Randomized Phase II Trial of Carboplatin–Paclitaxel Compared with Carboplatin–Paclitaxel–Trastuzumab in Advanced (Stage III–IV) or Recurrent Uterine Serous Carcinomas that Overexpress Her2/Neu (NCT01367002): Updated Overall Survival Analysis

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ABSTRACT

Purpose: Uterine-serous-carcinoma (USC) is an aggressive variant of endometrial cancer. On the basis of preliminary results of a multicenter, randomized phase II trial, trastuzumab (T), a humanized-mAb targeting Her2/Neu, in combination with carboplatin/paclitaxel (C/P), is recognized as an alternative in treating advanced/recurrent HER2/Neu-positive USC. We report the updated survival analysis of NCT01367002.

Patients and Methods: Eligible patients had stage III to IV or recurrent disease. Participants were randomized 1:1 to receive C/P for six cycles ± T followed by maintenance T until progression or toxicity. Progression-free survival (PFS) was the primary endpoint; overall survival (OS) and toxicity were secondary endpoints.

Results: Sixty-one patients were randomized. After a median-follow-up of 25.9 months, 43 progressions and 38 deaths occurred among 58 evaluable patients. Updated median-PFS continued to favor the T-arm, with medians of 8.0 months versus 12.9 months in the control and T-arms (HR = 0.46; 90% CI, 0.28–0.76; $P = 0.005$). Median-PFS was 9.3 months versus 17.7 months among 41 patients with stage III to IV disease undergoing primary treatment (HR = 0.44; 90% CI, 0.23–0.83; $P = 0.015$), and 7.0 months versus 9.2 months among 17 patients with recurrent disease (HR = 0.12; 90% CI, 0.03–0.48; $P = 0.004$). OS was higher in the T compared with the control arm, with medians of 29.6 months versus 24.4 months (HR = 0.58; 90% CI, 0.34–0.99; $P = 0.046$). The benefit was most notable in those with stage III to IV disease, with survival median not reached in the T-arm versus 24.4 months in the control arm (HR = 0.49; 90% CI, 0.25–0.97; $P = 0.041$). Toxicity was not different between arms.

Conclusions: Addition of T to C/P increased PFS and OS in women with advanced/recurrent HER2/Neu-positive USC, with the greatest benefit seen for the treatment of stage III to IV disease.

Introduction

This year, an estimated 61,880 women in the United States will be diagnosed with uterine cancer, and 12,160 women will die of the disease (1, 2). Although the global incidence and mortality from most solid tumors have declined or plateaued in the last three decades, endometrial cancer remains one of the only malignancies for which both the incidence and mortality are on the rise (1–3). Uterine serous carcinoma (USC) is an aggressive, high-grade endometrial cancer subtype associated with poor clinical outcomes and significant mortality (4–12). Although considered a rare tumor representing only 10% of all uterine cancer deaths, USC accounts for a disproportionate 40% of deaths from endometrial cancer, with an overall 5-year survival rate of 45%, compared with 91% for those with endometrioid adenocarcinoma (13).

USC is typically treated with hysterectomy and surgical staging followed by platinum/taxane combination chemotherapy (14–17). Initial response rates to the most commonly used chemotherapy regimen (i.e., carboplatin and paclitaxel) may be as low as 20% to 60%, which is no better than the response rate of 10% to 50% among those with recurrent disease (18). The risk of recurrence is high (19, 20), and progression-free survival (PFS) and overall survival (OS) are considerably worse relative to other endometrial histologies (21, 22).

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Translational Relevance

Uterine serous carcinoma (USC) is a rare but highly aggressive variant of endometrial cancer overexpressing Her2/Neu, the target of the mAb trastuzumab, in approximately 30% of cases. We report the final results of a randomized multicenter phase II trial of trastuzumab (T) in combination with carboplatin/paclitaxel (C/P) compared with carboplatin/paclitaxel (C/P) alone in patients with USC overexpressing Her2/Neu. T/C/P treated patients achieved a significantly longer progression-free survival (PFS) and overall survival (OS) when compared with C/P patients. The benefit was most notable in USC patients with stage III to IV disease, with median survival not reached in the T-arm versus 24.4 months in the control arm (HR = 0.49; 90% CI, 0.25–0.97; P = 0.041). Toxicity was not different between treatment arms. Mature OS findings support T/C/P as a new, safe, and effective treatment option for patients with USC overexpressing HER2/Neu.

Therefore, there is a unmet clinical need to identify better therapies for women with this endometrial cancer subtype.

