Extending Survival with Chemotherapy in Metastatic Breast Cancer

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Key Words. Metastatic • Overall survival • Docetaxel • Paclitaxel • Trastuzumab • Bevacizumab

LEARNING OBJECTIVES

After completing this course, the reader will be able to:

1. Identify trials that have demonstrated a survival benefit with a modern chemotherapeutic agent or regimen in MBC.
2. Summarize recent findings of randomized trials showing survival benefits with targeted therapy–chemotherapy combinations in MBC.
3. Discuss quality-of-life findings and their implications in clinical practice.

ABSTRACT

Metastatic breast cancer (MBC) remains essentially incurable, and goals of therapy include the palliation of symptoms, delay of disease progression, and prolongation of overall survival time without negatively impacting quality of life. Anthracycline and taxane-based therapies have traditionally shown the highest degree of activity in MBC. Though numerous randomized clinical trials have shown improvements in overall response rates, few have found clear survival benefits. In recent years, however, there has been a small but growing series of clinical trials demonstrating modest, but meaningful survival advantages in metastatic disease.

A common feature in many of these trials has been the use of a taxane, and more recently, a taxane combined with an antimetabolite. In addition, the development of targeted biologic agents active against MBC, such as trastuzumab and bevacizumab, has demonstrated great potential for enhancing the effects of chemotherapy and producing meaningful survival improvements. The role of the taxanes, antimetabolites, and biologics in extending survival in MBC is discussed. The Oncologist 2005;10(suppl 3):20–29

INTRODUCTION

Breast cancer is the most frequently diagnosed cancer in women in the U.S. In 2005, an estimated 211,240 new cases of invasive breast cancer are expected to occur [1]. Continuing on a trend established over the past decade, the overall incidence of breast cancer continues to gradually increase. The mortality rate from breast cancer declined approximately 2.3% per year from 1990 through 2001, due in large part to increased awareness, earlier detection, and improved therapies [1]. Nonetheless, it is estimated that 40,410 women in the U.S. will die of breast cancer in 2005, with breast cancer ranking second only to lung cancer in cancer-related mortality in women.

The majority of breast cancer-related deaths are a result of complications from recurrent or metastatic disease. As an initial presentation, metastatic breast cancer (MBC) is uncommon, occurring in only about 6% of newly diagnosed cases [2]. Despite advances in the treatment of breast cancer, approximately 30% of women initially diagnosed with earlier stages of breast cancer eventually develop recurrent advanced or metastatic disease.
The use of combination therapy versus monotherapy or sequential single agents remains a controversial issue [9]. Depending on the individual patient and specific treatment goals, either can be appropriate. Combination therapies generally result in higher overall response rates and times to disease progression than with sequential single agents, but usually at a cost of greater toxicity. In addition, the higher overall response rates with combination therapy versus sequential single agents may not necessarily translate into superior survival outcomes.

Demonstrating this point are the results of Intergroup trial E1193, in which patients were randomized to receive either paclitaxel (Taxol®; Bristol-Myers Squibb, Princeton, NJ, http://www.bms.com), docetaxel (Taxotere®; Aventis Pharmaceuticals Inc., Bridgewater, NJ, http://www.aventispharma-us.com), or a combination of the two as first-line treatment of MBC [10]. In both the single-agent arms, patients were crossed over to treatment with the alternate single agent at the time of disease progression. Combination therapy produced a significantly higher overall response rate and longer time to treatment failure than either single agent arm; however, there were no differences in overall survival times among the three arms (Table 1). Other groups have compared combination chemotherapy with sequential therapy in randomized trials (Table 1), showing similar outcomes in terms of response rate and progression-free and overall survival [11–13]. Toxicity was in general less with sequential administration.

Combinations of traditional chemotherapeutics with targeted biologic agents, such as trastuzumab (Herceptin®; Genentech, Inc., South San Francisco, CA, http://www. genecom) and more recently bevacizumab (Avastin®; Genentech, Inc.), appear to present a new dimension. With the potential to realize clinical synergism between chemotherapy and the biologics, significant improvements in overall survival with the use of these agents in combination have been seen [14–16].

