Challenges and Success: Treatment of Metastatic Breast Cancer 2012

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2012: What’s New?

- HER2+ disease
  - A wealth of riches
- Reversing hormone resistance
- New treatments for triple negative disease
- The future
  - Moving forward from intrinsic subtypes
  - Consensus building
HER2 Positive MBC

The problem

- Despite high response rates, almost all patients eventually develop progressive disease in viscera or brain

Can we improve up-front therapy?

- Combined signal blockade

Current standards

- Continue HER2 directed therapy through progression
  - Capecitabine + lapatinib > capecitabine (Geyer et al)
  - Capecitabine + trastuzumab > capecitabine (von Minckwitz et al)
  - Lapatinib + trastuzumab > lapatinib (Blackwell et al)
Trastuzumab continually suppresses HER2 activity

Flags cells for destruction by the immune system

- Activates ADCC

Pertuzumab inhibits HER2 forming dimer pairs

Suppresses multiple HER signaling pathways

Flags cells for destruction by the immune system

- Activates ADCC
Cleopatra: Study Design and Patients

- Double-blind, placebo controlled phase III trial
  - Docetaxel 75 mg/m² escalated to 100 as tolerated, about 6 cycles
  - Trastuzumab and pertuzumab/placebo q 3 weeks

- Primary endpoint
  - Independently assessed PFS

- 808 patients with treatment naïve centrally confirmed HER2+ MBC
  - Adjuvant therapy
    - 53% no prior chemo
    - 10% prior trastuzumab
    - 49% ER+, 24% received endocrine therapy

Baselga et al, SABCS 2011 and NEJM, 2011
Primary Endpoint: Independently Assessed PFS

n = 433 PFS events

D, docetaxel; PFS, progression-free survival; Pla, placebo; Ptz, pertuzumab; T, trastuzumab

0 5 10 15 20 25 30 35 40
0 10 20 30 40 50 60 70 80 90 100

Progression-free survival (%)

Time (months)

Ptz + T + D: median 18.5 months
Pla + T + D: median 12.4 months

HR = 0.62
95% CI 0.51–0.75
p < 0.0001

6.1 month gain in PFS to > 18 months

Stratified by prior treatment status and region

Baselga et al, SABCS 2011 and NEJM, 2011
Overall Survival: Predefined Interim Analysis

Median follow-up: 19.3 months

Overall survival (%)

N = 165 out of 385 OS events required for HR 0.75 (193 expected)

HR = 0.64*
95% CI 0.47–0.88
p = 0.0053*

* The interim OS analysis did not cross the pre-specified O'Brien-Fleming stopping boundary (HR ≤0.603; p ≤0.0012)

D, docetaxel; OS, overall survival; Pla, placebo; Ptz, pertuzumab; T, trastuzumab

Baselga et al, SABCS 2011 and NEJM, 2011
Additional Data/Conclusions

- PFS benefit seen in essentially all predefined subsets
- Complete responses rare at 4 to 5.5% (partial response 65 to 75%) suggests presence of alternate resistance pathways
- Minimal additional toxicity with pertuzumab
- Survival impact is practice changing
  - Approved 6/2012 in the US
Historical Timeline: First-Line Treatment of HER2+ Disease –

<table>
<thead>
<tr>
<th></th>
<th>Slamon¹ N=469*</th>
<th>Marty² N=186</th>
<th>Cleopatra³ N=808</th>
<th>Averel⁴ N=424</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PFS/TTP (mo)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Tr</td>
<td>4.6</td>
<td>6.1</td>
<td>12.4</td>
<td>13.7</td>
</tr>
<tr>
<td>+Tr</td>
<td>7.3</td>
<td>11.7</td>
<td>18.5</td>
<td>16.5</td>
</tr>
<tr>
<td><strong>OS (mo)</strong></td>
<td>20</td>
<td>23</td>
<td>NR @ med FU 19.3 mo</td>
<td>38.3</td>
</tr>
</tbody>
</table>

