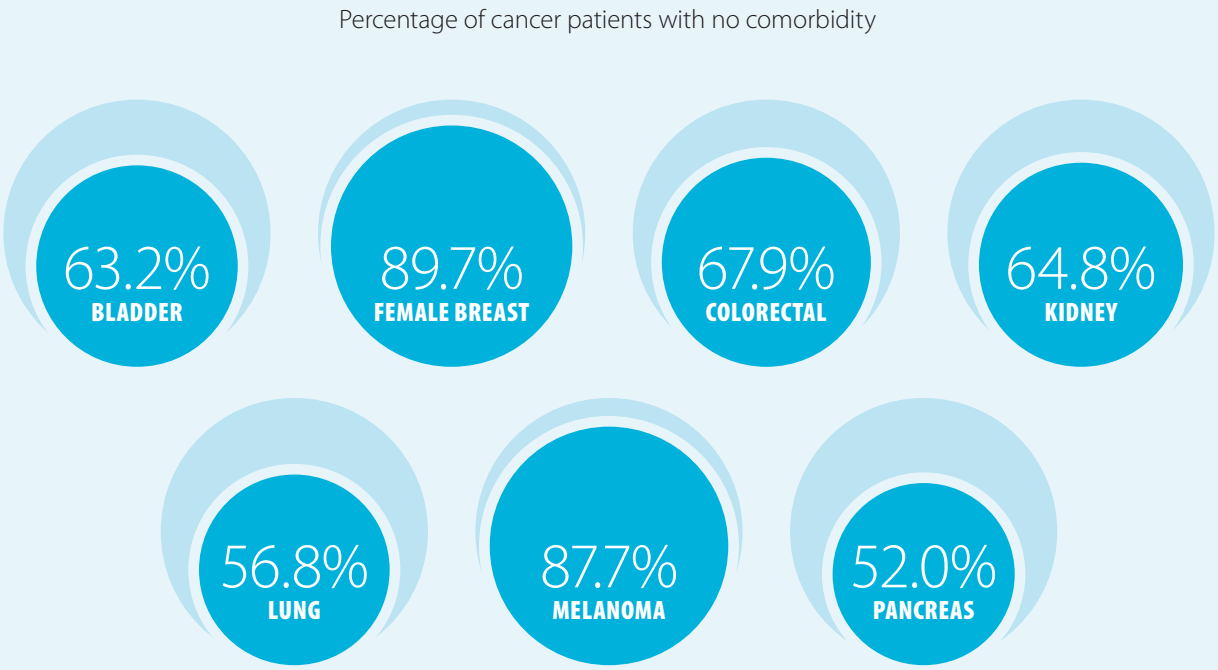


Table 3.1 **Prevalence of comorbidities by cancer type for selected cancers, Ontario, 2011–2015**

Cancer type	CCI score		
	0	1–2	3+
Bladder	6,239 (63.2%)	2,705 (27.4%)	934 (9.5%)
Breast (female)	40,934 (89.7%)	4,033 (8.8%)	656 (1.4%)
Colorectal	25,783 (67.9%)	9,561 (25.2%)	2,652 (7.0%)
Kidney	6,572 (64.8%)	2,691 (26.5%)	876 (8.6%)
Lung	24,855 (56.8%)	14,368 (32.9%)	4,509 (10.3%)
Melanoma	12,269 (87.7%)	1,363 (9.7%)	355 (2.5%)
Pancreas	4,291 (52.0%)	2,868 (34.7%)	1,096 (13.3%)

CCI=Charlson Comorbidity Index
Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (November 2016), CCO; Discharge Abstract Database; National Ambulatory Care Reporting System