Optimization of chemotherapy for the treatment of MBC remains an ongoing effort. While it is generally accepted that chemotherapy can provide substantial clinical benefit, the potential to positively impact overall survival and QoL remains the subject of debate. This manuscript provides an overview of recent randomized trials in MBC, focusing on survival outcomes and QoL issues.

**CHEMOTHERAPY AND SURVIVAL OUTCOMES IN MBC**

In the treatment of MBC, there is an underlying assumption that improvements in overall response rates would translate into long-term survival benefits. While there is indirect evidence to support a relationship between response and
Extending Survival in Metastatic Breast Cancer

overall survival [17–20], few randomized trials have provided direct evidence.

There are indications, though, that with modern chemotherapeutic agents and biologics, progress has been made toward improving survival outcomes in women with MBC. In a population-based analysis of survival outcomes in MBC conducted in British Columbia, the introduction of new agents over the past decade, such as the taxanes, aromatase inhibitors, and trastuzumab, was associated with significant improvements in overall survival times across the population [21].

In addition, there is a small but growing number of randomized clinical trials reporting statistically significant survival improvements in women with MBC [14, 15, 22–30]. A common feature of these studies has been the use of a taxane or combination therapy with a targeted biologic agent such as trastuzumab.

### Taxanes in Anthracycline-Pretreated Patients with MBC

The taxanes docetaxel and paclitaxel are highly active in MBC and have established activity in patients who have been previously treated with anthracyclines, including patients with anthracycline-refractory disease [31, 32]. Taxane-based therapy, therefore, is often a primary option for patients who have previously been treated with anthracyline-based therapy and present with disease progression or recurrence.

A survival advantage with the use of single-agent docetaxel in women with anthracycline-pretreated MBC has been observed in two of four randomized phase III trials (Table 2) [22, 23, 33, 34]. In the first of these studies, 392 patients with progressive MBC following anthracycline-based chemotherapy were randomized to receive either single-agent docetaxel (100 mg/m²) or combination therapy with mitomycin (Mutamycin®; Bristol-Myers Squibb) (12 mg/m²) and vinblastine (Velban®; Eli Lilly and Company) (6 mg/m²) [22]. The overall response rate, median time to disease progression, and overall survival time were all significantly greater with docetaxel. The median overall survival time with docetaxel was 11.4 months, 2.7 months longer than with mitomycin and vinblastine. While grade 3–4 neutropenia occurred more frequently with docetaxel, other acute adverse events were similar in the two treatment arms. A QoL analysis was conducted, and though interpretation of the results was limited, there were no apparent differences in QoL between treatment groups.

The second study compared single-agent docetaxel (100 mg/m²) with single-agent paclitaxel (175 mg/m²) in 449 patients with MBC who had previously received first-line metastatic therapy with an anthracycline-based regimen or had disease progression within 12 months of completing anthracyline-based adjuvant or neoadjuvant therapy [23]. The overall response rate, median time to disease progression, and overall survival time were statistically significantly longer in the docetaxel arm (Table 2). Docetaxel was associated with more toxicities than paclitaxel, including grade 3–4 neutropenia, asthenia, edema, infection, and stomatitis.
Interestingly, there were no statistically significant differences in global QoL scores (as assessed by the Functional Assessment of Cancer Therapy tool) between treatment groups over time, suggesting that toxicity differences did not affect QoL.

Paclitaxel was also directly compared with albumin-bound paclitaxel (ABI-007) in 460 patients with MBC (who had not received prior paclitaxel or docetaxel for MBC) in a randomized phase III trial [35]. ABI-007 was associated with a significantly greater response rate (33% vs. 19%; \( p = .001 \)) and time to tumor progression (23 weeks vs. 16.9 weeks; \( p = .006 \)) than paclitaxel, but median survival rates were similar in the two treatment groups (65 weeks vs. 55.7 weeks, respectively).