Approximately 30% of USC overexpress Her2/Neu (23–31), a receptor tyrosine kinase critical to cancer signaling, growth, survival, and proliferation, and the target of the mAb trastuzumab. HER2 overexpression and amplification appears to be a poor prognostic factor for USC, similar to breast cancer. In 2018, we reported the preliminary results of a randomized phase II trial that showed improvement in PFS by nearly 5 months in patients with advanced and recurrent Her2/Neu-positive USC who received trastuzumab in addition to carboplatin/paclitaxel when compared with carboplatin/paclitaxel alone (32). OS data were not yet mature at the time of publication of that report, but in a preliminary sensitivity analysis for stage IIIC or IV disease, a 66% mortality reduction in the trastuzumab arm was observed (HR = 0.34; 90% CI, 0.14–0.86; P = 0.023). Subsequently, the National Comprehensive Cancer Network Uterine Neoplasm Guidelines endorsed the addition of trastuzumab to standard cytotoxic chemotherapy as the preferred regimen for the treatment of Her2/Neu-positive, advanced or recurrent USC (33). Herein, we report the mature OS data for this trial.

Patients and Methods

Study design and conduct

The patient eligibility criteria and study design for this investigator-initiated randomized phase II study (NCT01367002) were as described previously (32). The study was approved by the Yale institutional review board (HIC) and conducted in accordance with the Declaration of Helsinki guidelines and informed written consent was obtained from each subject. Briefly, across 11 participating academic institutions within the United States, patients were randomized 1:1 by the lead study institution using minimization (33) to balance the treatment arms for study site, disease status (advanced vs. recurrent USC), and residual tumor after debulking within the advanced-disease group. Patients were scheduled to receive intravenous carboplatin AUC 5 and paclitaxel 175 mg/m^2 over 3 hours every 21 days with or without trastuzumab at 8 mg/kg for the first dose and 6 mg/kg in subsequent cycles until disease progression or prohibitive toxicity (**Fig. 1**). The trial was designed to accrue 100 participants at a rate of five per month for 20 months. Interim analysis for futility was scheduled on observing 26 recurrences, progressions, or deaths and final analysis on observing 85 events. Power calculations assumed that median progression-free survival (PFS) would be 6 months on the carboplatin-paclitaxel arm and 10.5 months on the carboplatin-paclitaxel-trastuzumab arm, equivalent to an HR of 0.57 with trastuzumab addition. For the final efficacy analysis, we planned to compare the carboplatin-paclitaxel-trastuzumab arm to the carboplatin-paclitaxel arm for the expected increase in PFS by means of the log-rank test, conducted using a one-sided a of 0.10. Under this plan, 85 recurrence/progression/death events gave the study 90% power to detect HR of 0.57 with carboplatin-paclitaxel-trastuzumab versus carboplatin-paclitaxel. Power was adjusted for the interim futility analysis using the O'Brien-Fleming spending function to allocate type II error. We expected to observe the 26th recurrence/progression/death event at 12.9 months and the 85th recurrence/progression/death event at 33.6 months. The first subject was enrolled in August of 2011, after which (1) the accrual rate was slower than planned, and (2) observed PFS exceeded original expectations. The study was closed to further accrual in March of 2017 with a total of 61 enrolled subjects. Efficacy analysis commenced in August 2017. The current updated analysis was performed at the time of 43 progressions and 38 deaths.

Eligibility

All patients were 18 years of age or older and had FIGO 2009 stage III to IV (34) or recurrent (any previous stage) Her2/Neu-positive USC as defined by an IHC score of 3+ or 2+ with gene amplification confirmed by FISH. Her2/Neu-positive status was determined using paraffin-embedded tumor tissue from either primary surgery or from recurrent disease. Scoring was performed according to guidelines set forth by the 2007 American Society of Clinical Oncology/College of American Pathologists (ASOC/CAP) for breast cancer (34). Specimens were centrally reviewed for Her2/Neu+ and confirmed to contain ≥10% USC by two gynecologic pathologists. Patients may have been either optimally or suboptimally debulked after primary surgery. Patients were enrolled within 8 weeks after surgery or diagnosis of recurrent disease. Patients were required to exhibit an Eastern Cooperative Oncology Group (35) performance status of 0 to 2, adequate bone marrow, renal function, and hepatic function. All patients diagnosed with recurrence were required to have measurable disease, defined as at least one target lesion per RECIST v1.1 (36). A treatment-free interval of >6 months from last carboplatin/paclitaxel treatment was required in those with recurrent disease. Patients with recurrent disease may not have received >3 prior chemotherapies for treatment of their uterine cancer. The schemata for treatment modification are provided in the full protocol (Supplementary Fig. S1).