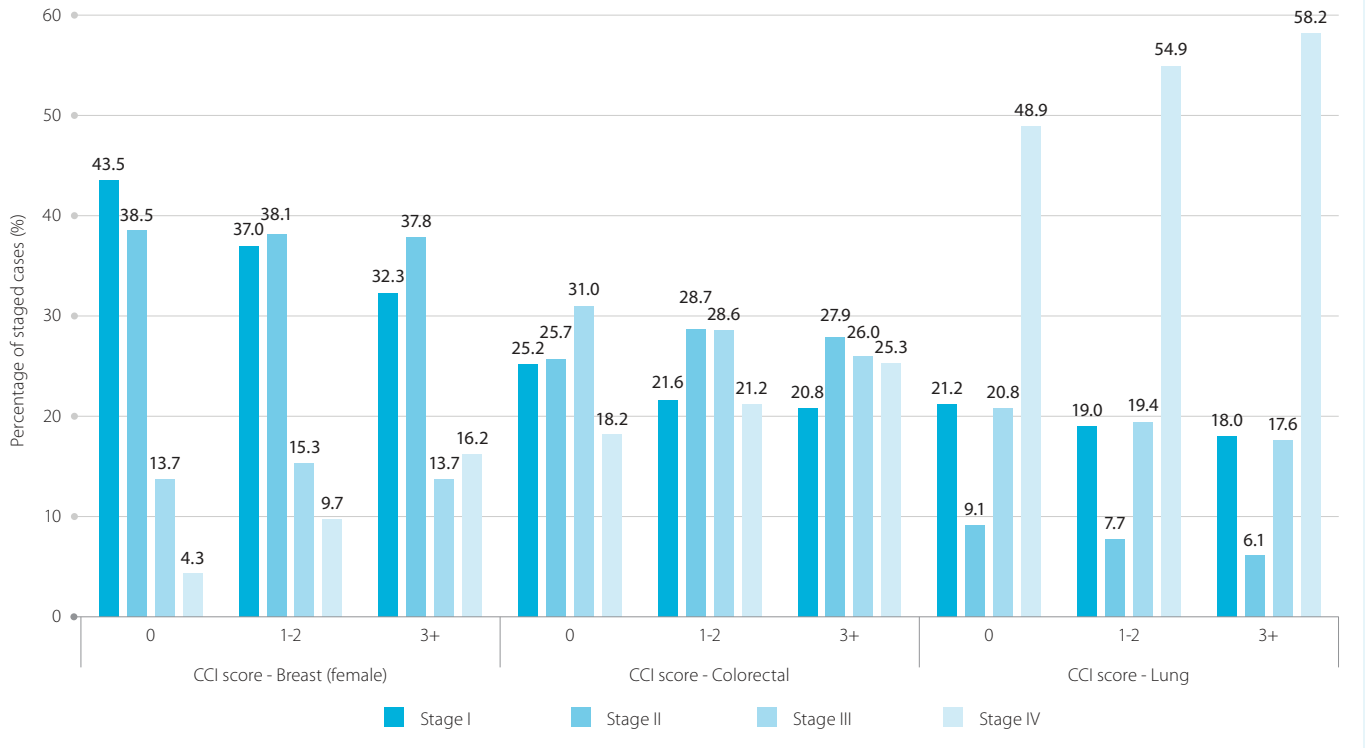
Comorbidity by stage

The prevalence of comorbidities by stage for the cancers for which stage data was available are presented in Figure 3.1. In general, for all three cancer types assessed, increasing level of comorbidity was associated with increasing likelihood of a stage IV diagnosis.

- Among breast cancer patients with no comorbidity the largest proportion were diagnosed at stage I (43.5%), while 18.0% were diagnosed at an advanced stage (stage III or stage IV). Among those with moderate comorbidities, 25.0% were diagnosed at an advanced stage, while 29.9% of those with severe comorbidities were diagnosed at an advanced stage.
- While 49.2% of colorectal cancer patients with no comorbidity were diagnosed at an advanced stage, the number was similar at 51.3% among those with severe comorbidities. However, the proportion of patients diagnosed at stage IV increased from 18.2% among those with no comorbidities to 25.3% among those with severe comorbidities.
- Among lung cancer patients, the proportion of those diagnosed at an advanced stage increased with increasing prevalence of comorbidities. However, lung cancer tends to be diagnosed at more advanced stages regardless of the prevalence of comorbidity in the patient. In 2013, 71.0% of staged lung cancer cases were diagnosed at stage III or IV (see *Chapter 4: Cancer incidence rates and trends*). A similar number (75.8%) of lung cancer patients with severe comorbidities were diagnosed at an advanced stage.

It has been argued that patients with comorbidity are more likely to be diagnosed at more advanced stages because comorbidity may mask the early symptoms of cancer.[16] Previous studies of comorbidity and stage at diagnosis have found differing results including that patients with comorbidity are more likely to be diagnosed earlier, later or at a similar stage as those without comorbidity, with the variations in

Figure 3.1 **Prevalence of comorbidities by cancer type, stage at diagnosis and CCI score for selected cancers, Ontario, 2011–2015**



CCI=Charlson Comorbidity Index
Note: Case counts are as follows: breast n = 45,623 (excludes unknown stage = 310); colorectal n = 37,996 (excludes unknown stage = 1,010); lung n = 43,732 (excludes unknown stage = 399). Cases that were not staged were excluded from this analysis.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (November 2016), CCO; Discharge Abstract Database; National Ambulatory Care Reporting System

findings attributed to cancer type, comorbidity type, different populations and different healthcare systems.[15] In Ontario, at least, it appears that the possible positive implication of comorbidities (i.e., more frequent contact with the healthcare system) have not resulted in increased detection of cancer, and that those with comorbidities are more likely to be diagnosed at an advanced stage than those without comorbidities.

It should be noted that approximately 10% to 20% of breast, lung and colorectal cancer cases in the Ontario Cancer Registry are missing any information on stage at diagnosis and are therefore excluded from this analysis. We cannot be sure that the distribution of comorbidity score would be the same for these cases.

Type of comorbidity

For each of the seven cancers of interest, the five most common comorbidities measured by the CCI index are presented in Table 3.2.

For bladder, breast, colorectal and pancreatic cancers, as well as melanoma, the most common comorbidities were diabetes without complications, followed by another cancer diagnosis (other than the cancer of interest) and COPD. For kidney cancer, the third most common comorbidity was renal disease, followed by COPD. For lung cancer, COPD was the most common comorbidity.

Cardiovascular conditions (congestive heart failure and myocardial infarction) were another common comorbidity, appearing in the five most common comorbidities for all cancer types except kidney.

Table 3.2 **Five most common comorbidities by cancer type for selected cancers, Ontario, 2011–2015**

Bladder		Breast (female)		Colorectal	
Diabetes without complications	16.0%	Diabetes without complications	5.5%	Diabetes without complications	15.4%
Cancer (non-bladder)	11.7%	Cancer (non-breast)	2.0%	Cancer (non-colorectal)	6.4%
COPD	5.1%	COPD	1.3%	COPD	4.3%
Renal disease	4.4%	Congestive heart failure	0.9%	Congestive heart failure	3.9%
Congestive heart failure	3.8%	Diabetes with complications	0.6%	Myocardial infarction	2.8%
Kidney		**Lung**		**Melanoma**	
Diabetes without complications	16.4%	COPD	16.7%	Diabetes without complications	4.9%
Cancer (non-kidney)	9.4%	Diabetes without complications	14.3%	Cancer (non-melanoma)	4.5%
Renal disease	4.6%	Cancer (non-lung)	10.4%	Congestive heart failure	1.2%
COPD	4.4%	Congestive heart failure	4.9%	COPD	1.1%
Diabetes with complications	4.3%	Myocardial infarction	3.5%	Myocardial infarction	0.9%
Pancreas					
Diabetes without complications	26.9%				
Cancer (non-pancreatic)	14.0%				
COPD	4.6%				
Diabetes with complications	4.4%				
Congestive heart failure	3.0%				