Two additional phase III trials compared single-agent docetaxel with either sequential methotrexate and 5-fluorouracil or 5-fluorouracil in combination with vinorelbine (Table 2) [33, 34]. In comparison with sequential methotrexate and 5-fluorouracil, docetaxel produced a significantly higher overall response rate and longer time to disease progression, but median overall survival was not different between the two treatment groups. Grade 3–4 toxicities, including fatigue, alopecia, and infection, were more frequent with docetaxel. In comparison with the combination of 5-fluorouracil and vinorelbine, no significant differences in response or survival outcomes were seen between study arms, though overall tolerability was greater with docetaxel.

Clinical outcomes with taxane combination regimens in anthracycline-pretreated breast cancer patients have been very encouraging, with significant survival benefits observed in two phase III trials [24–26]. The first of those trials compared the combination of docetaxel (75 mg/m²) and capecitabine (2,500 mg/m²) with docetaxel alone (100 mg/m²) in 511 patients with disease progression or recurrence following anthracycline-based chemotherapy (Table 3) [24]. The overall response rate, median time to disease progression, and median overall survival time were all statistically superior with the combination, with an absolute improvement in median overall survival time of 3 months.

### Table 2. Phase III trials with single-agent taxanes in anthracycline-pretreated metastatic breast cancer

<table>
<thead>
<tr>
<th>Study</th>
<th>Regimen</th>
<th>No. of patients</th>
<th>Overall response rate</th>
<th>Median time to progression (months)</th>
<th>Median overall survival (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nabholtz et al. [22]</td>
<td>Docetaxel</td>
<td>203</td>
<td>30% ( (p = .0001) )</td>
<td>4.4 ( (p = .001) )</td>
<td>11.4 ( (p = .0097) )</td>
</tr>
<tr>
<td></td>
<td>Mitomycin/vinblastine</td>
<td>189</td>
<td>12%</td>
<td>2.5</td>
<td>8.7</td>
</tr>
<tr>
<td>Jones et al. [23]</td>
<td>Docetaxel</td>
<td>225</td>
<td>32%</td>
<td>5.7 ( (p = .0001) )</td>
<td>15.4 ( (p = .03) )</td>
</tr>
<tr>
<td></td>
<td>Paclitaxel</td>
<td>224</td>
<td>25%</td>
<td>3.6</td>
<td>12.7</td>
</tr>
<tr>
<td>Sjöström et al. [33]</td>
<td>Docetaxel</td>
<td>143</td>
<td>42% ( (p &lt; .001) )</td>
<td>6.3 ( (p &lt; .001) )</td>
<td>10.4</td>
</tr>
<tr>
<td></td>
<td>Methotrexate/5-fluorouracil</td>
<td>139</td>
<td>21%</td>
<td>3</td>
<td>11.1</td>
</tr>
<tr>
<td>Bonneterre et al. [34]</td>
<td>Docetaxel</td>
<td>86</td>
<td>43%</td>
<td>6.5</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>5-fluorouracil/vinorelbine</td>
<td>90</td>
<td>34%</td>
<td>5.1</td>
<td>15</td>
</tr>
</tbody>
</table>

### Table 3. Phase III trials with taxane combinations in anthracycline-pretreated metastatic breast cancer

<table>
<thead>
<tr>
<th>Study</th>
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<th>No. of patients</th>
<th>Overall response rate</th>
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<th>Median overall survival (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O’Shaughnessy et al. [24]</td>
<td>Docetaxel and capecitabine</td>
<td>255</td>
<td>42% ( (p = .006) )</td>
<td>6.1 ( (p = .0001) )</td>
<td>14.5 ( (p = .0126) )</td>
</tr>
<tr>
<td></td>
<td>Docetaxel</td>
<td>256</td>
<td>30%</td>
<td>4.2</td>
<td>11.5</td>
</tr>
<tr>
<td>Albain et al. [25] and O’Shaughnessy et al. [26]</td>
<td>Paclitaxel and gemcitabine</td>
<td>267</td>
<td>39% ( (p = .0007) )</td>
<td>5.4 ( (p = .0013) )</td>
<td>18.5 (HR 0.775; ( p = .018 ))</td>
</tr>
<tr>
<td></td>
<td>Paclitaxel</td>
<td>262</td>
<td>26%</td>
<td>3.5</td>
<td>15.8</td>
</tr>
</tbody>
</table>

