

Survival and Time to Initiation of Adjuvant Chemotherapy Among Breast Cancer Patients in Uruguay

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Introduction: Increases in disease-free survival and overall survival (OS) with the use of adjuvant chemotherapy in early breast cancer (BC) are widely known; however, the optimal time to initiate treatment with adjuvant chemotherapy remains controversial.

Objective: To evaluate the time elapsed between surgery and the initiation of adjuvant chemotherapy and its possible impact on OS in patients diagnosed with BC stages I–III.

Materials and Methods: This retrospective study included 112 patients diagnosed with BC stages I–III who received adjuvant chemotherapy at the Mastology Unit of the Hospital de Clínicas in Uruguay from 2009 to 2019. OS was estimated using the Kaplan–Meier method, and a Cox proportional hazards model was used to estimate hazard ratios (HRs) and 95% confidence intervals.

Results: No statistically significant association was found between the time from surgery to the initiation of chemotherapy and the described variables. OS was worse for patients initiating chemotherapy more than 90 days after breast surgery ($n = 19$) (HR 7.63; $p = 0.004$) and between 61 and 90 days after surgery ($n = 46$) (HR 4.58; $p = 0.040$) compared to those who started before 30 days ($n = 23$). Controlling by type of surgery and stage, the prognosis of patients who started chemotherapy between 61 and 90 days after surgery was similar to that of patients who underwent chemotherapy within the first 30 days, controlling for surgery (HR 4.10; $p = 0.056$) and controlling for stage (HR 3.76; $p = 0.075$). Prognosis was worse for patients with stage III disease ($p = 0.022$) who underwent a mastectomy and/or axillary lymph node dissection ($p = 0.025$).

Conclusion: Patients who started chemotherapy more than 90 days following surgery and those with stage III disease or underwent mastectomy and/or axillary lymph node dissection who initiated it between 61 and 90 days had a worse OS. Multiple factors are involved in the time between surgery and the initiation of chemotherapy, and further studies are needed to evaluate which of these factors influence the delay of chemotherapy in order to design strategies to avoid such delays and their negative impact on survival.

Keywords: time, adjuvant chemotherapy, breast cancer, survival

Introduction

As observed worldwide, breast cancer (BC) in Uruguay is the most frequent cancer in women and is the leading cause of death from cancer.^{1,2} Increases in disease-free survival and overall survival (OS) with the use of adjuvant chemotherapy in early BC have been consistently observed in many patient subgroups.³ In clinical studies that have evaluated the impact of adjuvant chemotherapy on survival, the time required for enrollment between surgery and the initiation of systemic

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treatment has been defined arbitrarily. Retrospective studies have evaluated the impact of this time on survival; some of them did show a positive relationship between a shorter time and OS.^{4,5} In this regard, a meta-analysis also showed that for each 4-week delay in the initiation of adjuvant chemotherapy, there was a 6% increase in the risk of death.⁶ However, there is evidence that the magnitude of this impact may differ according to BC subtype.⁷ Other studies did not show any relationship between the time interval before chemotherapy initiation and OS;^{8–10} although, the number of patients enrolled was low and non-standard (outdated) chemotherapy regimens were administered.

Likewise, there is evidence that punctuality in attendance is associated with better cancer outcomes; therefore, ensuring that adjuvant chemotherapy is provided diligently is an issue that concerns both the medical team and the patients.^{11–14} Multiple studies have shown that some sociodemographic factors may contribute to the delay in initiating treatment.^{7,15,16}

The primary aim of this study was to evaluate the time elapsed between surgery and the initiation of adjuvant chemotherapy and its possible impact on OS in patients diagnosed with BC stages I–III. We evaluated whether: a) the time elapsed between surgery and the initiation of chemotherapy differed according to variables related to sociodemographic characteristics of the patients (age, marital status, and comorbidities); b) there was an association between the time elapsed between surgery and the initiation of chemotherapy according to variables related to tumor characteristics (stage I–II vs III [tumor, node, and metastasis {TNM} classification, 8th Edition]), biological subtypes, or type of surgery (mastectomy and/or axillary lymph node dissection [ALND]). Survival time was also estimated based upon the time elapsed between surgery and the initiation of chemotherapy.