Endpoints

The primary endpoint in this study was PFS, defined as the length of time from randomization to disease recurrence, disease progression, or death for any reason, whichever occurred first. This primary endpoint drove our previously published sample-size considerations (32). Secondary endpoints included objective response, OS, and safety of trastuzumab in study subjects. Response was defined by RECIST 1.1 (36). Common Terminology Criteria for Adverse Events (CTCAE) version 4.0 were used to describe adverse events (37).

Statistical analyses

The statistical design of this trial was described previously (32). Briefly, patient characteristics, objective response rate, and occurrence of adverse events were examined for differences between treatment arms using two-sided Fisher exact and Wilcoxon rank sum tests at a = 0.05. PFS and OS, both overall and stratified by disease status, were

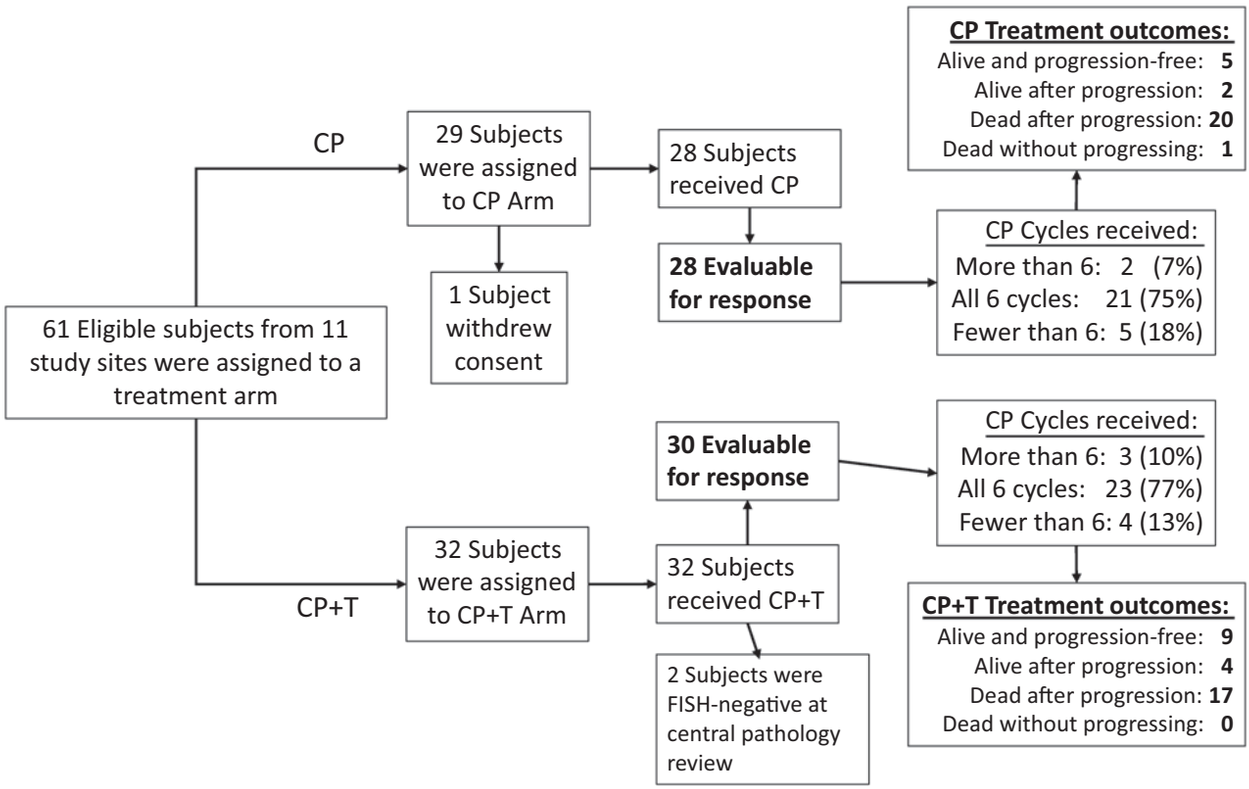

Figure 1.
CONSORT diagram.

determined using Kaplan–Meier analysis. One-sided log-rank tests were used to compare survival functions and improvement with trastuzumab. For the primary efficacy analysis, the log-rank test used a one-sided $a = 0.10$ significance level, as originally specified in the study's protocol. All other log-rank tests used one-sided $a = 0.05$ significance levels. Every assessment was accompanied by a Cox regression HR with two-sided 90% CI.