Abbreviation: HR, hazard ratio.
The incidences of grade 3–4 adverse events were similar in both treatment groups, and though these rates were relatively high, treatment was generally tolerable. Gastrointestinal adverse events and hand-foot syndrome were more common with combination therapy, whereas febrile neutropenia, sepsis, arthralgia, and myalgia were more common with single-agent docetaxel. QoL scores were similar in the two treatment arms, and overall global health quality was generally maintained over time.

For patients treated with docetaxel alone, crossover to single-agent capecitabine was not mandatory. A subsequent survival analysis suggested that patients who received capecitabine following docetaxel had a longer median survival time than patients receiving other poststudy chemotherapy agents [36]. Although retrospective, these data suggest that sequential administration of docetaxel and capecitabine may also have favorable survival outcomes.

The second phase III trial compared the combination of paclitaxel (175 mg/m²) and gemcitabine (1,250 mg/m²) with single-agent paclitaxel (175 mg/m²) in 529 patients with MBC who had previously received an anthracycline but had no prior chemotherapy for metastatic disease [25, 26]. Combination therapy resulted in a significantly higher overall response rate and longer progression-free and overall survival times than single-agent paclitaxel (Table 3). The median overall survival time with the combination was 18.5 months, 2.7 months higher than that seen with single-agent paclitaxel. Again, crossover was not mandated, and the potential impact of sequential therapy on survival outcomes has not been evaluated. Although grade 4 neutropenia was more common with the combination, overall toxicities in both arms were manageable. A QoL analysis indicated better global scores for patients receiving combination therapy than for those receiving single-agent paclitaxel [37].

### Table 4. Phase III trials of single-agent taxanes in metastatic breast cancer with no or minimal prior anthracycline exposure

<table>
<thead>
<tr>
<th>Study</th>
<th>Regimen</th>
<th>No. of patients</th>
<th>Overall response rate</th>
<th>Median time to progression (months)</th>
<th>Median overall survival (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chan et al. [38]</td>
<td>Docetaxel</td>
<td>161</td>
<td>42% ($p = .008$)</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Doxorubicin</td>
<td>165</td>
<td>30%</td>
<td>4.8</td>
<td>14</td>
</tr>
<tr>
<td>Paridaens et al. [39]</td>
<td>Paclitaxel</td>
<td>166</td>
<td>25%</td>
<td>3.9</td>
<td>15.6</td>
</tr>
<tr>
<td></td>
<td>Doxorubicin</td>
<td>165</td>
<td>41% ($p = .003$)</td>
<td>7.5 ($p &lt; .001$)</td>
<td>18.3</td>
</tr>
<tr>
<td>Bishop et al. [27]</td>
<td>Paclitaxel</td>
<td>107</td>
<td>29%</td>
<td>5.3</td>
<td>17.3 ($p = .025$)*</td>
</tr>
<tr>
<td></td>
<td>CMFP</td>
<td>102</td>
<td>35%</td>
<td>6.4</td>
<td>13.9</td>
</tr>
</tbody>
</table>

*By multivariate analysis.

Abbreviation: CMFP, cyclophosphamide, methotrexate, fluorouracil, and prednisone.
infections occurred more frequently with doxorubicin. A QoL analysis showed no differences in global health scores between the two arms after the third cycle of therapy.