Methods and Statistical Analysis

This was a retrospective observational study that included patients diagnosed with BC stages I–III who received adjuvant chemotherapy at the Mastology Unit of the Hospital de Clínicas in Montevideo, Uruguay, from 2009 to 2019. Data were extracted from both paper medical records and oncology electronic medical records between December 2019 and May 2020. A descriptive statistical analysis of the population was performed by collecting sociodemographic data, which included the age at diagnosis, place of residence, marital status, social support status,

occupation, and education level. Information on comorbidities (overweight/obese, diabetes mellitus, heart failure, ischemic heart disease, hypertension [HT], thyroid dysfunction), tumor size, axillary lymph node status, human epidermal growth factor receptor 2 (HER2) status, estrogen receptor (ER) status, progesterone receptor (PR) status, surgical treatment performed (breast conservative surgery [BCT], mastectomy, ALND, sentinel lymph node biopsy [SLNB], reconstructive surgery), and the type of chemotherapy administered (concurrent anthracyclines and taxanes, sequential anthracyclines and taxanes \pm trastuzumab \pm hormone therapy, regimen without anthracyclines \pm trastuzumab \pm hormone therapy) was collected.

Three subtypes of HER2, ER, and PR were defined based on positive or negative tumor expression by immunohistochemistry and fluorescence in situ hybridization, if necessary, for HER2:

1. Hormone receptor+, HER2-: ER+ and PR+, ER-/PR+, ER+/PR-
2. HER2+
3. ER-, PR-, HER2- (triple negative)

The association between the time elapsed between surgery and the initiation of chemotherapy with the variables was evaluated using the chi-square test.

The OS in months was estimated using the Kaplan-Meier method. The differences between survival curves were evaluated using a Log rank test. Simple and multiple Cox models were constructed to evaluate the significance of the hazard ratio using a 95% confidence interval (CI). In all cases, $\alpha = 0.05$, was used. Data analysis was performed using the survival package in R software, version 4.0.2.

The study was conducted in accordance with international ethical standards for biomedical research (“MERCOSUR standards on regulation of clinical studies” and the “Declaration of Helsinki”) and with the research regulations approved by the National Ethics Commission in 2019. Patient anonymity was maintained in the analysis of the results, and the study was approved by the Ethics Committee of the Hospital de Clínicas.

Ethical Aspects

The current study was performed in compliance with the international ethical standards applied to biomedical research (ie, the MERCOSUR Standards on the Regulation of Clinical Trials and the World Medical Association’s Declaration of Helsinki [including its

amendment dated October 2013)). Patient anonymity was maintained in the analysis, and the study was approved by the research ethics committee of the School of Medicine of the University of the Republic.

Given that it was a retrospective study and an anonymized database was used with biological samples, the ethics committee of the Hospital de Clínicas did not consider it necessary to request the informed consent of the participants.

Results

A total of 112 female patients were included. Most were married or had a partner (49.1%, 55 patients). In terms of occupation, most were housewives (33.9%, 38 patients) or pensioners (28.6%, 32 patients). The remaining sociodemographic data are presented in Table 1.

The median age at diagnosis was 60 years (range, 38–87 years), 71% (n= 80) were stage I–II, and 28% (n= 32) were stage III. Regarding biological subtype, 43% (n= 48) were ER+/PR+/HER2-, 22% were HER2 + (n= 25), and 17% were triple-negative (n= 19), while there was no information regarding the subtype of the remaining 18% (n= 20).

Regarding the number of comorbidities, most of the patients (68.7%, 77 patients) presented with only 1 or no comorbidity and 24.1% (27 patients) between 2 and 4 comorbidities, with no patient having 5 or more comorbidities. It was not possible to collect data in 7.2% (8 patients). The most frequent comorbidities were HT, diabetes mellitus, and being overweight/obese, which were present in 36%, 15%, and 11% of the patients, respectively.

Approximately 50% of patients (n= 56) were treated with conservative surgery, sentinel node biopsy, or axillary nodal biopsy.

The type of surgery performed, systemic treatment administered, and chemotherapy regimens used are shown in Table 2. All patients who were candidates for adjuvant chemotherapy were included. All patients with HER2+ BC received adjuvant trastuzumab, while all patients with hormone receptor positive BC received treatment with adjuvant hormonal therapy.