Results

Patients

As published previously (32), between August 2011 and January 2017, sixty-one subjects were enrolled (**Fig. 1**). Three participants were excluded due to withdrawal of consent ($n = 1$) or failure to confirm Her2/Neu positivity by FISH following 2+ IHC ($n = 2$) at the time of central review, leaving 58 subjects (28 in the carboplatin/paclitaxel arm and 30 in the carboplatin/paclitaxel/trastuzumab arm) evaluable for response to treatment. Forty-one subjects (71%) had primary, advanced disease; 17 subjects (29%) had recurrent disease. Of the subjects with advanced disease, 22 (54%) received primary radiation, and only 5 (11.6%) had gross residual disease following debulking surgery. Of the subjects with recurrent disease, the median number of prior lines of chemotherapy was 1 (range 0–2). The treatment arms did not differ significantly for race, ethnicity, study site, or disease status (advanced vs. recurrent disease), radiation or optimal debulking among advanced-disease subjects, or number of prior lines of chemotherapy among recurrent-disease subjects; however, subjects in the trastuzumab arm were younger (median 66 years; interquartile range of 64–69 years) compared with the control arm (median 73 years; interquartile range of 68–78 years; $P = 0.006$).

Treatment

The 28 subjects in the control arm completed a total of 156 cycles of carboplatin and paclitaxel (range 1–8). The 30 subjects in the trastuzumab arm completed 178 cycles of carboplatin and paclitaxel (range 4–9). At the time of analysis, subjects in the trastuzumab arm had received a total of 654 cycles of trastuzumab (median: 16 cycles; range: 5–86 cycles). In all, 23 subjects (82%) on the control arm completed six or more cycles of carboplatin/paclitaxel. On the trastuzumab arm, 26 subjects (87%) completed six or more paclitaxel cycles whereas 28 subjects (93%) completed six or more carboplatin cycles. To date, six patients (20%) on the trastuzumab arm remain on the drug without evidence of disease progression. These patients all had primary, advanced-stage disease.

Primary endpoint: updated PFS

At the time of this updated analysis, the 58 response-evaluable subjects experienced 44 events (43 progressions and 38 deaths) during a total follow-up of 1,865 months (median: 25.9 months; range: 0.33–91.5 months). Among all patients, the updated analysis continued to favor the trastuzumab arm, with median PFS of 8.0 months in patients who received carboplatin/paclitaxel alone and 12.9 months in patients who received chemotherapy plus trastuzumab (HR = 0.46; 90% CI, 0.28–0.76; $P = 0.005$; **Fig. 2**, left). After subgrouping subjects by disease status (i.e., advanced or recurrent), median PFS was 9.3 in the control arm versus 17.7 months in the trastuzumab arm among 41 stage III to