Slamon: q 3 wk paclitaxel or AC, all others q 3 week docetaxel

* FISH + subset

APHINITY ADJUVANT TRIAL
N=3806

TCa x 6

Trastuzumab* 6mg/kg 3-weekly

Pertuzumab** 420mg IV 3-weekly#

TCa x 6

Trastuzumab* 6mg/kg 3-weekly

Placebo IV 3-weekly#

Anti-HER2 therapy for a total of 1 year (52 weeks)

Radiotherapy and/or endocrine therapy may be started after the end of adjuvant chemotherapy and in accordance with the protocol recommendations.

KEY

A 3-4 cycles of anthracycline containing chemotherapy
T 3-4 cycles of taxane containing chemotherapy

Trastuzumab Placebo

Pertuzumab

TCa = 6 cycles of docetaxel and carboplatin

* Trastuzumab must be given at a 8mg/kg loading dose at the first trastuzumab cycle.
** Pertuzumab must be given at a 840mg/kg loading dose at the first pertuzumab cycle.

# All site, study and sponsor personnel will be blinded as to treatment assignment.
T-DM1 selectively delivers DM1 to HER2-positive tumor cells

- Targeted intracellular delivery of a potent antimicrotubule agent, DM1
- Spares normal tissue from toxicity of free DM1
- Trastuzumab-like activity by binding to HER2

Receptor-T-DM1 complex is internalized into HER2-positive cancer cell

Potent antimicrotubule agent is released once inside the HER2-positive tumor cell
**EMILIA Study Design**

- **Stratification factors:** World region, number of prior chemo regimens for MBC or unresectable LABC, presence of visceral disease
- **Primary end points:** PFS by independent review, OS, and safety
- **Key secondary end points:** PFS by investigator, ORR, duration of response, time to symptom progression
- **Statistical considerations:** Hierarchical statistical analysis was performed in pre-specified sequential order: PFS by independent review → OS → secondary end points

Verma et al, NEJM 2012
Progression-Free Survival by Independent Review

<table>
<thead>
<tr>
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<th>Median (mos)</th>
<th>No. events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap + Lap</td>
<td>6.4</td>
<td>304</td>
</tr>
<tr>
<td>T-DM1</td>
<td>9.6</td>
<td>265</td>
</tr>
</tbody>
</table>

Stratified HR=0.650 (95% CI, 0.55, 0.77)  
\(P<0.0001\)

Unstratified HR=0.66 (\(P<0.0001\)).

Median follow-up, mos (range): Cap + Lap, 12.4 (0–35); T-DM1, 12.9 (0–34)
Overall Survival: Confirmatory Analysis

Data cut-off July 31, 2012; Unstratified HR=0.70 (\(P=0.0012\)).
## Overview of Adverse Events

<table>
<thead>
<tr>
<th></th>
<th>Cap + Lap (n=488)</th>
<th>T-DM1 (n=490)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-grade AE, n (%)</td>
<td>477 (97.7)</td>
<td>470 (95.9)</td>
</tr>
<tr>
<td>Grade ≥3 AE, n (%)</td>
<td>278 (57.0)</td>
<td>200 (40.8)</td>
</tr>
<tr>
<td>AEs leading to treatment discontinuation (for any study drug), n (%)</td>
<td>52 (10.7)</td>
<td>29 (5.9)</td>
</tr>
<tr>
<td>AEs leading to death on treatment, n (%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5 (1.0)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>LVEF &lt;50% and ≥15-point decrease from baseline, %&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7 (1.6)</td>
<td>8 (1.7)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Cap + Lap: CAD, multiorgan failure, coma, hydrocephalus, ARDS;
<sup>a</sup>T-DM1: metabolic encephalopathy.

<sup>b</sup>Evaluable pts: 445 (Cap + Lap); 481 (T-DM1).