COPD=Chronic obstructive pulmonary disease
Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (November 2016), CCO; Discharge Abstract Database; National Ambulatory Care Reporting System

Survival by prevalence of comorbidities

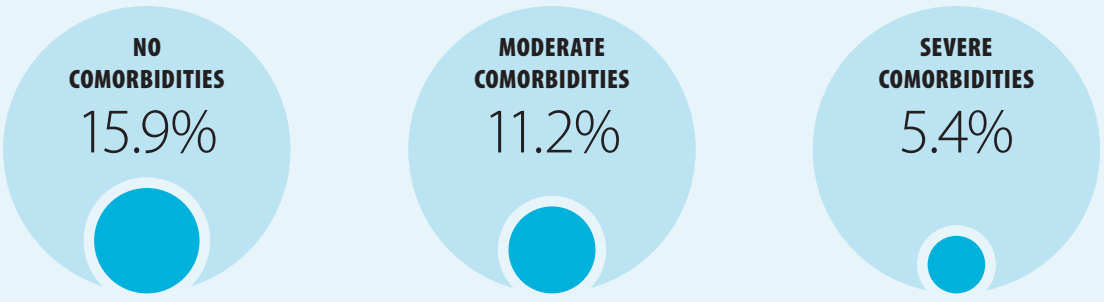
Three-year relative survival for the period 2011 to 2015 tended to decrease with increasing CCI score (Table 3.3). These findings are in line with other data that showed similar findings.[11] In this analysis, although survival for all seven cancer types decreased significantly, the level of decrease varied by cancer type. Comorbidities had the greatest effect on survival for pancreatic and lung cancers and the least effect on survival for kidney and breast cancers.

- For bladder cancer, the three-year relative survival ratio (RSR) decreased significantly from 77.6% for those with a CCI score of zero (no comorbidities) to 58.6% for those with a score of one or two (moderate comorbidities) and to 36.4% for those with a score of three or more (severe comorbidities).
- Breast cancer survival decreased less compared to the other cancers examined. Survival was very high at 94.8% for those with a CCI score of zero, although it declined to 53.1% for those with severe comorbidities. This finding is in line with previous studies, which also found that the effect of comorbidity on breast cancer survival persisted even after adjustment for age and stage at diagnosis.[17]
- Survival for colorectal cancer also declined considerably, from 80.3% for those with a score of zero to 40.5% for those with severe comorbidities.
- Kidney cancer survival decreased from high survival of 85.2% among those with a CCI score of zero to 53.4% among those with severe comorbidities.

Three-year relative survival tended to decrease with increasing CCI score. Comorbidities had the greatest effect on survival for pancreatic and lung cancers and the least effect on survival for kidney and breast cancers.

- Lung cancer survival decreased from 32.5% for those with a score of zero to just 13.5% for those with severe comorbidities. This decline may be the result of comorbid pulmonary diseases that may delay the diagnosis of lung cancer.[18] In addition, a CCI score of three or more has been shown to increase the risk of post-operative complications following therapeutic surgery for lung cancer[18] — although recent increases in the use of video-assisted thoracoscopic surgery has helped to improve safety.[19–21]
- Comorbidities had a considerable effect on survival for melanoma. While people with a score of zero had a high three-year RSR of 92.7%, this number fell to just 41.7% for those with severe comorbidities.
- Pancreatic cancer showed the lowest survival of all the cancers examined, patients with a CCI score of zero had a three-year RSR of just 15.9%. This number declined to 11.2% for those with moderate comorbidities and 5.4% for those with severe comorbidities. This decrease is particularly concerning because almost half of pancreatic cancer patients had comorbidities (Table 3.1).

Three-year relative survival ratios for patients with pancreatic cancer - the lowest survival of all cancers examined



These results are somewhat contrary to other studies that have found that comorbidity has a greater effect on survival for high survival cancers than low survival cancers.[11, 22] This analysis, on the other hand, found that pancreatic and lung cancers—both low survival cancers—showed the greatest relative change in survival with increasing comorbidity.

While this analysis highlights the importance of comorbidity as a prognostic factor for the seven cancer types discussed, it does not explain the mechanism behind this relationship. Further analysis will be required to isolate what factors lead to decreased survival in people with comorbidity. Although these results have shown that cancer patients with comorbidities in Ontario are more likely to be diagnosed at an advanced stage, comorbidity may also affect choice of treatment, adherence and response to that treatment, or the cancer or its treatment may affect the comorbidity itself. These underlying mechanisms need to be understood before interventions can be implemented to mitigate the effect of comorbidity on the burden of cancer. The prevalence of comorbidities in new cancer patients is expected to increase as Ontario's population ages, emphasizing the importance of further understanding the impact of comorbidity on patient care and outcomes.