It was possible to collect the dates of surgery and initiation of chemotherapy treatment in 100 of the 112 patients included. Of these 100 patients, 26% (26 patients) received their first cycle of adjuvant chemotherapy within 30 days, 38% (38 patients) between 31 and 60 days, 16% (16 patients) between 61 and 90 days, and 20% (20 patients) after more than 90 days.

Table 1 Socio-Demographic Characteristics

| | n | % |
|---------------------------|-----|------|
| Sex | | |
| Female | 112 | 100 |
| Place of residence | | |
| Montevideo (capital city) | 54 | 48.2 |
| Rest of the Country | 58 | 51.8 |
| Civil status | | |
| Married/common law | 55 | 49.1 |
| Widow | 9 | 8 |
| Single | 15 | 13.4 |
| Divorced/separated | 10 | 8.9 |
| No data | 23 | 20.5 |
| Occupation | | |
| Retired | 32 | 28.6 |
| Housewife | 38 | 33.9 |
| Employee. | 17 | 15.2 |
| Unemployed | 6 | 3 |
| Independent worker | 9 | 8 |
| No data. | 10 | 8.9 |
| Sex | | |
| Female | 112 | 100 |
| Civil status | | |
| Married/common law | 55 | 49.1 |
| Widow | 9 | 8 |
| Single | 15 | 13.4 |
| Divorced/separated | 10 | 8.9 |
| No data | 23 | 20.5 |
| Occupation | | |
| Retired | 32 | 28.6 |
| Housewife | 38 | 33.9 |
| Employee. | 17 | 15.2 |
| Unemployed | 6 | 3 |
| Independent worker | 9 | 8 |
| No data. | 10 | 8.9 |

Table 2 Characteristics of the Treatments Received

| Type of Adjuvant Systemic Treatment | n | % |
|--|-----|------|
| Chemotherapy | 112 | 100 |
| Hormonal therapy | 81 | 72.3 |
| Trastuzumab | 23 | 20.5 |
| Type of surgery | | |
| Mastectomy and ALND | 47 | 42 |
| BCT + SLNB | 23 | 20.5 |
| BCT + ALND | 33 | 29.4 |
| Mastectomy + SLNB | 6 | 5.3 |
| Mastectomy + Reconstruction +SLNB | 2 | 1.8 |
| Other | 1 | 0.8 |
| Total | 112 | 100 |
| Chemotherapy regimen | | |
| Sequential anthracycline- and taxane-based regimen | 45 | 40.1 |
| Docetaxel -Cyclophosphamide | 27 | 24.1 |
| Sequential anthracycline- and taxane-based regimen followed by Trastuzumab | 15 | 13.4 |
| Docetaxel, Carboplatin and Trastuzumab | 3 | 2.7 |
| Concurrent anthracycline- and taxane-based regimen | 3 | 2.7 |
| Other | 17 | 15.1 |
| No data | 2 | 1.8 |
| Total | 112 | 100 |

After analyzing the different variables, no statistically significant association was found between the time elapsed between surgery and the initiation of chemotherapy and age, marital status, number of comorbidities, tumor stage, biological subtype, or type of surgery (Table 3).

It was possible to collect the date of death or last consultation for 88 of the 100 patients for whom the date of initiation of chemotherapy was available and perform the OS analysis stratified according to the time elapsed between surgery and adjuvant chemotherapy with the following categories: less than 30 days, between 31 and 60 days, between 61 and 90 days, or more than 90 days.

With a median follow-up of 47 months (range 27–65 months), the median OS was not reached for those patients who underwent chemotherapy before 60 days. Cox univariate analysis showed a statistically significantly worse

OS for the subgroups of patients beginning chemotherapy after 61 and 90 days (HR 4.58; $p=0.04$) and more than 90 days (HR 7.63; $p=0.004$) versus those beginning chemotherapy before 30 days (Figure 1 and Table 4).

Cox models were adjusted for the time elapsed between surgery and the initiation of chemotherapy and the type of surgery (high morbidity surgery [mastectomy and/or ALND] and stage (I–II vs III).

As can be seen in the data presented in Tables 5 and 6, the risk of death was markedly higher in those who underwent chemotherapy after more than 90 days compared to within the first 30 days after adjusting for the type of surgery (HR 9.1; $p=0.002$) and tumor stage (HR 6.48, $p=0.008$). A delay of more than 90 days in the initiation of adjuvant chemotherapy was a poor prognostic factor for all patients, even in the multiple models, adjusting for the stage of disease (HR 2.70; $p=0.02$) and type of surgery (HR 0.37; $p=0.024$).