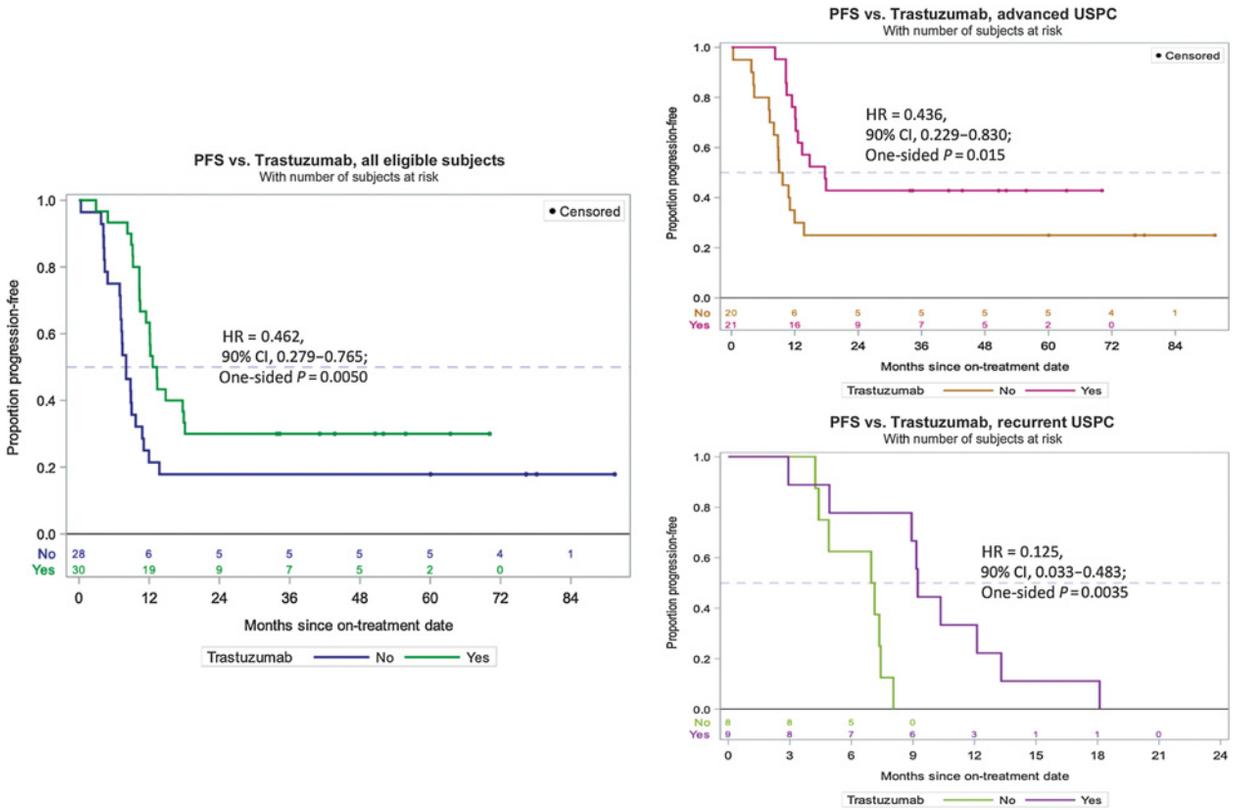

Figure 2.

Updated PFS analyses continue to support the addition of trastuzumab to the treatment of advanced/recurrent USC. Left: Median PFS was 8.0 months in patients who received CP and 12.9 months in patients who received CP+T (HR = 0.46; 90% CI, 0.28–0.76; $P = 0.005$). Benefit from the addition of trastuzumab was greatest in those undergoing primary treatment. Right, top: Median-PFS was 9.3 (CP) versus 17.7 (CP+T) months among 41 stage III to IV pts undergoing primary treatment (HR = 0.44; 90% CI, 0.23–0.83; $P = 0.015$). Right, bottom: Median-PFS 7.0 (CP) versus 9.2 (CP+T) months among 17 patients with recurrent disease (HR = 0.12; 90% CI, 0.03–0.48; $P = 0.004$).

IV patients undergoing primary treatment (HR = 0.44; 90% CI, 0.23–0.83; $P = 0.015$; **Fig. 2**, right top), and 7.0 months versus 9.2 months among 17 patients with recurrent disease (HR = 0.12; 90% CI, 0.03–0.48; $P = 0.004$; **Fig. 2**, right bottom).

In a subset analysis of those undergoing primary treatment (**Fig. 3**, left) restricted to patients with the highest risk for distant failure and worst outcomes (stage IIIC or stage IV), the addition of trastuzumab ($n = 17$) continued to provide PFS benefit over control ($n = 19$; 9.0 months vs. 14.8 months; HR = 0.40; 90% CI, 0.203–0.758; $P = 0.008$).

A total of 15 subjects did not experience disease progression. Five were randomized to the control arm, 9 were randomized to the experimental arm. After disease progression, 9 (30%) of the 30 subjects randomized to the carboplatin/paclitaxel-alone arm ultimately received a trastuzumab-containing therapy off-trial.

Secondary endpoints: OS

Among all patients, OS was significantly higher in the trastuzumab arm compared with the control arm, with medians of 29.6 months versus 24.4 months, respectively (HR = 0.58; 90% CI, 0.34–0.99; $P = 0.046$, **Fig. 4**, left). This benefit was particularly striking in the stage III to IV patients (**Fig. 4**, right top), in whom median OS was not reached in the trastuzumab arm versus 25.4 months in the control arm (HR = 0.49; 90% CI, 0.25–0.97; $P = 0.041$). Improvement in OS was also notable in the subset analysis of stage IIIC/IV patients undergoing primary therapy (21.3 months vs. 31.9 months; HR = 0.44; 90% CI, 0.22–0.88; $P = 0.023$; **Fig. 3**, right). No significant OS benefit from trastuzumab was observed in those with recurrent disease (**Fig. 4**, bottom right). Of the 38 deaths thus far, 37 were preceded by disease progression whereas 1 death was from thromboembolic events.

Secondary endpoints: safety

Trastuzumab was given over a median of 11.3 months (range: 3.45–62.1). No patient required discontinuation of trastuzumab for toxicity, although there were several instances of dose delays due to patient scheduling conflicts or transportation barriers. Sixty patients were evaluable for toxicity; 57 of them had a CTCAE event. At the time of the preliminary analysis, there were no differences in toxicity between the control and experimental treatment arms ($P = 0.49$, Wilcoxon rank-sum for maximum toxicity per patient). Since the original report, there were 42 additional adverse events reported, which included 5 before treatment was assigned (all grade 1); 10 during treatment with chemotherapy and trastuzumab, including grade 3 pruritus ($n = 1$) and grade 3 neutropenia ($n = 1$); 1 at the end of treatment with chemotherapy alone (alopecia of unknown grade); 13 during post-chemotherapy treatment with trastuzumab alone, including grade 3 leukopenia ($n = 1$); 13 during quarterly surveillance after chemotherapy alone (including grade 3 abdominal pain and grade 3 nausea, both