Table 3.3 **Three-year relative survival ratios by CCI score for selected cancers, Ontario, 2011–2015**

Cancer type	RSR % (95% CI)		
	CCI score = 0	CCI score = 1–2	CCI score = 3+
Bladder	77.6 (74.0–77.2)	58.6 (55.9–61.1)	36.4 (32.3–40.6)
Breast (female)	94.8 (94.4–95.2)	79.3 (77.4–81.1)	53.1 (47.8–58.2)
Colorectal	80.3 (79.6–80.9)	63.2 (61.7–64.4)	40.5 (38.0–43.1)
Kidney	85.2 (83.9–86.3)	72.4 (70.1–74.6)	53.4 (49.0–57.7)
Lung	32.5 (31.7–33.2)	22.0 (21.1–22.9)	13.5 (12.1–14.9)
Melanoma	92.7 (91.9–93.5)	69.6 (66.0–73.0)	41.7 (34.7–48.7)
Pancreas	15.9 (14.5–17.4)	11.2 (9.8–12.8)	5.4 (3.8–7.4)

CCI=Charlson Comorbidity Index
CI=Confidence interval
RSR=Relative survival ratio
Note: Analysis was restricted to ages 15 to 99.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (November 2016), CCO; Discharge Abstract Database; National Ambulatory Care Reporting System

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Part 2:

Wait time and cancer

While some wait for treatment is inevitable, because cancer may grow and spread to other parts of the body over time, a delay in initiating treatment may result in the loss of an opportunity for a cure.[1] Longer wait times result not only in delays in receiving treatment but have also been linked to inefficiencies and poorer quality of care.[2, 3] In addition, long wait times to treatment have been shown to adversely affect the patient's quality of life.[4]

This section focuses on the wait time to one particular type of cancer treatment: surgery. In the past, wait times for cancer surgery had increased over time both in Ontario[5–9] and other Canadian provinces.[10, 11] This resulted in a first minister's conference on wait times in 2004 and was a major impetus for creating the Wait Time Information System (WTIS) as well as access-to-care targets with public reporting for cancer surgery and other surgical services in Ontario.[1]

Surgery is a key component of curative treatment for most cancers. About 80% of cancer patients will have surgery at some point during their treatment.[12] Wait time is defined here as the time between the decision to treat the cancer with surgery and the first therapeutic surgery performed after diagnosis. This is known as 'Wait 2'. The decision-to-treat date is the date on which sufficient pre-treatment testing has been completed that the physician can reasonably assume that the patient will be treated, and the patient has agreed to the treatment.[1]

Statistics are presented for cases diagnosed from 2011 to 2015 for seven cancers:

- breast
- colorectal
- esophagus
- lung
- oral cavity & pharynx
- ovary
- pancreas

These cancer types were chosen because surgical treatment is often a primary method of treatment for these cancers. While this analysis includes only patients who received surgical treatment, it does not exclude patients who had other treatments as well (e.g., radiation, chemotherapy).

Wait time statistics are also examined by stage at diagnosis and age because these two factors may influence the urgency of surgery—although it is recognized that other factors such as aggressiveness of the cancer type and patient health are also important prognosticators considered by clinicians when assigning a priority level for wait. Survival by wait time is also examined.

While statistics presented for years beyond 2013 in other chapters of this report are based on projected data, in this chapter actual non-projected data were used for all analyses.

While some wait for treatment is inevitable, because cancer may grow and spread to other parts of the body over time, a delay in initiating treatment may result in the loss of an opportunity for a cure.

Wait time by cancer type and stage

Of the seven cancers examined, female breast and esophageal cancers had the shortest median wait times for surgical treatment at 16 days (Table 3.4). The longest median wait time was for oral cavity & pharynx cancers at 20 days. In addition:

- The median wait time was similar for breast cancer cases regardless of stage at diagnosis, averaging between 15 and 16 days.
- Wait time tended to decrease with increasing stage for colorectal cancer. Stage I cases had a median of 20 days while stage IV cases had a median of 15 days.
- Lung cancer wait times also decreased with increasing stage but by a greater degree, declining from a median of 20 days at stage I to nine days at stage IV.

Table 3.4 Wait time to receipt of surgical treatment by stage for selected cancers, Ontario, 2011–2015

Cancer type	Stage at diagnosis	N	Median wait time (days)	Wait time interquartile range (days)	Wait time range (days)
Breast (female)	All stages	42,882	16.0	15.0	0–1127
	I	18,328	16.0	14.0	0–1127
	II	16,737	15.0	14.0	0–750
	III	5,967	15.0	16.0	0–366
	IV	549	16.0	15.0	0–77
Colorectal	All stages	22,397	18.0	17.0	0–375
	I	4,644	20.0	17.0	0–208
	II	6,122	17.0	16.0	0–375
	III	7,636	18.0	18.0	0–373
	IV	2,822	15.0	17.0	0–373
Esophagus	All stages	1,084	16.0	15.5	0–167
Lung	All stages	9,100	17.0	15.0	0–390
	I	4,128	20.0	15.0	0–390
	II	1,868	16.0	14.0	0 - 129
	III	1,620	15.0	15.0	0–132
	IV	985	9.0	14.0	0–79
Oral cavity & pharynx	All stages	4,010	20.0	16.0	0–682
Ovary	All stages	3,015	19.0	21.0	0–229
Pancreas	All stages	1,566	17.0	18.0	0–141

Notes: 1. Analysis was restricted to cases with surgical treatment.
2. Priority level one cases were excluded.
3. Stage data was not available for esophageal, oral cavity & and pharynx, ovarian or pancreatic cancers. Stage analysis excludes the following cases with unknown stage: breast n = 1,191; colorectal n = 1,091; lung n = 491. Cases that were not staged were excluded from this analysis.
4. Dates Affecting Readiness to Treat (DART) wait time was excluded from this analysis.
5. Interquartile range is the difference between the 75th and 25th percentiles.

Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (March 2017), CCO; Wait Times Information System (March 2017), CCO

Wait time by age

The median wait time to treatment varied not only by cancer type but also by age group (Table 3.5). Other findings include:

- Among women with breast cancer the median wait time increased with increasing age, with those diagnosed under the age of 40 having a median wait time of 14 days and those diagnosed at age 80 or older having a median time of 18 days.
- Median wait time for colorectal cancer treatment ranged between 17 and 18 days regardless of the age of the patient.
- Wait time for esophageal cancer treatment was relatively short for the youngest age group (0–39 years) with a median of 10 days, although this was based on a small number of cases (n=11). After age 39, the median wait time decreased from 17 days for those ages 40–59 to 15 days for those 80 and older.
- Wait time for lung cancer surgery tended to increase with increasing age: from a median of 12 days in the youngest age group to 17 days in the oldest age group.
- As with colorectal cancer, wait time for oral cavity & pharynx cancer surgery was similar across age groups although the oldest age group experienced slightly longer wait times than younger people.
- For ovarian cancer patients median wait time was lowest for those ages 60–79 (16 days) but was higher (19 to 20 days) for those in the other age groups.
- For pancreatic cancer surgery wait time tended to decrease with increasing age, with those diagnosed before the age of 40 experiencing a median wait time of 21 days while those diagnosed at age 80 or older had a median wait time of 17 days.

Table 3.5 **Wait time to surgical treatment by age group for selected cancers, Ontario, 2011–2015**

Cancer type	Age group (years)											
	0–39			40–59			60–79			80+		
	N	Median wait time (days)	Interquartile range (days)	N	Median wait time (days)	Interquartile range (days)	N	Median wait time (days)	Interquartile range (days)	N	Median wait time (days)	Interquartile range (days)
Breast (female)	2,236	14.0	14.0	18,789	16.0	14.0	18,668	16.0	14.0	3,189	18.0	14.0
Colorectal	566	17.0	18.0	6,147	17.0	17.0	12,085	18.0	17.0	3,599	18.0	16.0
Esophagus	11	10.0	21.0	353	17.0	15.0	661	16.0	16.0	59	15.0	18.0
Lung	89	12.0	14.0	1,914	15.0	15.0	6,355	17.0	16.0	742	17.0	15.0
Oral cavity & pharynx	167	21.0	15.0	1,587	20.0	17.0	1,893	20.0	16.0	363	22.0	17.0
Ovary	238	19.0	20.0	1,275	19.0	20.0	1,369	16.0	21.0	133	20.0	21.0
Pancreas	59	21.0	33.0	470	15.5	18.0	937	18.0	17.0	100	17.0	15.5

Notes: 1. Analysis was restricted to cases with surgical treatment.
2. Priority level one cases were excluded.
3. Dates Affecting Readiness to Treat (DART) wait time was excluded from this analysis.
4. Interquartile range is the difference between the 75th and 25th percentiles.

Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (March 2017), CCO; Wait Time Information System (March 2017), CCO

Wait time by priority level

In Ontario, once the decision to treat the cancer with surgery is made, the patient is assigned a priority level that reflects the urgency of surgery. Priority level is based on the urgency of the cancer treatment and is therefore dependent on many factors including tumour stage, tumour behaviour and patient health.[13]

There are four priority levels:

- level I (surgery recommended within 24 hours);
- level II (highly aggressive malignancies, surgery recommended within 14 days);
- level III (invasive malignancies that do not meet the criteria for priority level II or IV, surgery recommended within 28 days); and
- level IV (slow growing malignancies, surgery recommended within 84 days).

Priority level I cases were excluded from this analysis due to incomplete wait time data.

These priorities are only a guide; clinical judgement, based on individual patient symptomatology and condition, take precedence. Recommended maximum wait times should be interpreted as the longest that any patient should have to wait, recognizing that some will require surgery sooner and some later within that time interval, based on the specific tumour biology.[1]

For the seven cancer types examined, the majority of cases were assigned priority level III, regardless of stage at diagnosis.

For the seven cancer types examined, the majority of cases were assigned priority level III (28 days), regardless of stage at diagnosis (Table 3.6). Other findings include:

- Breast cancer cases were the least likely to be assigned priority II of all the cancer types examined. Additionally, the proportion of breast cancer cases assigned either priority level II or IV increased with advancing stage at diagnosis. In the case of priority II level patients, this reflects the greater urgency of treatment as stage at diagnosis increases. In the case of priority level IV patients, on the other hand, this probably reflects the increased likelihood that surgery is being used for symptom management only.
- Unlike breast cancer, the proportion of colorectal cancer cases assigned priority level IV decreased with increasing stage, as would be expected. However, 17.1% of stage IV colorectal cases were still assigned priority level IV status.
- Esophageal cancer had the highest proportion of cases assigned priority level III, at 83.3%.
- The proportion of lung cancer cases assigned priority level II increased with stage at diagnosis, and almost a quarter of stage IV cases were priority level II. A similar proportion of cases were assigned priority level IV across the stages.
- Oral cavity & pharynx and pancreatic cancer cases were the most likely of the cancers examined to be assigned priority level IV with approximately a quarter of cases falling into this category.
- An equal proportion of ovarian cancer cases were assigned priority level II (8.5%) as priority level IV (8.8%).