- Cap and Lap: More grade 3 diarrhea (21 vs 1.6%), hand foot syndrome (16 vs 0%)
- TDM1: More transaminiitis (4 vs 1%), grade 3/4 thrombocytopenia (13 vs 0%)
Emilia and Ongoing Trials

- T-DM1 superior to cap/lap
  - PFS, OS, response, safety
  - Will clearly be a new standard in this setting
  - Approval expected towards the end of 2012/early 2013

- Marianne (n=1092, untreated HER2+ MBC)
  - Three arms
    - Trastuzumab + taxane
    - TDM1 + pertuzumab
    - TDM1 plus placebo

- Th3RESA (n=795)
  - Prior trastuzumab/lapatinib/anthra/taxane/cape
  - 2:1 randomization to TDM1 v TPC
Trials in Early Stage Disease

- Post-neoadjuvant cooperative group
- Neoadjuvant company sponsored
- Adjuvant small tumors: **ATTEMPT** Trial – Tolaney PI (DFCI)

**Stage I BC**
HER2+
N=500

**Randomize 3:1**

- **3**
  - Trastuzumab emtansine q 3 weeks x 17
    N=375
  - Paclitaxel + Trastuzumab weekly x 12
    Trastuzumab every 3 weeks x 13
    N=125

- **1**
What About Bevacizumab (Avastin)?
AVEREEL Investigator-Assessed PFS According to Baseline Plasma VEGF-A

<table>
<thead>
<tr>
<th>Plasma VEGF-A</th>
<th>HR (95% CI)</th>
<th>H + DOC + BEV better</th>
<th>H + DOC better</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ median</td>
<td>0.83 (0.50–1.36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; median</td>
<td>0.70 (0.43–1.14)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diagram Description:**
- **H + DOC low VEGF-A (n=45)**
- **H + DOC high VEGF-A (n=37)**
- **H + DOC + BEV low VEGF-A (n=36)**
- **H + DOC + BEV high VEGF-A (n=43)**

**Estimated probability vs Time (months):**
- Time points: 8.5, 13.6, 16.6, 16.5
Confirmatory Study Schema: MERiDiAN

MBC, HER2-Negative Chemo-naïve N=480

- VEGF-A (low/high)
- Adjuvant therapy (yes/no)
- Hormonal status (ER +/-)

RANDOMIZED

Paclitaxel 90 mg/m2 weekly x 3 q4 weeks / Bevacizumab 10 mg/kg q2w

Paclitaxel 90mg/m2 weekly x 3 q4 weeks / Placebo 10 mg/kg q2w

Co-Primary Endpoints: PFS (All Patients), PFS (VEGF high subset)

Secondary Endpoints: OS; ORR; Symptoms/QoL; Safety
The Problem in ER+ Tumors is Endocrine Therapy Resistance

- About 50% of hormone receptor-positive breast cancers are de novo resistant to endocrine therapy.
- Almost all patients with advanced disease will develop acquired resistance to endocrine therapies.
- The mechanisms of de novo and acquired resistance are likely similar, but are not completely understood.
- Changing patterns of adjuvant therapy have decreased efficacy and reduced time to progression in the metastatic setting.
- Is there a way to reverse hormone resistance in HER2 normal disease?
A Phase III Randomized Trial of Anastrozole versus Anastrozole and Fulvestrant as First-Line Therapy for MBC. SWOG S0226: Efficacy (Intent-to-Treat)

<table>
<thead>
<tr>
<th></th>
<th>Anastrozole (n = 345)</th>
<th>Anastrozole + fulvestrant (n = 349)</th>
<th>Hazard ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median PFS</td>
<td>13.5 mos</td>
<td>15.0 mos</td>
<td>0.8</td>
<td>0.007</td>
</tr>
<tr>
<td>Median OS</td>
<td>41.3 mos</td>
<td>47.7 mos</td>
<td>0.81</td>
<td>0.049</td>
</tr>
<tr>
<td>Grade ≥3 AE</td>
<td>12.7%</td>
<td>14.5%*</td>
<td>—</td>
<td>NS</td>
</tr>
</tbody>
</table>

