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Variation in Additional Breast Imaging Orders and Impact on Surgical Wait Times at a Comprehensive Cancer Center

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Abstract

Background—In the multidisciplinary care model, breast imagers frequently provide second opinion reviews of imaging studies performed at outside institutions. However, the need for additional imaging and timeliness of obtaining these studies has yet to be established. We sought to evaluate the frequency of additional imaging orders by breast surgeons and to evaluate the impact of this supplementary imaging on timeliness of surgery.

Methods—We identified 2,489 consecutive women with breast cancer who underwent first definitive surgery (FDS) at our comprehensive cancer center between 2011 and 2013. The number of breast-specific imaging studies performed for each patient between initial consultation and FDS was obtained. Chi-squared tests were used to quantify the proportion of patients undergoing additional imaging by surgeon. Interval time between initial consultation and additional imaging and/or biopsy was calculated. The delay of additional imaging on time to FDS was assessed by t-test.

Results—Of 2,489 patients, 615 (24.7%) had at least one additional breast-specific imaging study performed between initial consultation and FDS, with 222 patients undergoing additional biopsies (8.9%). The proportion of patients receiving imaging tests by breast surgeon ranged from 15% to 39% ($p<0.0001$). Patients receiving additional imaging had statistically longer wait times to FDS for BCT (21.4 to 28.5 days, $p<0.0001$).

Conclusions—Substantial variability exists in the utilization of additional breast-specific imaging and in the timeliness of obtaining these tests among breast surgeons. Further research is warranted to assess the sources and impact of this variation on patient care, cost and outcomes.

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INTRODUCTION

Multidisciplinary management is the cornerstone of contemporary breast cancer care, with comprehensive cancer centers relying on specialty teams to evaluate and offer opinions on treatment options for newly diagnosed patients. These centers frequently treat patients who initiate their diagnostic workups at other institutions, necessitating detailed reviews of outside studies, including pathology slides and imaging, before treatment decisions are made. In addition to the traditional group of oncologists (surgical, medical and radiation), pathologists and breast imagers are often included in the care team, with several studies from large cancer centers demonstrating that their second opinion reviews can alter oncologic management (1–6).

During the evaluation of newly diagnosed patients, breast surgical oncologists may order supplemental imaging ranging from additional mammography views to bilateral breast magnetic resonance imaging (MRI) studies. Performing additional preoperative imaging is not without anticipated drawbacks, including the added cost and time required to obtain these studies (7–12). While the impact of a prolonged preoperative period has on disease-specific survival may be debatable (13, 14), preoperative delays can impact other patient-related factors including patient satisfaction, stress and anxiety (15, 16), and timeliness of care has been suggested as a possible quality measure for surgeons (17, 18).

Research regarding the frequency of additional imaging orders is limited, and any variation in imaging ordering practices among breast surgeons has yet to be established. We sought to determine the proportion of patients undergoing additional imaging following initial consultation to identify surgeon variation in imaging orders and to understand the overall impact that additional imaging has on the breast cancer treatment timeline for patients undergoing first definitive surgery (FDS) at our cancer center.

METHODS

Setting

We examined the care of women treated for breast cancer at the Dana-Farber/Brigham and Women's Cancer Center (DF/BWCC), a Harvard-affiliated, NCI-designated comprehensive cancer center, offering comprehensive cancer services for a full range of hematologic and solid tumor malignancies. The breast cancer program is organized as a multidisciplinary disease center, with over 3,000 unique new patients annually, and is staffed by 26 medical oncologists, 12 surgical oncologists, 6 radiation oncologists, 12 radiologists and 6 pathologists who practice across four ambulatory sites.

Data Source

We developed an internal dataset of patients through the integration of administrative and billing data. Surgeon billing data were used to identify women with breast cancer diagnoses who underwent breast conserving surgery (BCS) or mastectomy, with or without immediate reconstruction, at two primary surgical sites between January 1, 2011 and December 31, 2013 using ICD-9/CPT codes. Using unique patient identifiers and administrative appointment systems, we determined the initial consultation date for each patient. We

extracted information regarding breast-specific imaging exams and biopsies from our radiology scheduling system, Percipio. These imaging studies and biopsies were matched to the patients who underwent FDS at our institution. Tumor registry data were used to document tumor stage. The final dataset included: surgical procedure, breast surgeon, modality of imaging, date imaging study was performed, tumor stage, and sociodemographic information (age, gender, race, primary language, and insurance). Patients who were male or received either neoadjuvant or pre-operative radiation therapy were excluded.