Table 3.6 Distribution of cases by stage at diagnosis and priority level assignment for selected cancers, Ontario, 2011–2015

Cancer type	Stage	Priority level		
		II n (%)	III n (%)	IV n (%)
Breast (female)	All stages	2,310 (5.4%)	34,933 (81.5%)	5,628 (13.1%)
	I	824 (4.5%)	15,126 (82.6%)	2,373 (13.0%)
	II	941 (5.6%)	13,737 (82.1%)	2,057 (12.3%)
	III	399 (6.7%)	4,670 (78.3%)	896 (15.0%)
	IV	69 (12.6%)	376 (68.5%)	104 (18.9%)
Colorectal	All stages	2,158 (9.6%)	16,000 (71.5%)	4,223 (18.9%)
	I	303 (6.5%)	3,355 (72.3%)	980 (21.1%)
	II	618 (10.1%)	4,416 (72.2%)	1,086 (17.8%)
	III	736 (9.6%)	5,428 (71.1%)	1,468 (19.2%)
	IV	378 (13.4%)	1,958 (69.5%)	482 (17.1%)
Esophagus	All stages	78 (7.2%)	901 (83.3%)	103 (9.5%)
Lung	All stages	520 (5.7%)	7,443 (81.8%)	1,135 (12.5%)
	I	81 (2.0%)	3,515 (85.2%)	532 (12.9%)
	II	65 (3.5%)	1,591 (85.3%)	210 (11.3%)
	III	80 (4.9%)	1,360 (84.0%)	180 (11.1%)
	IV	243 (24.7%)	607 (61.6%)	135 (13.7%)
Oral cavity & pharynx	All stages	240 (6.0%)	2,741 (68.4%)	1,026 (25.6%)
Ovary	All stages	103 (8.5%)	2,492 (82.7%)	266 (8.8%)
Pancreas	All stages	103 (6.6%)	1,110 (70.9%)	353 (22.5%)

Notes: 1. Analysis was restricted to cases with surgical treatment.
2. Priority level one cases were excluded.
3. Stage data was not available for esophageal, oral cavity & pharynx, ovarian or pancreatic cancers. Stage analysis excludes the following cases with unknown stage: breast n = 1,191; colorectal n = 1,091; lung n = 491. Cases that were not staged were excluded from this analysis.
4. Dates Affecting Readiness to Treat (DART) wait time was excluded from this analysis.

Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (March 2017), CCO; Wait Time Information System (March 2017), CCO

Wait time to receipt of surgery

The majority of patients received surgery within the time recommended by their priority level (Table 3.7). The proportion of patients receiving treatment within the recommended time increased with increasing priority level. Similar results were previously reported for all cancers combined in Ontario.[13] In addition:

- Among priority level II breast cancer patients, 72.1% received surgical treatment within 14 days (as prescribed by their priority level); however, 4.9% waited more than 28 days. For priority level III patients, 87.1% received surgery within 28 days. For priority level IV patients, 98.9% received surgery within 84 days.
- Colorectal cancer patients showed a similar pattern to breast cancer patients with 76.3% of priority level II patients receiving surgery with 14 days, 82.0% of priority level III patients receiving surgery within 28 days and 97.9% of priority level IV patients receiving treatment within 84 days.
- Among esophageal cancer patients, 83.3% of priority level II patients received surgery within 14 days while 86.3% of priority level III patients received surgery within 28 days. However 13.3% of priority level III patients waited more than 28 days.
- Of the cancers examined, lung cancer patients were the most likely to receive surgical treatment within the recommended time. Among priority level II lung cancer patients, 92.7% of received surgery within 14 days. Among the priority level III patients 85.5% received treatment within 28 days. However, 1.9% of priority level IV patients waited more than 84 days for treatment.
- Oral cavity & pharynx cancer priority level II patients had a relatively low proportion meet the wait time recommendations, with just 72.5% receiving surgery within 14 days. Among priority level III patients, 78.2% received treatment within the recommended 28 days. Oral cavity & pharynx cancer patients were also the most likely to wait more than 84 days, with 3.7% of priority level IV patients falling into this category.
- Of the cancers examined, ovarian cancer patients were the least likely to receive surgery within the recommended time. Among priority II patients just 65.2% of patients received surgery within the recommended 14 days. This pattern continued with priority III patients among whom 74.5% received treatment within 28 days. Finally, 2.3% of priority IV patients had a wait time of more than 84 days.
- Priority II pancreatic cancer patients received surgery within 14 days 77.7% of the time, while 83.2% of priority III patients received surgery within 28 days.

Based on the results listed in Table 3.7, a considerable proportion of priority level II and III patients were required to wait longer than recommended. There are many possible reasons for these waits that involve both system delays and individual patient requirements. These include delays associated with obtaining additional diagnostic testing prior to surgery, treatment of comorbidities prior to surgery, scheduling surgery based on availability of a surgical oncologist and operating room, and the need to administer pre-operative chemotherapy for some cancers.

Lung cancer patients receiving surgical treatment within the recommended time

Table 3.7 Distribution of cases by wait time to surgical treatment by assigned priority level for selected cancers, Ontario, 2011–2015