Discussion

The role of adjuvant chemotherapy in early BC is well established, as it has demonstrated an increase in disease-free survival and OS.³ Adjuvant chemotherapy, according to its definition, occurs after breast surgery. However, the optimal time to initiate treatment with adjuvant chemotherapy remains controversial in clinical practice. In relation to this, a relevant question to answer is whether a delay in initiation has a negative impact on OS.

Due to the nature of the question, prospective clinical studies are not available to answer this, as they are considered unfeasible and unethical. Several retrospective clinical studies have addressed this question with conflicting results, with some reporting that the time to initiation of chemotherapy affects OS,^{4,6,17–20} while others finding no relationship between them.^{8–10} We should bear in mind that the studies that found no association between the time to initiation of chemotherapy and OS included a low number of patients and used non-standard treatment regimens.

In our study, it was observed that the time to initiation of chemotherapy after definitive surgery impacts the OS in patients with BC. The results suggest that a delay in the initiation of adjuvant chemotherapy is associated with reduced OS.

Fifty-eight percent of patients underwent adjuvant chemotherapy (65 patients) before 60 days and 74% (83 patients) before 90 days after surgery. Only 16.9% of patients (19 patients) underwent adjuvant chemotherapy more than 90 days after surgery.

Table 3 Chi Square Analysis

| Time Between Surgery and Initiation of Chemotherapy | | | | | | |
|---|-------------------------|-------------------|--------------------|--------------------|-------------------|------|
| | | Less Than 30 Days | Between 30–60 Days | Between 61–90 Days | More Than 90 Days | p |
| Age | ≤60 | 11 | 21 | 10 | 9 | 0.53 |
| | >60 | 15 | 17 | 6 | 11 | |
| Marital status | Widow, single, divorced | 6 | 14 | 1 | 9 | 0.07 |
| | Married, free union | 15 | 14 | 10 | 10 | |
| Number of comorbidities | 0–1 | 19 | 28 | 8 | 14 | 0.05 |
| | ≥2 | 7 | 4 | 8 | 6 | |
| Type of surgery | ALND or mastectomy | 12 | 13 | 8 | 7 | 0.61 |
| | No ALND or mastectomy | 14 | 25 | 8 | 13 | |
| Stage | I–II | 20 | 30 | 10 | 12 | 0.34 |
| | III | 6 | 8 | 6 | 8 | |
| Biological subtype | TN | 6 | 6 | 1 | 3 | 0.79 |
| | Her2 like | 4 | 9 | | 4 | |
| | HR+, HER2- | 16 | 23 | 13 | 10 | |

With a median follow-up of 47 months, there was evidence that a delay in initiating adjuvant chemotherapy of 61 or more days after surgery, compared to initiating it

within 30 days, was associated with a lower OS (HR 4.58; CI 95%, 1.07–19.63; $p = 0.004$). For patients who underwent chemotherapy between 61 and 90 days and (HR 7.63;