This initiative was undertaken as a quality improvement project and was determined to be exempt from review by the Dana-Farber/Harvard Cancer Center Institutional Review Board.

Cohort Selection

We identified 2,489 consecutive women with breast cancer who underwent FDS at our center during the study timeframe. Within this cohort, we identified 615 patients who underwent additional imaging and/or biopsy prior between initial consultation and FDS. Only breast-specific studies ordered by our breast surgeons or surgical nurse practitioners (NPs) were included. Imaging and biopsy modalities performed included: breast US, breast MRI, mammography, stereotactic core biopsy, ultrasound (US)-guided biopsy, MRI-guided biopsy and fine needle aspiration (FNA). A single database was generated, establishing a unique timeline for each patient.

Statistical Analysis

We generated descriptive statistics on *1)* the interval time between initial consultation and completion of imaging and/or biopsy and *2)* the time between initial consultation and FDS. The interval time from initial consultation to imaging/biopsy completion was determined by calculating the days to complete a single imaging study. For patients who underwent more than one imaging study on multiple days, the last imaging study date was used to calculate the overall interval time-to-imaging. These data were stratified by FDS procedure, breast surgeon and imaging modality. The proportion of patients with additional imaging orders by breast surgeon was examined using chi-squared analysis. A t-test was used to determine the impact of additional imaging on time to FDS.

A multivariate regression model was used to identify factors associated with the receipt of additional imaging. Variables included were patient age, insurance type, race, primary language, tumor stage and FDS procedure. We excluded patients for whom tumor stage was not accessible through the Dana-Farber Cancer Institute tumor registry. Adjusted odds ratios, 95% CIs, and p-values were calculated to determine the strength of the association between the variables and receipt of additional imaging.

We also examined patient and tumor-specific characteristics by breast surgeon in the overall cohort to identify any differences in the referral population.

The dataset was built using Microsoft Excel (2007) and the analyses were performed using SAS 9.2 (Carey, NC); all tests were 2-sided, and a p value of <0.05 was considered to be statistically significant.

Results

We identified 2,489 female patients with either invasive carcinoma or ductal carcinoma in situ (DCIS) who underwent breast surgery at our cancer center. Overall, the mean age was 57.6 years (range 15–101). The majority were white (83.8%); 3.9% indicated a primary language other than English, and 67.3% had private insurance

A total of 615 patients (25%) underwent at least one breast-specific additional imaging test between initial consultation and FDS. Among these patients, 60.6% had one study performed, 23.2% had two studies and 16.1% had more than three studies performed prior to FDS. Overall 712 breast-specific images and 278 biopsies were performed between initial consultation and FDS among the 615 patients.

The median number of days between initial consultation and completion of an individual imaging study was 3.5 (IQR 14) for US, 3.0 (IQR 14) for mammography, and 7.0 (IQR 11) for MRI (Table 1). The median number of days from initial consultation to biopsy was 9.0 (IQR 11.0) for US-guided core, 9.0 (IQR 11) for stereotactic core, 15.0 (IQR 12.5) for MRI-guided core and 7.0 (IQR 13.0) for FNA. The overall median number of days required to complete all additional radiologic testing was 7.0 days (IQR 15.0).

Significant practice variation in preoperative imaging orders was observed when stratified by breast surgeon (Table 2). The proportion of patients receiving imaging tests by breast surgeon ranged from 15% to 39% ($p<0.0001$). The time to complete imaging studies also varied when stratified by surgeon, with the median number of days between initial consultation and imaging completion ranging from 1.0 day (IQR 18) to 13.5 days (IQR 23.0) (Table 3).

Patients undergoing additional imaging were found to have significantly longer wait times for BCT (21.4 to 28.5 days, $p<0.0001$) compared to those without additional imaging. Patients receiving additional imaging also experienced numerically but not statistically significant longer wait times to mastectomy (33.2 to 38.8 days, $p=0.08$) and to mastectomy with immediate reconstruction (39.0 to 41.2 days, $p=0.23$).