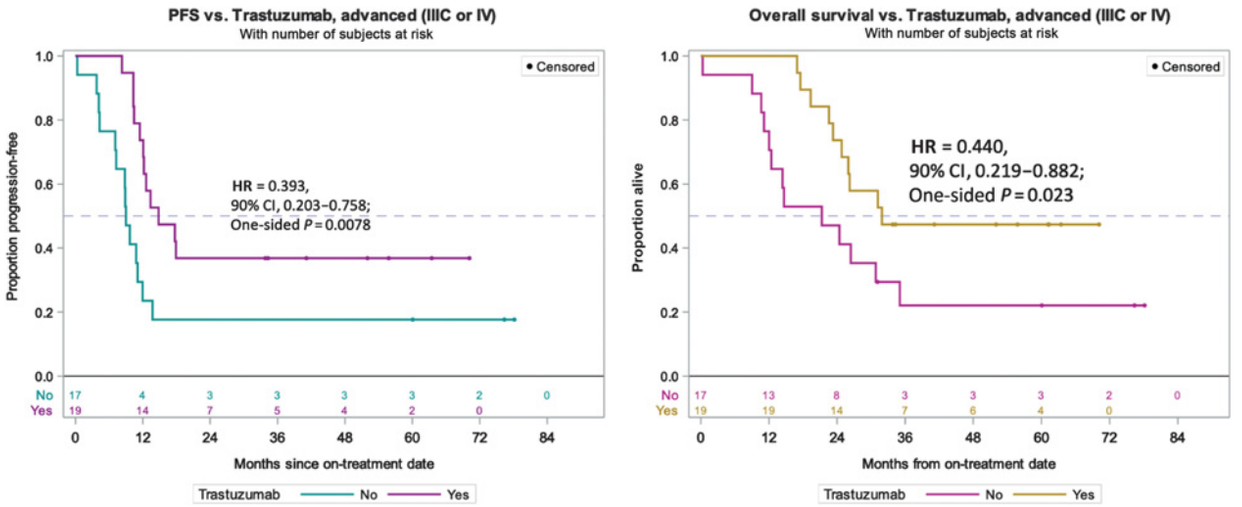

Figure 3.

In a subset analysis of patients restricted to stage IIIC/IV disease, the addition of trastuzumab ($n = 17$) continued to provide both (left) PFS benefit over control ($n = 19$; 9.0 months vs. 14.8 months; HR = 0.393; 90% CI, 0.203–0.758; $P = 0.0078$) and (right) OS benefit over control (21.1 months vs. 31.9 months; HR = 0.440; 90% CI, 0.219–0.882; $P = 0.0230$).