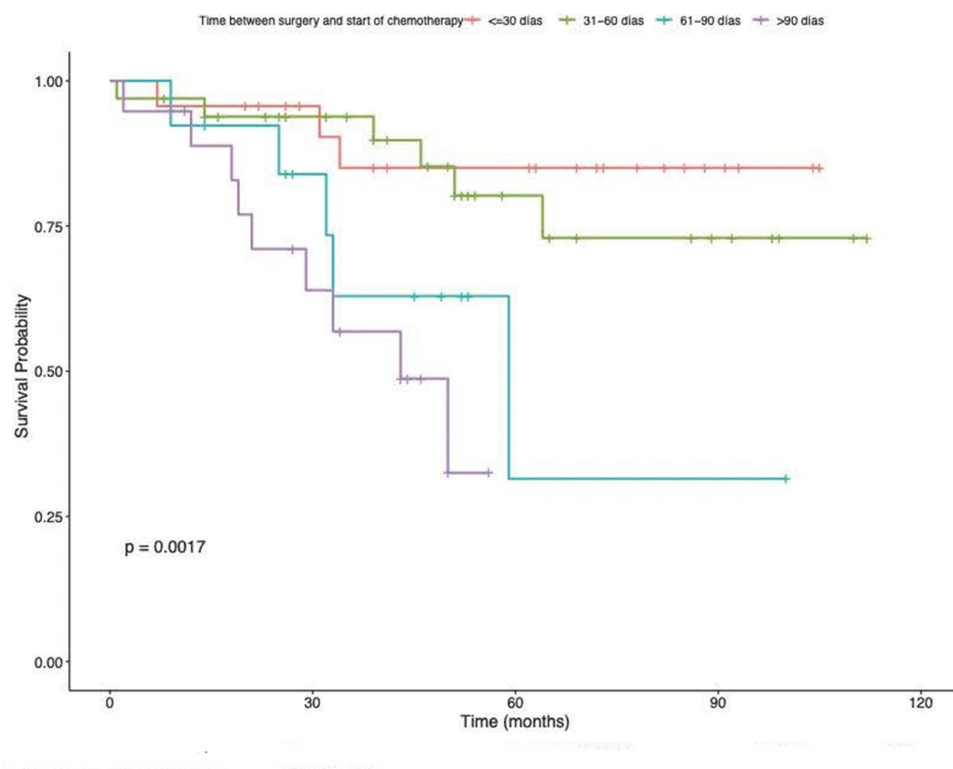
**Figure 1** Stratified survival analysis between surgery and start of chemotherapy.

Table 4 Cox Univariate Analysis: Interval Period Between First Surgery and Start of Adjuvant Chemotherapy

| Time to Initiation of Chemotherapy After Definitive Surgery | HR | CI 95% | p |
|---|------|------------|-------|
| ≤ 30 days | 1 | | |
| 31–60 days | 1.60 | 0.40–6.43 | 0.508 |
| 61–90 days | 4.58 | 1.07–19.63 | 0.040 |
| > 90 days | 7.63 | 1.94–30.00 | 0.004 |

Table 5 Cox Model Adjusted According to Type of Surgery

| | | HR | CI 95% | p |
|---|------------------------------|------|------------|-------|
| Time to initiation of chemotherapy after definitive surgery | ≤ 30 days | 1 | | |
| | 31–60 days | 1.75 | 0.44–7.04 | 0.429 |
| | 61–90 days | 4.10 | 0.96–17.47 | 0.056 |
| | > 90 days | 9.10 | 2.30–36.02 | 0.002 |
| Type of surgery. | ALND or mastectomy and ALND. | 1 | | |
| | No ALND neither mastectomy | 0.37 | 0.16–0.88 | 0.024 |

95% CI, 1.93–30; $p=0.004$) and those who were initiated after 90 days (HR xxx; 95% CI, xx-xx; $p=0.000$).

In patients treated with less aggressive surgeries, this effect was diminished for the group who underwent chemotherapy > 90 days after surgery; however, a negative impact was maintained in patients with BC stage III, that is, in patients with a higher risk of relapse. This represents a point of vital importance, which, if validated in later studies with a larger number of patients, will help us to select patients who would benefit most from the early initiation of adjuvant chemotherapy and will allow us to design strategies aimed at reducing the time elapsed between surgery and the initiation of chemotherapy.

A delay of more than 90 days in the initiation of adjuvant chemotherapy was a poor prognostic factor for all patients, even when controlling for the stage of disease or type of surgery. These results were consistent with those reported in previous international studies. In this regard,

a meta-analysis published by Yu et al, which included 34,097 patients from seven different studies, showed that OS decreased by 15% for each additional 4-week delay in the initiation of adjuvant chemotherapy (HR 1.15; CI 95%, 1.03–1.28).¹⁹

Several studies have found that a delay in the initiation of chemotherapy may be associated with age, marital status, place of residence, tumor stage, and type of surgery, with the delay being greater in older patients, as well as in those living alone, from rural areas, with BC stage III, and having undergone surgeries with greater morbidity (mastectomy and ALND).^{21,22} However, in our study, when analyzing the different variables that could influence the time to the initiation of chemotherapy, no statistically significant association was found for age, marital status, place of residence, number of comorbidities, tumor stage, type of surgery, or biological subtype (Table 3). We must take into account that these values were at the limit of

Table 6 Cox Model Adjusted According to Stage

| | | HR | CI 95% | p |
|---|------------|------|------------|-------|
| Time to initiation of chemotherapy after definitive surgery | ≤ 30 days | 1 | | |
| | 31–60 days | 1.59 | 0.39–6.39 | 0.515 |
| | 61–90 days | 3.76 | 0.87–16.12 | 0.075 |
| | > 90 days | 6.48 | 1.64–25.60 | 0.008 |
| Stage | I–II | 1 | | |
| | III | 2.66 | 1.15–6.15 | 0.022 |

significance for the patients' number of comorbidities and marital status, yet we believe that this should be evaluated in the future with a larger number of patients.