Multivariate analyses in Table 4 highlight factors associated with the receipt of additional imaging. Patients over 70 years of age (OR= 0.59, 95 CI= 0.35–0.99, p= 0.04) were found to be significantly less likely to receive additional imaging than patients between 40–49 years of age. Medicare recipients (OR=0.65, 95 CI= 0.44–0.94, p=0.02) were also significantly less likely to undergo additional imaging compared to those with private insurance. Patients with stage III disease (OR=1.99, 95 CI=1.12–3.52, p=0.02) were found to be significantly more likely to undergo additional imaging compared to patients with DCIS, and patients who eventually underwent mastectomy with immediate reconstruction (OR=1.37, 95 CI=1.04–1.81, p=0.02) were significantly more likely to undergo additional imaging as compared to patients undergoing BCT. Patient race and primary language were not found to be associated with receipt of additional imaging in our analysis.

Discussion

Our study identified significant variation in the use of additional imaging among breast surgical oncologists and the impact these supplemental studies have on the timeliness of receiving local therapy. Although prior research has identified factors, including use of multimodal imaging, associated with preoperative delays (7–12, 19–21), this is the first study characterizing the preoperative imaging trends for breast cancer patients referred to a comprehensive cancer center at both a provider-specific and practice level. Our results suggest that imaging-associated delays may be modifiable, providing an area to focus quality improvement efforts to reduce delays in breast cancer treatment.

Overall, 25% of the patients undergoing FDS at our institution between 2011 and 2013 had additional imaging performed following their initial consultation, with the proportion of patients receiving imaging varying more than two-fold among surgeons (range: 15–39%). Slight variation among physician clinical practice patterns may be expected for a variety of reasons, including provider and patient specific preferences as well as potential variation in the recommendations made by breast imagers reviewing the initial studies patients brought to our center. However the significant variation among physicians practicing at the same institution, observed in our study necessitates specific consideration.

In examining whether patient-related factors contribute to the variation in imaging-ordering practices, we found that patients who were under 70 years of age, who had stage III disease, or who underwent mastectomy with immediate reconstruction were more likely to receive additional imaging. That patients over 70 years of age were significantly less likely to receive additional imaging is expected given that younger women with denser breast tissue may require more imaging in order to complete diagnosis and treatment planning. However, our finding that Medicare recipients are likely to undergo less imaging warrants additional investigation. Although Medicare recipients are also of an older age, our regression controlled for age, and we are unable to determine whether imaging was not performed as a result of insurance reimbursement limitations or whether there are other attributes of this population that reduced the likelihood that imaging would be requested. In patients with stage III disease, imaging may play a greater role in guiding treatment decisions than in early stage cancers where management strategies may include potential for neoadjuvant therapy or recommendation for a more extensive surgical procedure. Similarly in patients undergoing immediate reconstruction, the additional imaging may be performed as part of preoperative planning considerations that identify additional foci of disease or increase the size of the primary tumor necessitating more extensive surgical procedures.

While we identified patient-specific factors influencing the likelihood that additional imaging would be performed, these characteristics could explain the significant variation in image-ordering behavior observed amongst surgeons only if the patient populations treated by our surgeons varied substantially. However, our breast surgeons treat patients from the same referral pool and, despite slight differences in patient socio-demographic characteristics, tumor stage and procedure type observed among our breast surgeons (Table 5), we do not believe that the significant variation in imaging ordering practices can be

attributed to these small disparities in referred patient populations, suggesting other factors likely contribute to the observed variation.

Provider-specific differences such as training and years of experience could influence image ordering practices, assuming senior clinicians may rely less on imaging to guide treatment decisions than their less-experienced colleagues. Although such a relationship was not identified, the two surgeons with the lowest proportion of imaging orders (15%) were trained in the same fellowship program, suggesting a potential connection between training and image-ordering patterns. A larger study is necessary to validate the role specific fellowship training programs have on these clinical practice patterns.

Our multidisciplinary breast cancer model includes second opinion radiology reviews, whereby dedicated breast imagers evaluate outside images and make recommendations on the necessity for additional imaging studies. Despite this practice being consistent across our center, the degree to which each surgeon relied upon or followed the radiologists' recommendations may have varied. Although we did not examine whether additional imaging recommendations were followed, in a prior pilot study over a 5-month period, we found that 32% of patients (25/78) who had additional imaging recommended by breast imagers did not undergo these studies, suggesting that multidisciplinary input may influence ordering-practice behavior (6).