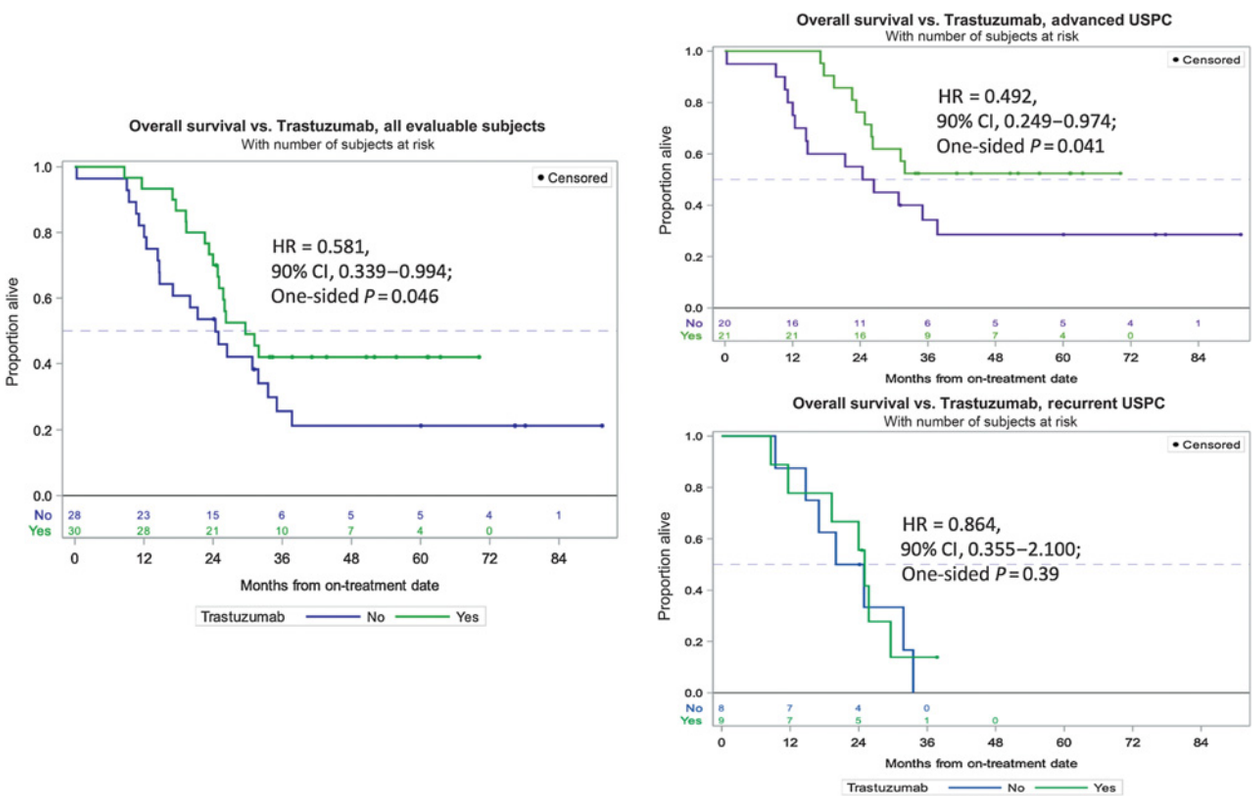

Figure 4.

Addition of trastuzumab improves OS in advanced USC. Left: Among all patients, OS was 24.4 (CP) versus 29.6 (CP+T) months (HR = 0.581; 90% CI, 0.339–0.994; $P = 0.0462$). Right-top: Benefit was greatest in those undergoing primary therapy with advanced disease (OS 25.4 months vs. not reached; HR = 0.492; 90% CI, 0.249–0.974; $P = 0.0406$). Right-bottom: Benefit was not apparent in the recurrent setting (22.5 months vs. 25.0 months; HR = 0.864; 90% CI, 0.355–2.100; $P = 0.3929$).

in the same patient). Only one new adverse event (grade 3 pruritus) was classified as serious. There were 12 new adverse events (all belonging to the same subject), 4 of which resulted in hospitalization including grade 1 bowel obstruction, grade 1 abdominal distension, and grade 3 nausea and abdominal pain described above.

Discussion

In this prospective, randomized phase II trial update of women with stage III to IV or recurrent, HER2/neu-positive USC, the addition of trastuzumab to carboplatin/paclitaxel resulted in significantly improved PFS and OS, with the greatest benefit in both survival categories observed in women with stage III/IV disease undergoing primary therapy after surgery. Updated median-PFS continued to favor the trastuzumab arm by approximately 5 months in the entire cohort, with a >8-month improvement for women with stage III to IV disease undergoing primary treatment. OS was also significantly higher in the trastuzumab arm by 5 months, with a particular benefit again noted in those with stage III to IV disease treated upfront (median OS not reached in the trastuzumab arm vs. 25.4 months in the control arm). The addition of trastuzumab was well tolerated by patients, with few high-grade adverse events. In fact, 20% of patients on the trastuzumab arm remain on the drug without evidence of disease recurrence. This is the first randomized treatment trial powered to study survival outcomes for this rare endometrial cancer subtype.

Notably, approximately 30% of patients who experienced disease recurrence or progression on the carboplatin/paclitaxel only arm ultimately received trastuzumab therapy off clinical trial, which could have potentially blunted the OS benefit of trastuzumab. Although PFS was selected as the primary study endpoint precisely because therapies administered downstream of the trial treatments may impact OS outcomes, a significant OS benefit was still observed to favor the trastuzumab arm.

In this work, we have demonstrated that Her2/Neu overexpression in women with advanced or recurrent USC, defined as 3+ by IHC or 2+ with confirmatory FISH testing, reliably identifies a target population for whom clinical benefit can be achieved with trastuzumab. Approved algorithms exist for scoring HER2 expression and amplification in breast and gastrointestinal carcinomas. At the time of study conception, no standardized criteria existed for gynecologic cancers, including USC. Typically, the ASCO/CAP breast cancer algorithms are employed. This algorithm has undergone two recent modifications, most recently in 2018. Given that HER2/neu expression or amplification based on the 2007 algorithm appeared to be a biomarker for trastuzumab response, we maintained the use of the 2007 ASCO/CAP HER2/neu scheme throughout the trial duration. Efforts to validate the 2018 testing criteria in this setting are underway.