An additional phase III trial compared single-agent paclitaxel (200 mg/m²) with the alkylating agent–based combination of cyclophosphamide, methotrexate, fluorouracil, and prednisone (Deltasone®; Pfizer Pharmaceuticals) (CMFP) in 209 patients as first-line therapy for metastatic disease [27]. Prior adjuvant chemotherapy was permitted. Overall response rates and times to disease progression were not different between the two study arms (Table 4). The absolute difference in median overall survival was 3.4 months in favor of paclitaxel, but this difference did not achieve statistical significance on univariate analysis. In a multivariate model that factored in significant prognostic factors, however, this difference was found to be significant ($p = .025$).

Leukopenia, thrombocytopenia, nausea and vomiting, and mucositis occurred more frequently with CMFP. Overall QoL assessments were similar for both treatment arms.

Seven phase III trials have evaluated a taxane in combination with an anthracycline versus a standard anthracycline-based combination in patients with MBC (Table 5) [28, 29, 40–44]. Three trials evaluated a docetaxel-based combination and four trials evaluated a paclitaxel-based combination.

The combination of doxorubicin (50 mg/m²) and docetaxel (75 mg/m²) (AD) was compared with doxorubicin (60 mg/m²) and cyclophosphamide (500 mg/m²) (AC) as first-line chemotherapy in 429 women with MBC [40]. Prior nonanthracycline-based adjuvant chemotherapy was allowed. The overall response rate and median time to disease progression were statistically superior with AD than with AC, though the median overall survival time did not differ between the two treatment arms (Table 5). Of the 60% of patients who received additional chemotherapy, 29% in the AC group received docetaxel as additional treatment versus 6% in the AD group. Grade 3–4 neutropenia occurred frequently in both treatment arms, and febrile neutropenia and infection occurred more commonly with the AD combination.

A second phase III trial compared docetaxel, doxorubicin, and cyclophosphamide (TAC) at doses of 75/50/500 mg/m², respectively, with the combination of 5-fluorouracil, doxorubicin, and cyclophosphamide (FAC, 500/50/500 mg/m²) as first-line chemotherapy for metastatic disease in 484 women [41]. Prior adjuvant chemotherapy was allowed, and patients could have received prior doxorubicin up to a cumulative dose of 240 mg/m². While the overall response rate with TAC was significantly higher, time to disease progression and overall sur-

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Table 5. Phase III trials of taxane combinations in metastatic breast cancer with no or minimal prior anthracycline exposure

<table>
<thead>
<tr>
<th>Study</th>
<th>Regimen</th>
<th>No. of patients</th>
<th>Overall response</th>
<th>Median time to progression (months)</th>
<th>Median overall survival (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nabholtz et al. [40]</td>
<td>AD</td>
<td>214</td>
<td>59% ($p = .009$)</td>
<td>8.6 ($p = .014$)</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>AC</td>
<td>215</td>
<td>47%</td>
<td>7.3</td>
<td>21.7</td>
</tr>
<tr>
<td>Mackey et al. [41]</td>
<td>DAC</td>
<td>242</td>
<td>55% ($p = .02$)</td>
<td>7.2</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>FAC</td>
<td>242</td>
<td>44%</td>
<td>6.7</td>
<td>22</td>
</tr>
<tr>
<td>Bontenbal et al. [28]</td>
<td>AD</td>
<td>108</td>
<td>64% ($p = .002$)</td>
<td>8.1 ($p = .002$)</td>
<td>22.6 ($p = .02$)</td>
</tr>
<tr>
<td></td>
<td>FAC</td>
<td>107</td>
<td>41%</td>
<td>6.6</td>
<td>16.1</td>
</tr>
<tr>
<td>Jassem et al. [29]</td>
<td>AP</td>
<td>134</td>
<td>68% ($p = .032$)</td>
<td>8.3 ($p = .034$)</td>
<td>22.3 ($p = .013$)</td>
</tr>
<tr>
<td></td>
<td>FAC</td>
<td>133</td>
<td>55%</td>
<td>6.2</td>
<td>18.3</td>
</tr>
<tr>
<td>Biganzoli et al. [42]</td>
<td>AP</td>
<td>138</td>
<td>58%</td>
<td>6.0</td>
<td>20.6</td>
</tr>
<tr>
<td></td>
<td>AC</td>
<td>137</td>
<td>54%</td>
<td>6.0</td>
<td>20.5</td>
</tr>
<tr>
<td>Carmichael [43]</td>
<td>EP</td>
<td>705 (total)</td>
<td>67%</td>
<td>6.5</td>
<td>13.7</td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td></td>
<td>56%</td>
<td>6.7</td>
<td>13.8</td>
</tr>
<tr>
<td>Lück et al. [44]</td>
<td>EP</td>
<td>429 (total)</td>
<td>46%</td>
<td>9.0</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td></td>
<td>41%</td>
<td>7.6</td>
<td>NR</td>
</tr>
</tbody>
</table>