Prior work has demonstrated the delays associated with obtaining preoperative MRIs, and at least one study, using the SEER Medicare claims database, identified that all imaging modalities significantly increase wait times to surgery (11). Our present findings corroborate this conclusion, and advance the existing literature by quantifying incidence of additional imaging studies and their associated delays in surgery for patients presenting to a comprehensive cancer center. By focusing on the timeframe to FDS from initial consultation, rather than initial diagnosis, we believe we have identified a process-of-care that can be altered to improve care timeliness.

Although additional imaging introduces delays in care, investigators have also demonstrated the clinical benefit of second opinion reviews in the surgical treatment of breast cancer (1–6). Additional imaging can identify new foci of cancer and impact the treatment for breast cancer patients, with studies indicating that 11.7–42.7% of patients may have their management altered following additional imaging studies (3–6). The clinician thus faces a struggle between overutilization of imaging and the associated delay in treatment, and the potential benefit of obtaining additional imaging to improve care management.

Our study is subject to several limitations. Although we uncovered variability in the ordering of additional imaging by surgeon, we could not conclusively identify the cause for these differences. Furthermore, we have limited knowledge of the case-specific reasons for each additional imaging request. We can hypothesize based on prior work that additional imaging may have been conducted due to incomplete initial diagnostic work-up, inadequate quality of initial imaging studies, or based on the recommendation of the multidisciplinary care team following review of outside studies. We are also unable to determine the impact that the additional imaging studies and biopsies had on the surgical management of the

patients in our cohort. A more in depth analysis is required to determine, for example, if the biopsies performed led to the identification of additional foci of cancer.

Despite these limitations, our present study is still the first to demonstrate the practice variations among breast surgical oncologists at a single comprehensive cancer center in obtaining preoperative imaging and to quantify the impact these additional imaging studies have on the breast cancer treatment timeline. While the observed delay in receipt of additional imaging prior to surgery may not impact patient outcomes (13, 14), we believe that it is essential that processes-of-care be streamlined to ensure the efficient completion of radiologic workups and the delivery of expeditious, patient-centered care.

Conclusion

Significant image-ordering variation exists among breast surgical oncologists, and these image-ordering practices can have a significant impact on the timeliness of breast surgery. Given the patient- and system-centered ramifications that additional imaging and associated delays in time-to-FDS can have, future research is warranted to investigate the practice of additional imaging request so that negative impacts on breast cancer outcomes may be minimized.

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Table 1

Time to Imaging Study by Modality

Modality	Number	Median Time to Imaging (IQR)
Mammography	340	3.0 days (14.0)
Ultrasound	236	3.5 days (14.0)
MRI	136	7.0 days (11.0)
Fine Needle Aspiration	35	7.0 days (13.0)
Core Biopsy Ultrasound	92	9.0 days (11.0)
Core Biopsy Stereo	71	9.0 days (11.0)
Core Biopsy MRI	80	15.0 days (12.5)

Table 2

Imaging Orders by Breast Surgeon

FDS Provider	Total Patients	Patients receiving additional imaging	% of Patients Receiving Imaging	P-value
Surgeon 1 (5–10)	441	68	15%	<0.0001
Surgeon 2 (5–10)	287	42	15%	0.0001
Surgeon 3 (20–25)	124	21	17%	0.05
Surgeon 4 (10–15)	296	62	21%	0.15
Surgeon 5 (20–25)	379	90	24%	0.68
Surgeon 6 (35–40)	87	26	30%	0.27
Surgeon 7 (20–25)	315	99	31%	0.01
Surgeon 8 (10–15)	259	90	35%	0.0004
Surgeon 9 (0–5)	301	117	39%	<0.0001
Total	**2,489**	**615**	**25%**	--

*Years of clinical experience from time of board certification to start of study period in parenthesis