Recent studies suggest improved activity in several cancer subtypes when trastuzumab and chemotherapy are combined with another humanized anti-HER2 mAb, pertuzumab. In 2017, the FDA granted pertuzumab approval for use in combination with trastuzumab and chemotherapy as an adjuvant treatment for patients with HER2-positive, early-stage breast cancer at high risk of recurrence based on the double-blind, phase III APHINITY trial. In addition, *in vitro* studies by our research group demonstrated that pertuzumab plus trastuzumab induce strong antibody-dependent cell cytotoxicity in HER2/neu amplified USC cell lines (38). Given these promising findings a U.S. cooperative group study is planned to determine the efficacy of carboplatin/paclitaxel/trastuzumab with or without pertuzumab in women with advanced, HER2/neu-positive disease.

Strengths of this study include the randomized trial design, rigorous HER2/neu testing, central pathology review, and the relatively large number of U.S. centers included. Study limitations include the small number of patients enrolled, that the control arm has significantly older patients and this may have impacted OS outcomes, that we enrolled a somewhat heterogeneic cohort of patients with advanced/primary and recurrent disease, and premature trial closure was performed due to slow patient accrual. Despite this, the trial findings illustrate the ability to perform clinically meaningful studies in women with uncommon endometrial cancer histologies using an innovative trial design and a coordinated multi-institutional approach. Finally, trastuzumab is an expensive treatment associated with a high drug acquisition cost. However, studies demonstrate that this drug appears to be a reasonably cost effective treatment option for patients with breast cancer, especially as primary/adjuvant treatment in contrast to treatment in the palliative disease setting (39). A study is planned to evaluate the cost effectiveness of trastuzumab in women with primary, advanced HER2-positive USC.

The identification of novel and improved treatment strategies for USC is imperative. The addition of trastuzumab to carboplatin and paclitaxel chemotherapy in this randomized phase II study may represent a new standard treatment for USC tumors that overexpress HER2/neu, particularly in women with advanced, primary disease. Future studies are needed to determine if the addition of other anti-HER2/neu antibodies or targeted agents to trastuzumab have the potential to augment survival further.

Disclosure of Potential Conflicts of Interest

A. Alvarez Secord reports grants from AbbVie, Amgen, Astellas Pharma Inc., Astex Pharmaceuticals Inc, Boehringer Ingelheim, Bristol Myers Squibb, Clovis (honorarium for advisory board), Eisai, Endocyte, Exelixis, Immutep Ltd, Incyte, PharmaMar, Seattle Genetics, Inc., VBL Therapeutics, and National Cancer Trial Network; grants and personal fees from AstraZeneca (honorarium for advisory board), Merck (honorarium for advisory board), Roche/Genentech (honorarium for advisory board), Tesaro/GSK (honorarium for advisory board); personal fees from Aravive (honorarium for advisory board), Cordgenics (honorarium for advisory board), Eisai (honorarium for advisory board), Janssen/Johnson & Johnson (honorarium for advisory board), Mersana (honorarium for advisory board), Myriad (honorarium for advisory board), Oncoquest (honorarium for advisory board); other from GOG Board of Directors (board member) outside the submitted work; and reports being a Steering Committee member for the OVAL trial (VBL Therapeutics) and the AtTend trial (Roche/Genentech), noncompensated and not relevant to submitted work. L. Havrilesky reports grants from AstraZeneca and Tesaro outside the submitted work. D.M. O'Malley reports other from Yale University (institutional support for the trial) during the conduct of the study; personal fees and other from Genentech/Roche, AstraZeneca, Tesaro/GSK, Clovis, Immunogen, Abbvie, Janssen/J&J, Regeneron, GOG Foundation, Agenus, Merck, Eisai, Tarveda, and Iovance (personal consulting and advisory fees and institutional support for clinical research); other from Array Biopharma, EMD Sereno, Ergomed, Cerulean, BMS (institutional support for clinical research), and Myriad (personal support for advisory board); and personal fees from Ambry (personal support for advisory board) outside the submitted work. F.J. Backes reports personal fees from Clovis Oncology, Eisai Inc, Merck, Genentech, AstraZeneca, GlaxoSmithKline, and Agenus (advisory board) and other from CEC Oncology (CME lectures) outside the submitted work. B. Edraki reports personal fees from AstraZeneca (speakers bureau), Abbvie (*ad hoc* advisory board), and Clovis Oncology (speakers bureau) outside the submitted work. W. Lowery reports other from AstraZeneca (speakers bureau) outside the submitted work. E. Ratner is an advisory board member for Tesaro, Genentech, and Zai Labs. D.-A. Silasi reports personal fees from Zai Lab outside the submitted work. A.D. Santin reports grants from Genentech/Roche during the conduct of the study; personal fees and other from Merck and Puma (advisory board); and grants from Immunomedics, R-Pharma, Boehinger-Ingelheim, Synthon, Merck, Gilead, Genentech/Roche, and Tesaro outside the submitted work. No potential conflicts of interest were disclosed by the other authors.

Authors' Contributions

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