No prior adjuvant tamoxifen (n = 414)

<table>
<thead>
<tr>
<th></th>
<th>(n = 208)</th>
<th>(n = 206)</th>
<th>Hazard ratio</th>
<th>p-value</th>
</tr>
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<tbody>
<tr>
<td>Median PFS</td>
<td>12.6 mos</td>
<td>17 mos</td>
<td>0.74</td>
<td>0.0055</td>
</tr>
<tr>
<td>Median OS</td>
<td>39.7 mos</td>
<td>47.7 mos</td>
<td>0.74</td>
<td>0.0362</td>
</tr>
</tbody>
</table>

Mehta RS et al. San Antonio Breast Cancer Symposium 2011;Abstract S1-1.
The PI3K/AKT/mTOR Pathway

mTOR (mammalian target of rapamycin) signaling plays a key role in

- Cell growth
- Cell proliferation
- Regulation of
  - Apoptosis
  - Angiogenesis
  - Lymphocytes
  - Homeostasis
  - Metabolism

TAMRAD (Phase II): Tamoxifen ± Everolimus in Advanced BC

- 111 postmenopausal women with ER+ advanced BC previously treated with an AI were randomized in a phase II trial.

Al = aromatase inhibitor; BC = breast cancer; ER+ = estrogen receptor-positive; EVE = everolimus; TAM = tamoxifen.

Bourgier C et al. ECCO/ESMO 2011 (Abstract #5005)
Bolero-2: Phase III Trial of Exemestane +/- Everolimus

724 PM women with ER+ MBC

- Progression on letrozole or anastrozole
- Up to two prior hormone agents
- 84% sensitive to hormone therapy

N = 724

- Postmenopausal ER+
- Unresectable locally advanced or metastatic BC
- Recurrence or progression after letrozole or anastrozole

R 2:1

EVE 10 mg daily + EXE 25 mg daily (n = 485)

Placebo + EXE 25 mg daily (n = 239)

Rugo et al, ASCO Breast Symposium, Baselga et al, NEJM 2011
PFS Based on Local Assessment at 18-month Follow-Up

Hazard ratio = 0.45 (95% CI: 0.38-0.54)
Log-rank \( P < 0.0001 \)

Kaplan-Meier medians
- EVE 10 mg + EXE: 7.8 months
- PBO + EXE: 3.2 months

Number of Patients Still at Risk

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>6</th>
<th>12</th>
<th>18</th>
<th>24</th>
<th>30</th>
<th>36</th>
<th>42</th>
<th>48</th>
<th>54</th>
<th>60</th>
<th>66</th>
<th>72</th>
<th>78</th>
<th>84</th>
<th>90</th>
<th>96</th>
<th>102</th>
<th>108</th>
<th>114</th>
<th>120</th>
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</thead>
<tbody>
<tr>
<td>EVE 10 mg + EXE</td>
<td>485</td>
<td>436</td>
<td>366</td>
<td>304</td>
<td>257</td>
<td>221</td>
<td>185</td>
<td>158</td>
<td>124</td>
<td>91</td>
<td>66</td>
<td>50</td>
<td>35</td>
<td>24</td>
<td>22</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>PBO + EXE</td>
<td>239</td>
<td>190</td>
<td>132</td>
<td>96</td>
<td>67</td>
<td>50</td>
<td>39</td>
<td>30</td>
<td>21</td>
<td>15</td>
<td>10</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Abbreviations: CI = confidence interval; EVE = everolimus; EXE = exemestane; PBO = placebo.
BOLERO-2 (18 mo f/up): Response & Clinical Benefit

- **Response**
  - Everolimus + Exemestane: 12.0%
  - Placebo + Exemestane: 1.3%
  - *P* < 0.0001