Abbreviations: AC, doxorubicin and cyclophosphamide; AD, doxorubicin and docetaxel; AP, paclitaxel and doxorubicin; DAC, docetaxel, doxorubicin, cyclophosphamide; EC, epirubicin and cyclophosphamide; EP, epirubicin and paclitaxel; FAC, 5-fluorouracil, doxorubicin, and cyclophosphamide; NR, not reported.
vival times were similar in the two treatment groups. A greater percentage of patients in the FAC group received crossover treatment with a taxane than those in the TAC group (46.2% vs. 16.5%). Both regimens were associated with a high rate of grade 3–4 hematologic toxicities, though neutropenia and febrile neutropenia occurred more frequently with TAC.

A randomized phase II study compared AD (50/75 mg/m²) with FAC (500/50/500 mg/m²) as first-line chemotherapy in 215 MBC patients [28]. That study permitted limited prior doxorubicin exposure in the adjuvant setting. In contrast to the previous trial, significant differences in time to disease progression and overall survival time along with a superior overall response rate were seen with AD versus FAC. The absolute median survival difference was 6.5 months, representing a 40% longer survival time than in the FAC arm. The incidences of grade 3–4 neutropenia were similar for both arms, although febrile neutropenia occurred more frequently with AD.

Among the three trials evaluating paclitaxel-based combinations, one demonstrated significantly better outcomes favoring the taxane combination. That trial compared doxorubicin and paclitaxel (50/220 mg/m²) with FAC (500/50/500 mg/m²) as first-line chemotherapy in 267 anthracycline-naïve MBC patients [29]. The overall response rate, median time to disease progression, and overall survival time were significantly better with AP than with FAC, with AP producing a median survival time that was 4 months longer. Approximately the same number of patients on the FAC and AP arms received second-line chemotherapy (44% and 48%, respectively). Paclitaxel and docetaxel were administered to 10% and 14% of patients, respectively, in the FAC group and each was administered to 1% of patients in the AP group. Grade 3–4 neutropenia occurred more frequently with AP, although the incidence of febrile neutropenia was low in both arms. Overall QoL measures were similar in the two treatment arms. Symptom scales of pain, fatigue, insomnia, and diarrhea favored FAC therapy, while the nausea and vomiting symptom scale favored AP therapy.

In a phase III trial comparing AP (60/175 mg/m²) with AC (60/600 mg/m²) as first-line chemotherapy in 265 anthracycline-naïve MBC patients [29], the addition of trastuzumab to AC increased overall response rate, median time to disease progression, and overall survival time than with chemotherapy alone (Table 6). An absolute survival advantage of 4.8 months was seen with the addition of trastuzumab. Approximately two thirds of the patients in the chemotherapy-alone arm crossed over to receive trastuzumab at disease progression. The most important adverse event was a higher incidence of congestive heart failure in patients receiving trastuzumab with AC.

In a separate study, a QoL analysis was performed in a sample of 400 patients who received either chemotherapy with trastuzumab (n = 208) or chemotherapy alone as first-line therapy for MBC [46]. After completion of therapy, fatigue scores were significantly better than baseline scores in patients receiving chemotherapy and trastuzumab (p < .05). In addition, patients who received trastuzumab had a significant improvement in global QoL scores (p < .05).