Table 3

Time to Receipt of Breast Imaging by Breast Surgeon

FDS Provider	Patients receiving additional imaging	Mean Time from CON to Imaging (Std)	Median Time from CON to Imaging (IQR)
Surgeon 1	68	10.1 days (18.4)	3.5 days (14.5)
Surgeon 2	42	11.1 days (8.3)	10.5 days (10.0)
Surgeon 3	21	10.7 days (15.2)	1.0 day (18.0)
Surgeon 4	62	10.0 days (11.7)	7.5 days (15.0)
Surgeon 5	90	6.1 days (8.8)	1.0 days (9.0)
Surgeon 6	26	17.8 days (16.8)	13.5 days (23.0)
Surgeon 7	99	14.3 days (16.8)	9.0 days (15.0)
Surgeon 8	90	11.0 days (12.3)	8.0 days (15.0)
Surgeon 9	117	10.3 days (10.6)	8.0 days (13.0)
Total	615	10.8 (13.5)	7.0 (15.0)

Table 4

Factors associated with receipt of additional imaging

	Patients with Additional Imaging (n=436) Freq (%)	Patients without Additional Imaging (n=1,269) Freq (%)	Adjusted OR (95% CI)	P-value
Age				
< 40	43 (9.8%)	63 (5.0%)	1.38 (0.88–2.16)	0.15
40–49	133 (30.5%)	295 (23.2%)	1.00	--
50–59	128 (29.4%)	319 (25.1%)	0.96 (0.71–1.29)	0.77
60–69	96 (22.0%)	375 (29.6%)	0.76 (0.54–1.08)	0.13
70 +	36 (8.3%)	217 (17.1%)	0.59 (0.35–0.99)	0.04
Race				
White	352 (80.7%)	1,068 (84.2%)	1.00	--
Non-White	64 (14.7%)	155 (12.2%)	1.13 (0.80–1.60)	0.48
Missing	20 (4.6%)	46 (3.6%)	1.29 (0.74–2.25)	0.36
Language				
English	416 (95.4%)	1,213 (95.6%)	1.00	--
Non-English	20 (4.6%)	56 (4.4%)	1.09 (0.61–1.95)	0.77
Insurance				
Private	342 (78.4%)	817 (64.4%)	1.00	--
Medicaid	17 (3.9%)	41 (3.2%)	0.94 (0.51–1.73)	0.85
Medicare	72 (16.5%)	398 (31.4%)	0.65 (0.44–0.94)	0.02
Other	5 (1.2%)	13 (1.0%)	0.87 (0.30–2.52)	0.80
Stage*				
0	33 (7.6%)	112 (8.8%)	1.00	--
I	214 (49.1%)	776 (61.2%)	0.96 (0.63–1.47)	0.86
II	142 (32.5%)	310 (24.4%)	1.47 (0.94–2.31)	0.09
III	44 (10.1%)	65 (5.1%)	1.99 (1.12–3.52)	0.02
IV	3 (0.7%)	6 (0.5%)	1.87 (0.43–8.17)	0.40
Surgery Type				
Lumpectomy	252 (57.8%)	880 (69.3%)	1.00	--
Mastectomy	55 (12.6%)	151 (11.9%)	1.13 (0.79–1.61)	0.49
Mastectomy with Recon	129 (29.6%)	238 (18.8%)	1.37 (1.04–1.81)	0.02