Cancer type	Priority level	Wait time (days)				Total exceeding recommended wait time
		≤ 14 n (%)	15–28 n (%)	29–84 n (%)	> 84 n (%)	
Breast (female)	II	1,666 (72.1%)	529 (22.9%)	113 (4.9%)	**	**632 (27.8%)†**
	III	15,477 (44.3%)	14,938 (42.8%)	4,462 (12.8%)	56 (0.2%)	**4,518 (13.0%)**
	IV	1,656 (29.4%)	1,935 (34.4%)	1,974 (35.1%)	63 (1.1%)	**63 (1.1%)**
Colorectal	II	1,646 (76.3%)	392 (18.2%)	114 (5.3%)	6 (0.3%)	**512 (23.8%)**
	III	6,083 (38.0%)	7,037 (44.0%)	2,819 (17.6%)	61 (0.4%)	**2,880 (18.0%)**
	IV	1,049 (24.8%)	1,315 (31.2%)	1,771 (41.9%)	87 (2.1%)	**87 (2.1%)**
Esophagus	II	65 (83.3%)	10 (12.8%)	**	**	**13 (16.7%)**
	III	377 (41.8%)	401 (44.5%)	120 (13.3%)	0	**120 (13.3%)**
	IV	27 (26.2%)	31 (30.1%)	40 (38.8%)	**	**
Lung	II	482 (92.7%)	33 (6.4%)	**	**	**38 (7.3%)**
	III	2,083 (40.1%)	3377 (45.4%)	1,068 (14.4%)	15 (0.2%)	**1,083 (14.6%)**
	IV	321 (28.3%)	351 (30.1%)	441 (38.9%)	22 (1.9%)	**22 (1.9%)**
Oral cavity & pharynx	II	174 (72.5%)	49 (20.4%)	17 (7.1%)	0	**66 (27.5%)**
	III	832 (30.4%)	1,310 (47.8%)	588 (21.5%)	11 (0.4%)	**599 (21.9%)**
	IV	240 (23.4%)	333 (32.5%)	415 (40.5%)	38 (3.7%)	**38 (3.7%)**
Ovary	II	167 (65.2%)	57 (22.3%)	31 (12.1%)	**	**88 (34.4%)†**
	III	993 (39.9%)	862 (34.6%)	629 (25.2%)	8 (0.3%)	**637 (25.5%)**
	IV	85 (32.0%)	51 (19.2%	124 (46.6%)	6 (2.3%)	**6 (2.3%)**
Pancreas	II	80 (77.7%)	18 (17.5%)	**	**	**23 (22.3%)**
	III	478 (43.1%)	450 (40.1%)	180 (16.2%)	**	**180 (16.2%)†**
	IV	101 (28.6%)	102 (28.9%)	141 (39.9%)	9 (2.6%)	**9 (2.6%)**

**Suppressed due to small cell count (n<6)
†Excludes patients who were suppressed due to small cell count
Notes: 1. Analysis was restricted to cases with surgical treatment.
2. Priority level one cases were excluded.
3. Dates Affecting Readiness to Treat (DART) wait time was excluded from this analysis.
4. Red shading indicates cases that exceeded the recommeded wait time.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (March 2017), CCO; Wait Time Information System (March 2017), CCO

Survival by wait time

Because a cancer patient's prognosis can be influenced by when they receive their surgery, this section examines five-year survival in relation to wait time. Note that this section reports observed survival, unlike elsewhere in this report where relative survival statistics are presented, which are not directly comparable.

Observed survival is presented here because the study population is restricted to only those patients who underwent surgical treatment, a population for which available life tables are not applicable.

The following statistics show estimates of survival without taking into account other prognostic factors that may influence survival. As a result, these estimates should be interpreted with caution and with the understanding that this descriptive analysis did not control for these other factors. Future research on this topic is planned which will investigate these other variables and address some of the other limitations of this analysis.

Five-year observed survival by actual wait time to receipt of surgery and stage at diagnosis is presented in Table 3.8.

Breast cancer five-year observed survival did not change with increasing wait time to treatment:

- Patients who waited less than 15 days and patients who waited more than 84 days showed no significant difference in survival. There was similarly no difference in survival by wait time when survival was examined by stage at diagnosis.
- This is positive when compared to results from the United States, which found that increased wait time to breast cancer surgery in American patients resulted in decreased survival, particularly among stage I and II cases.[14] The American study, however, used a different methodology and controlled for a number of possible confounders that could not be included in this analysis. These differences in study design may explain the discordant results. Another study also found that increased wait time to treatment (all treatment types) decreased survival for breast cancer patients.[3] However, other studies found no association between wait time to treatment and breast cancer survival.[2, 15, 16]

Survival for colorectal cancer on the other hand did vary by wait time:

- Five-year survival for those that received treatment within 14 days (61.9%) was significantly lower than those who received treatment between 15 days and 28 days (68.8%) or 29 days to 84 days (69.5%).
- A significant difference in survival was found among stage I patients when the data were broken down by stage. Stage I patients who waited 14 days or less experienced significantly lower survival (78.0%) compared to those who waited 15 days to 28 days (83.8%) or 29 days to 84 days (84.3%).
- One UK study also found increased colorectal cancer mortality among patients with shorter wait times.[17] Other analyses have tended to find no association between wait times to colorectal cancer treatment and survival.[18–21]

Survival from esophageal cancer did not vary significantly by wait time, with patients showing similar five-year survival regardless of how long they waited for treatment. This finding is not surprising because esophageal cancer is one cancer type for which most studies have not found an association between wait time to treatment and survival.[22–25]

As with colorectal cancer, lung cancer patients who waited 14 days or less showed significantly lower five-year survival (37.8%) compared to those who waited more than 14 days.

- This finding agrees with previous studies of lung cancer which also found that shorter wait times were associated with poorer prognoses.[26, 27] However, other studies found no association between wait time to treatment and lung cancer outcomes.[28–30]
- In this analysis, when lung cancer survival was examined by stage, no significant differences by wait time were observed for any stage. A previous Ontario study of the effect of wait time to surgical treatment for non-small cell lung cancer found no difference in survival among stage I patients but lower survival among stage II patients who waited 29 days to 56 days compared to those who waited 14 days or less. [31]

Five-year observed survival for colorectal cancer:

Patients who waited 29 days to 84 days for oral cavity & pharynx surgery showed significantly higher survival (65.1%) compared to those who waited 14 days or less (55.5%) and 15 days to 28 days (57.0%).