The results of a phase III trial evaluating single-agent docetaxel (100 mg/m²) with or without trastuzumab as first-line therapy for MBC have also shown a significant benefit from the addition of trastuzumab (Table 6) [15]. The overall response rate, median time to disease progression, and median overall survival time were all statistically superior with the combination than with single-agent therapy. Both the overall response rate and median time to disease progression were nearly doubled by the addition of trastuzumab. The absolute difference in median survival time

**Chemotherapy in Combination with Targeted Biologic Agents in MBC**

Targeted biologic therapies offer an entirely new treatment dimension for patients with MBC. The monoclonal antibody trastuzumab targets an extracellular domain of the HER-2 receptor [45]. Overexpression of HER-2 is associated with clinically aggressive disease and a shorter survival time. Synergistic activity has been observed in cellular models between trastuzumab and several chemotherapeutic agents, including docetaxel and carboplatin (Paraplatin®, Bristol-Myers Squibb), while additive activity has been observed with paclitaxel, doxorubicin, and epirubicin [45].

Clinically, trastuzumab therapy is generally well tolerated. One important caveat, however, is the potential for congestive heart failure. As the risk for congestive heart failure is much greater when trastuzumab is given with doxorubicin, this combination is generally avoided [14].

Two important phase III trials have evaluated the addition of trastuzumab to chemotherapy in women with HER-2–overexpressing MBC [14, 15]. In a pivotal clinical trial reported by Slamon et al., patients received chemotherapy with either doxorubicin and cyclophosphamide (AC) or single-agent paclitaxel with or without trastuzumab. The combination of chemotherapy and trastuzumab resulted in significantly higher overall response rates with a longer median time to disease progression and overall survival time than with chemotherapy alone (Table 6). An absolute survival advantage of 4.8 months was seen with the addition of trastuzumab. Approximately two thirds of the patients in the chemotherapy-alone arm crossed over to receive trastuzumab at disease progression. The most important adverse event was a higher incidence of congestive heart failure in patients receiving trastuzumab with AC.

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The results of a phase III trial evaluating single-agent docetaxel (100 mg/m²) with or without trastuzumab as first-line therapy for MBC have also shown a significant benefit from the addition of trastuzumab (Table 6) [15]. The overall response rate, median time to disease progression, and median overall survival time were all statistically superior with the combination than with single-agent therapy. Both the overall response rate and median time to disease progression were nearly doubled by the addition of trastuzumab. The absolute difference in median survival time
in this study was impressive, at 8.5 months, 37% higher than with docetaxel alone. Of note, patients who received docetaxel first, followed by trastuzumab at progression, had worse survival than those who received the combination initially. Overall, toxicities were consistent with those expected, with the combination producing more grade 3–4 neutropenia than single-agent docetaxel. Both the trastuzumab–taxane randomized trials demonstrated that overall survival is optimized in HER-2–positive MBC patients by beginning trastuzumab along with the first chemotherapy regimen given for MBC rather than giving trastuzumab following first-line chemotherapy.

Bevacizumab is a monoclonal antibody targeting vascular endothelial growth factor (VEGF). Angiogenesis is essential for cancer growth and metastasis. The consequent hyperpermeable, irregular vessels cause irregular blood flow and high interstitial fluid pressure within the tumor, which can impair the delivery of oxygen (a known radiation sensitizer) and drugs to the tumor site. Bevacizumab decreases interstitial fluid pressure in tumors, improving drug delivery and penetration [47]. Preclinical data indicate that breast cancer invasiveness and metastasis is dependent on the establishment of new blood vessels, and VEGF is a potent stimulator of angiogenesis [48].