- **Clinical Benefit**
  - Everolimus + Exemestane: 50.5%
  - Placebo + Exemestane: 25.5%
  - *P* < 0.0001
BOLERO-2 (18 mo f/up): Most Common Adverse Events

<table>
<thead>
<tr>
<th></th>
<th>Everolimus + Exemestane (n = 482), %</th>
<th>Placebo + Exemestane (n = 238), %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Grades</td>
<td>Grade 3</td>
</tr>
<tr>
<td>Stomatitis</td>
<td>59</td>
<td>8</td>
</tr>
<tr>
<td>Rash</td>
<td>39</td>
<td>1</td>
</tr>
<tr>
<td>Fatigue</td>
<td>36</td>
<td>4</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>Appetite decreased</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Nausea</td>
<td>29</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Weight decreased</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>Cough</td>
<td>25</td>
<td>&lt;1</td>
</tr>
</tbody>
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Hortobagyi G et al. SABCS 2011 (Abstract #S3-7), Baselga et al, 2011
EVE ↓ Bone Turnover Marker Levels at 6 and 12 Weeks (Overall Population)

Bone metastases at BL\textsuperscript{a}: 76\% versus 77\%
Bisphosphonate use at BL\textsuperscript{a}: 44\% versus 54\%

<table>
<thead>
<tr>
<th></th>
<th>6 weeks</th>
<th></th>
<th>12 weeks</th>
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<tr>
<td></td>
<td>BSAP</td>
<td>P1NP</td>
<td>CTX</td>
<td>BSAP</td>
</tr>
<tr>
<td></td>
<td>401</td>
<td>395</td>
<td>329</td>
<td>400</td>
</tr>
<tr>
<td>EVE + EXE</td>
<td>189</td>
<td>187</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>PBO + EXE</td>
<td>187</td>
<td>186</td>
<td>124</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: BL, baseline; BSAP, bone-specific alkaline phosphatase; CTX, C-terminal cross-linking telopeptide of type I collagen; EVE, everolimus; EXE, exemestane; PBO, placebo; P1NP, amino-terminal propeptide of type I collagen.

Data from full analysis set.

\textsuperscript{a} Proportions of patients with bone metastases or bisphosphonate use reflect the status at study entry among patients with baseline bone marker assessments.
Everolimus Decreases Disease Progression in Bone

Overall Population (N=724)

Patients with Bone Metastases at Baseline (N=554)
New Chemotherapy

- Eribulin approved for later during the course of advanced cancer
- CALGB 40502
  - Compared Taxol (paclitaxel) to Ixabepilone to Abraxane (nab-paclitaxel) as treatment for metastatic disease.
  - More toxicity and less or similar efficacy compared to arms 2 and 3
CALGB 40502
Progression-Free Survival By Treatment Arm

Comparison | HR  | P-value | 95% CI   |
------------|-----|---------|----------|
Nab vs. Pac | 1.19| 0.12    | 0.96-1.49|
Ixa vs. Pac | 1.53| < 0.0001| 1.24-1.90|

Agent | N  | Median PFS |
------|----|------------|
paclitaxel | 283 | 10.6     |
nab-Paclitaxel | 271 | 9.2      |
ixabepilone | 245 | 7.6      |
Summary and New Directions

**HER2 positive disease**
- Pertuzumab a new standard of care for advanced HER2+ breast cancer
- TDM1 superior to lapatinib and capecitabine
- Other combinations (MTOR, PIK3CA, etc)

**ER+**
- MTOR inhibition in the second-line setting
  - Move to earlier stage setting for higher risk disease
- Explosion of new agents targeting this pathway in clinical trials
  - Combined inhibitors

**Critical to find markers that predict response to specific treatments**
What Does the Future Hold?

- Genomic testing
  - Looking at the DNA of a tumor (or in normal cells) for mutations or deletions
- Gene expression testing
  - Looks at RNA for specific genes
- Recent data
  - Analysis of breast cancer through the Cancer Genome Atlas Network
    - Identified 4 main breast cancer classes
    - Identified some of the most common mutations
- What does this mean today?
  - Studies such as these help to identify potential targets for individualized cancer therapy
  - Given complexity of tumor alterations, combinations of therapies are likely to be most effective approach
PARP Inhibition