*Excluded patients for whom tumor stage was not readily available

OR odds ratio, CI 95% confidence interval

Table 5

Patient and Tumor Specific Characteristics by Breast Surgeon

	Surgeon 1	Surgeon 2	Surgeon 3	Surgeon 4	Surgeon 5	Surgeon 6	Surgeon 7	Surgeon 8	Surgeon 9
Age									
< 40	29 (6.6%)	15 (5.2%)	5 (4.0%)	7 (2.3%)	28 (7.4%)	7 (8.1%)	15 (4.8%)	12 (4.6%)	23 (7.6%)
40–49	118 (26.8%)	52 (18.1%)	38 (30.7%)	68 (23.0%)	86 (22.7%)	18 (20.7%)	77 (24.4%)	59 (22.8%)	87 (28.9%)
50–59	113 (25.6%)	78 (27.2%)	33 (26.6%)	65 (22.0%)	116 (30.6%)	23 (26.4%)	79 (25.1%)	65 (25.1%)	74 (24.6%)
60–69	116 (26.3%)	74 (25.8%)	30 (24.2%)	88 (29.7%)	104 (27.4%)	25 (28.7%)	83 (26.3%)	75 (29.0%)	74 (24.6%)
70 +	65 (14.7%)	68 (23.7%)	18 (14.5%)	68 (23.0%)	45 (11.9%)	14 (16.1%)	61 (19.4%)	48 (18.5%)	43 (14.3%)
Race									
White	390 (88.4%)	237 (82.6%)	106 (85.5%)	260 (87.8%)	348 (91.8%)	61 (70.1%)	218 (69.2%)	206 (79.5%)	259 (86.0%)
Non-White	42 (9.5%)	34 (11.8%)	16 (12.9%)	25 (8.5%)	26 (6.9%)	10 (11.5%)	67 (21.3%)	31 (12.0%)	33 (11.0%)
Missing	9 (2.1%)	16 (5.6%)	2 (1.6%)	11 (3.7%)	5 (1.3%)	16 (18.4%)	30 (9.5%)	22 (8.5%)	9 (3.0%)
Language									
English	433 (98.2%)	273 (95.1%)	115 (92.7%)	288 (97.3%)	375 (98.2%)	85 (97.7%)	291 (92.4%)	245 (94.6%)	289 (96.0%)
Non-English	8 (1.8%)	14 (4.9%)	9 (7.3%)	8 (2.7%)	7 (1.8%)	2 (2.3%)	24 (7.6%)	14 (5.4%)	12 (4.0%)
Insurance									
Private	296 (67.1%)	192 (66.9%)	90 (72.6%)	179 (60.5%)	275 (72.6%)	62 (71.3%)	207 (65.7%)	160 (61.8%)	215 (71.4%)
Medicaid	8 (1.8%)	10 (3.5%)	3 (2.4%)	6 (2.0%)	3 (0.8%)	4 (4.6%)	10 (3.2%)	13 (5.0%)	14 (4.7%)
Medicare	121 (27.5%)	82 (28.6%)	30 (24.2%)	107 (36.2%)	100 (26.4%)	20 (23.0%)	97 (30.8%)	83 (32.0%)	69 (22.9%)
Other	16 (3.6%)	3 (1.0%)	1 (0.8%)	4 (1.3%)	1 (0.2%)	1 (1.1%)	1 (0.3%)	3 (1.2%)	3 (1.0%)
Stage*									
0	31 (9.3%)	12 (7.0%)	5 (6.9%)	11 (6.6%)	31 (12.0%)	4 (6.7%)	15 (6.4%)	19 (8.8%)	17 (8.7%)
1	205 (61.8%)	109 (63.7%)	36 (49.3%)	92 (55.1%)	142 (55.0%)	28 (46.7%)	147 (63.1%)	130 (60.5%)	101 (51.5%)
2	79 (23.8%)	35 (20.5%)	27 (37.0%)	53 (31.7%)	71 (27.5%)	20 (33.3%)	57 (24.5%)	50 (23.2%)	60 (30.6%)
3	16 (4.8%)	14 (8.2%)	5 (6.8%)	11 (6.6%)	13 (5.1%)	7 (11.7%)	12 (5.1%)	15 (7.0%)	16 (8.2%)
4	1 (0.3%)	1 (0.6%)	0	0	1 (0.4%)	1 (1.6%)	2 (0.9%)	1 (0.5%)	2 (1.0%)
Surgery Type									
Lumpectomy	259 (58.7%)	208 (72.5%)	59 (47.6%)	185 (62.5%)	269 (71.0%)	42 (48.3%)	208 (66.0%)	169 (65.2%)	174 (57.8%)

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	Surgeon 1	Surgeon 2	Surgeon 3	Surgeon 4	Surgeon 5	Surgeon 6	Surgeon 7	Surgeon 8	Surgeon 9
Mastectomy	54 (12.3%)	32 (11.1%)	30 (24.2%)	41 (13.8%)	44 (11.6%)	17 (19.5%)	42 (13.4%)	46 (17.8%)	50 (16.6%)
Mastectomy with Recon	128 (29.0%)	47 (16.4%)	35 (28.2%)	70 (23.6%)	66 (17.4%)	28 (32.2%)	65 (20.6%)	44 (17.0%)	77 (25.6%)

* Tumor Stage was not available for all patients in the cohort