Phase II data indicate a modest response rate of 9% for bevacizumab alone in previously treated MBC patients [49]. Building on this, a phase III trial comparing the combination of bevacizumab and capecitabine with capecitabine alone was conducted, enrolling MBC patients who had previously received both an anthracycline and a taxane [50]. The addition of bevacizumab produced a significantly higher overall response rate; however, there were no differences in median progression-free or overall survival times. There were no differences between treatment groups with respect to the incidence of diarrhea, hand-foot syndrome, thromboembolic events, or serious bleeding episodes, though hypertension requiring medical intervention was more common in the bevacizumab arm. Global QoL measures were similar for both treatment arms.

Preliminary results from a phase III trial of paclitaxel with or without bevacizumab as first-line treatment of 715 patients with MBC appear very promising [16]. Significantly greater overall response rate and median time to disease progression were seen with the combination (Table 6). Overall survival also favored the addition of bevacizumab, but median values had not yet been reached.

**Summary**

The assessment of the true survival benefits from chemotherapy in MBC can be difficult, given the potential for confounding issues, such as the impact of subsequent therapies. Nonetheless, there is an increasing number of randomized clinical trials that have documented significant survival differences.

With chemotherapy regimens, the taxanes have figured prominently in those trials exhibiting a survival benefit. When present, the improvement in survival time has usually been on the order of 3 months, representing a survival time that is about 20%–30% longer. It is interesting to note that, among all these trials, in no case has a docetaxel-based regimen been inferior with respect to overall survival outcome.

Capecitabine and gemcitabine, two antimetabolite cytotoxic agents, have shown high activity and acceptable tolerability in a range of settings for MBC. These include single-agent and combination regimens, including in patients with anthracycline- and/or taxane-pretreated disease.

The debate concerning combination therapy versus sequential single agents continues. Combination therapies are associated with higher overall response rates, albeit at a cost of greater toxicities. And aside from the E1193

<table>
<thead>
<tr>
<th>Study</th>
<th>Regimen</th>
<th>No. of patients</th>
<th>Overall response rate</th>
<th>Median time to progression (months)</th>
<th>Median overall survival (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slamon et al. [14]</td>
<td>AC or paclitaxel + trastuzumab</td>
<td>235</td>
<td>50% (<em>p &lt; .0001</em>)</td>
<td>7.4 (<em>p &lt; .0001</em>)</td>
<td>25.1 (<em>p = .046</em>)</td>
</tr>
<tr>
<td>Miller et al. [50]</td>
<td>Capecitabine + bevacizumab</td>
<td>232</td>
<td>19.8% (<em>p = .001</em>)</td>
<td>4.9</td>
<td>15.1</td>
</tr>
<tr>
<td>Miller et al. [16]</td>
<td>Paclitaxel + bevacizumab</td>
<td>350</td>
<td>28.2% (<em>p = .0001</em>)</td>
<td>11.0 (<em>p &lt; .001</em>)</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Abbreviations:** AC, doxorubicin and cyclophosphamide; NA, not available.
With targeted biologics, such as trastuzumab and bevacizumab, the potential for enhanced or synergistic activity is a compelling argument for the use of these agents in combination with traditional chemotherapeutics. In randomized studies, response and survival benefits have been impressive, with combination therapies resulting in substantially higher overall response rates. Trials with chemotherapy and trastuzumab have also demonstrated substantial improvements in overall survival ranging from 4 to 8 months, representing increases of 24% and 37% in survival time. Early data from the combination of paclitaxel and bevacizumab also appear to support a survival benefit.

With respect to QoL measures, in general, treatment regimens for MBC do not appear to impair overall QoL. With trastuzumab therapy, there has even been an indication of an improvement in overall QoL following treatment.

Overall, there is a growing body of phase III data on MBC that demonstrates that the introduction of modern chemotherapeutic agents, such as the taxanes, antimetabolites, and targeted biologic agents, has helped to improve survival outcomes in MBC.

**DISCLOSURE OF POTENTIAL CONFLICTS OF INTEREST**

Dr. O’Shaughnessy has acted as a consultant for Eli Lilly, Pfizer, Roche, sanofi-aventis, Abraxis, and Genentech and has received support from Roche, sanofi-aventis, Lilly, Genentech, and Abraxis.

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