- Novel mechanism – inhibition of DNA damage repair
- Efficacy in BRCA-associated cancer

# PARP Inhibitors in Development

<table>
<thead>
<tr>
<th>Agent</th>
<th>Company</th>
<th>Route</th>
<th>Current Trials</th>
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<tbody>
<tr>
<td>Rucaparib</td>
<td>Clovis</td>
<td>IV/Oral</td>
<td>BRCA+, post-neoadjuvant TNBC + cisplatin</td>
</tr>
<tr>
<td>Olaparib</td>
<td>AstraZeneca</td>
<td>Oral</td>
<td>BRCA+</td>
</tr>
<tr>
<td>Veliparib</td>
<td>Abbott</td>
<td>Oral</td>
<td>BRCA+, TNBC + paclit/carbo</td>
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<td>Iniparib</td>
<td>BiPar/Sanofi-Aventis</td>
<td>IV</td>
<td>Dose escalation</td>
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<td>BSI-201</td>
<td>BiPar/Sanofi-Aventis</td>
<td>IV</td>
<td></td>
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<td>LT673 (2011)</td>
<td>Biomarin</td>
<td>Oral</td>
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<td>INO-1001</td>
<td>Inotek</td>
<td>IV</td>
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<td>MK4827</td>
<td>Merck</td>
<td>Oral</td>
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<td>E7016</td>
<td>Eisai</td>
<td>Oral</td>
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</table>

Plummer R *BCR* 2011 vol. 13 (4) pp. 218. with edits
Leukocytes in Breast Cancer: Targets for Therapy?

Increased macrophage presence correlates with increased vessel density & decreased survival (Tsutsui et al., 2005; Bingle et al., 2002, Campbell et al., 2010)

CD45: leukocyte common antigen

H&E

Distal normal

Inv. Ductal Carcinoma
CTX naive

Increase in macrophage presence correlates with increased vessel density & decreased survival (Tsutsui et al., 2005; Bingle et al., 2002, Campbell et al., 2010)

Paclitaxel (10 mg/kg, i.v.)

PLX3397

MMTV-PyMT

Tumor volume (mm$^3$)

Age (days)

CD45

Ruffell et al., PNAS (2011)
Gene expression from 22 data sets >4000 Patients

CD68/CD8 mRNA Ratio Correlates with OS

DeNardo et al., Cancer Discovery (2011)
US Patent #61/420,718
Phase 1b Study: all BC

PLX3397 oral daily dosing
Eribulin: 1.4 mg/m^2 iv, day 1 and 8
Each cycle of treatment lasts 21 days

First Cohort = 600 mg/day
3-6 patients

Second Cohort = 800 mg/day
3-6 patients

Third Cohort = 1000 mg/day
3-6 patients

Phase II Study: Metastatic TNBC
Lead in period of 5-7d with PLX3397 at MTD
oral daily dosing (day -7/5 to day 0)

Starting Day 1
Add Eribulin 1.4 mg/m^2 iv day 1 and 8
Each cycle of treatment lasts 21 days

Biopsy for immune profiling

Komen Promise Grant: Coussens, Rugo, Hwang, Samson
Collaborators: Blackwell (Duke), Mayer (Vanderbilt)

Phase II Primary Endpoint: PFS at 12 weeks

PI: Hope Rugo M.D., UCSF

Coussens, Rugo, Hwang, Samson
Collaborators: Blackwell (Duke), Mayer (Vanderbilt)
Clinical Trials!
30 International breast cancer experts 11.2011 organized by Fatima Cardoso

Q2: From onset of diagnosis of MetaBC, patients should be offered personalised appropriate psychosocial, supportive and symptom-related interventions as a routine part of their care

- 100% vote yes
- More next year!