- Previous studies have found conflicting results, with some finding longer wait times for head and neck cancer treatment being associated with increased risk of mortality[32, 33] and others finding no association.[34]

Ovarian cancer patients who waited 29 days to 84 days showed significantly higher survival (51.6%) compared to those who waited 14 days or less (35.7%), but no significant difference compared to those who waited 15 days to 28 days.

Pancreatic cancer patients who waited 29 days to 84 days showed significantly higher survival (30.1%) than those who waited 14 days or less (18.1%) or 15 to 28 days (16.3%). There was no significant difference in survival between those who waited 14 days or less and those who waited 15 to 28 days. Most studies have found no significant association between pancreatic wait times and survival.[35, 36]

The results of this survival analysis found no evidence that increased wait time to surgical cancer treatment is associated with decreased survival in Ontario.

Without controlling for potentially confounding factors, wait time to surgical treatment for breast and esophageal cancer showed no effect on five-year observed survival. For colorectal, lung, oral cavity & pharynx, ovarian and pancreatic cancers, wait time does appear to affect survival—but not in the direction expected. For these cancers, when survival differed significantly by wait time, it was the patients with the shortest wait time who experienced lower survival compared to patients who waited longer. There are a number of possible explanations for this finding. One theory, which has been advanced by other researchers, is that this may be caused by selection bias, with patients with the more severe symptoms or aggressive disease being prioritized for surgery.[26] Patients may have also been prioritized for surgery due to factors external to the disease, including comorbidity and other personal risk factors. As a result, the lower survival in patients with shorter wait times may just be a reflection of generally lower survival among those with more advanced or aggressive disease and not the effect of wait time. This phenomenon has been termed the "waiting time paradox".[37] The results of this survival analysis found no evidence that increased wait time to surgical cancer treatment is associated with decreased survival in Ontario, supporting the appropriateness of the current wait time prioritization approach.

Table 3.8 Observed five-year survival by wait time and stage for selected cancers, Ontario, 2011

Cancer type	Stage	Wait time (days)			
		≤ 14 OS % (95% CI)	15 to 28 OS % (95% CI)	29 to 84 OS % (95% CI)	> 84 OS % (95% CI)
Breast (female)	All stages	86.3 (85.4–87.1)	86.1 (85.2–86.9)	84.7 (83.4–86.1)	84.5 (70.4–92.3)
	I	94.3 (93.3–95.1)	93.3 (92.3–94.2)	93.7 (92.2–95.1)	95.3 (71.3–99.3)
	II	86.1 (84.6–87.5)	84.6 (82.9–86.1)	83.7 (81.1–85.9)	**
	III	68.9 (65.7–71.8)	69.8 (66.3–73.0)	64.8 (59.8–69.4)	**
	IV	18.6 (10.8–28.1)	28.3 (19.2–38.0)	34.9 (20.7–49.4)	**
Colorectal	All stages	61.9 (60.3–63.5)	68.8 (67.2–70.0)	69.5 (67.3–71.6)	69.2 (57.3–78.4)
	I	78.0 (73.9–81.4)	83.8 (80.7–86.4)	84.3 (80.4–87.5)	**
	II	75.7 (72.9–78.4)	75.7 (72.6–78.5)	71.6 (67.0–75.2)	**
	III	63.4 (60.8–66.1)	66.0 (63.1–68.7)	66.2 (62.5–68.7)	**
	IV	15.3 (12.3–18.5)	18.7 (14.3–23.4)	20.9 (12.3–23.4)	**
Esophagus	All stages	23.7 (18.0–29.8)	32.0 (25.2–38.9)	24.1 (15.6–33.6)	**
Lung	All stages	37.8 (35.3–40.3)	50.2 (47.2–53.0)	47.3 (43.3–51.1)	**
	I	62.8 (57.3–67.8)	69.2 (64.6–73.3)	62.8 (56.6–68.4)	**
	II	46.2 (40.5–51.7)	45.2 (38.0–51.3)	40.7 (32.4–48.9)	**
	III	25.8 (20.9–30.9)	26.3 (20.7–32.2)	24.2 (17.1–32.2)	**
	IV	4.6 (2.7–7.1)	9.0 (4.7–15.1)	9.6 (4.4–20.0)	**
Oral cavity & pharynx	All stages	55.5 (50.6–60.0)	57.0 (52.9–60.1)	65.1 (60.5–69.2)	**
Ovary	All stages	35.7 (30.5–41.0)	43.5 (37.5–49.5)	51.6 (46.7–56.3)	**
Pancreas	All stages	18.1 (12.9–22.6)	16.3 (11.8–21.6)	30.1 (23.1–37.5)	**

CI=Confidence interval
OS=Observed survival
**Suppressed due to high variance
Notes: 1. Analysis was restricted to cases with surgical treatment.
2. Analysis was restricted to patients ages 15 to 99.
3. Stage data was not available for esophageal, oral cavity & pharynx, ovarian or pancreatic cancers. Stage analysis excludes the following cases with unknown stage: breast n = 1,191; colorectal n = 1,091; lung n = 491. Cases that were not staged were excluded from this analysis.
4. Dates Affecting Readiness to Treat (DART) wait time was excluded from this analysis.
Analysis by: Surveillance, Analytics and Informatics, CCO
Data sources: Ontario Cancer Registry (March 2017), CCO; Wait Time Information System (March 2017), CCO

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