The strengths of the present study include the incorporation of all the patients attended; that is, patients treated in routine clinical practice were represented. In addition, it took into account a significant number of patients, incorporated all age groups, had a prolonged follow-up, and included patients who received chemotherapy regimens appropriate to their risks of relapse following national and international recommendations. Additionally, they were treated with contemporary systemic regimens, and we were able to perform subgroup analysis according to the BC subtype.

The main weakness of this study lies in the impossibility of knowing the determinants of delay in the initiation of chemotherapy. Unfortunately, because of the lack of sufficiently valid data (or data susceptible to appropriate determination), economic characteristics were not investigated in our study, and the same occurred with those related to education level and delays linked to hospital management (late referrals or waiting times for studies). Thus, these aspects would need to be studied in future research. Additionally, our study was limited by its retrospective nature.

Finally, we must emphasize the need for a medical oncologist to inform different physicians managing patients diagnosed with BC (surgeons, imaging specialists, pathologists, etc.) regarding the consequences of delaying the initiation of adjuvant treatment with chemotherapy for the patient. Improving the time to initiation of chemotherapy is a challenge faced by the entire medical team.

Conclusions

In our study, the time between surgery and the initiation of chemotherapy was adequate for most patients, with 80% receiving treatment before 90 days and 63.6% before 60 days. No statistically significant association was found between the time elapsed between surgery and the initiation of chemotherapy based upon age, marital status, place of residence, number of comorbidities, biological subtype, or type of surgery. Patients who initiated chemotherapy more than 90 days following surgery had worse OS. In patients who received chemotherapy between 61 and 90 days, the impact of this time was greater for patients with stage III and those who underwent more aggressive surgeries. These findings suggest that higher risk patients (stage III disease) and patients undergoing mastectomy or ALND experience greater

benefits with early initiation of adjuvant chemotherapy in terms of OS.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

References

- Barrios E, Garau M. Cáncer: magnitud del problema en el mundo y en Uruguay, aspectos epidemiológicos. *Anales de la Facultad de Medicina*. 2017;4:9–46. doi:10.25184/anfamed2017.4.1.2
- Comision Honoraria de Lucha contra el Cancer. Informe Anual. Periodo 2011–2015 (Fecha acceso: 6/05/2019). Available from: http://www.comisioncancer.org.uy/uc_209_1.html. Accessed December 2, 2021.
- Early Breast Cancer Trialists' Collaborative Group (EBCTCG). Effects of chemotherapy and hormonal therapy for early breast cancer on recurrence and 15-year survival: an overview of the randomised trials. *Lancet*. 2005;365(9472):1687–1717. doi:10.1016/S0140-6736(05)66544-0
- Lohrisch C, Paltiel C, Gelmon K, et al. Impact on survival of time from definitive surgery to initiation of adjuvant chemotherapy for early-stage breast cancer. *J Clin Oncol*. 2006;24:4888–4894. doi:10.1200/JCO.2005.01.6089
- Colleoni M, Bonetti M, Coates AS, et al. Early start of adjuvant chemotherapy may improve treatment outcome for premenopausal breast cancer patients with tumors not expressing estrogen receptors. The International Breast Cancer Study Group. *J Clin Oncol*. 2000;18:584–590. doi:10.1200/JCO.2000.18.3.584
- Biagi JJ, Raphael M, King WD, Kong W, Booth CM, Mackillop WJ. The effect of delay in time to adjuvant chemotherapy (TTAC) on survival in breast cancer (BC): a systematic review and meta-analysis. *J Clin Oncol*. 2011;29(15_suppl):1128.
- Gagliato Dde M, Gonzalez-Angulo AM, Lei X, et al. Clinical impact of delaying initiation of adjuvant chemotherapy in patients with breast cancer. *J Clin Oncol*. 2014;32:735–744. doi:10.1200/JCO.2013.49.7693
- Buzdar AU, Smith TL, Powell KC, Blumenschein GR, Gehan EA. Effect of timing of initiation of adjuvant chemotherapy on disease-free survival in breast cancer. *Breast Cancer Res Treat*. 1982;2(2):163–169. doi:10.1007/BF01806452
- Jara Sánchez C, Ruiz A, Martín M, et al. Influence of timing of initiation of adjuvant chemotherapy over survival in breast cancer: a negative outcome study by the Spanish Breast Cancer Research Group (GEICAM). *Breast Cancer Res Treat*. 2007;101(2):215–223. doi:10.1007/s10549-006-9282-0
- Bellon JR, Come SE, Gelman RS, et al. Sequencing of chemotherapy and radiation therapy in early-stage breast cancer: updated results of a prospective randomized trial. *J Clin Oncol*. 2005;23(9):1934–1940. doi:10.1200/JCO.2005.04.032

11. Kaufman CS, Shockney L, Rabinowitz B, et al. National Quality Measures for Breast Centers (NQMBC): a robust quality tool: breast center quality measures. *Ann Surg Oncol*. 2010;17:377–385. doi:10.1245/s10434-009-0729-5
12. Del Turco MR, Ponti A, Bick U, et al. Quality indicators in breast cancer care. *Eur J Cancer*. 2010;46:2344–2356. doi:10.1016/j.ejca.2010.06.119
13. Desch CE, McNiff KK, Schneider EC, et al. American Society of Clinical Oncology/National Comprehensive Cancer Network quality measures. *J Clin Oncol*. 2008;26:3631–3637. doi:10.1200/JCO.2008.16.5068
14. Bleicher RJ, Ruth K, Sigurdson ER, et al. Time to surgery and breast cancer survival in the United States. *JAMA Oncol*. 2016;2:330–339. doi:10.1001/jamaoncol.2015.4508
15. Vandergrift JL, Niland JC, Theriault RL, et al. Time to adjuvant chemotherapy for breast cancer in National Comprehensive Cancer Network institutions. *J Natl Cancer Inst*. 2013;105:104–112. doi:10.1093/jnci/djs506
16. Chavez-MacGregor M, Clarke CA, Lichtensztajn DY, Giordano SH. Delayed initiation of adjuvant chemotherapy among patients with breast cancer. *JAMA Oncol*. 2015;2:322–329. doi:10.1001/jamaoncol.2015.3856
17. Yu KD, Huang S, Zhang JX, Liu GY, Shao ZM. Association between delayed initiation of adjuvant CMF or anthracycline-based chemotherapy and survival in breast cancer: a systematic review and meta-analysis. *BMC Cancer*. 2013;13:240. doi:10.1186/1471-2407-13-240
18. Smith-Graziani D, Lei X, Giordano SH, Zhao H, Karuturi M, Chavez-MacGregor M. Delayed initiation of adjuvant chemotherapy in older women with breast cancer. *Cancer Med*. 2020;9:6961–6971. doi:10.1002/cam4.3363
19. Kupstas AR, Hoskin TL, Day CN, Habermann EB, Boughey JC. Effect of surgery type on time to adjuvant chemotherapy and impact of delay on breast cancer survival: a national cancer database analysis. *Ann Surg Oncol*. 2019;26(10):3240–3249. doi:10.1245/s10434-019-07566-7
20. Shannon C, Ashley S, Smith IE. Does timing of adjuvant chemotherapy for early breast cancer influence survival? *J Clin Oncol*. 2003;21(20):3792–3797. doi:10.1200/JCO.2003.01.073
21. Hershman DL, Wang X, McBride R, Jacobson JS, Grann VR, Neugut AI. Delay of adjuvant chemotherapy initiation following breast cancer surgery among elderly women. *Breast Cancer Res Treat*. 2006;99(3):313–321. doi:10.1007/s10549-006-9206-z
22. Mosalam NA, El Aziz MH, Saad AS, Mohamed AW. The impact of adjuvant chemotherapy initiation time on the outcome of breast cancer. *J Oncol Transl Res*. 2017;3:113. doi:10.4172/2476-2261.1000113

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