
INIBITORI DI PARP NELLA TERAPIA ADIUVANTE DEL CARCINOMA MAMMARIO

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Early Drug Development for Innovative Therapies

European Institute of Oncology IRCCS

Milan, Italy

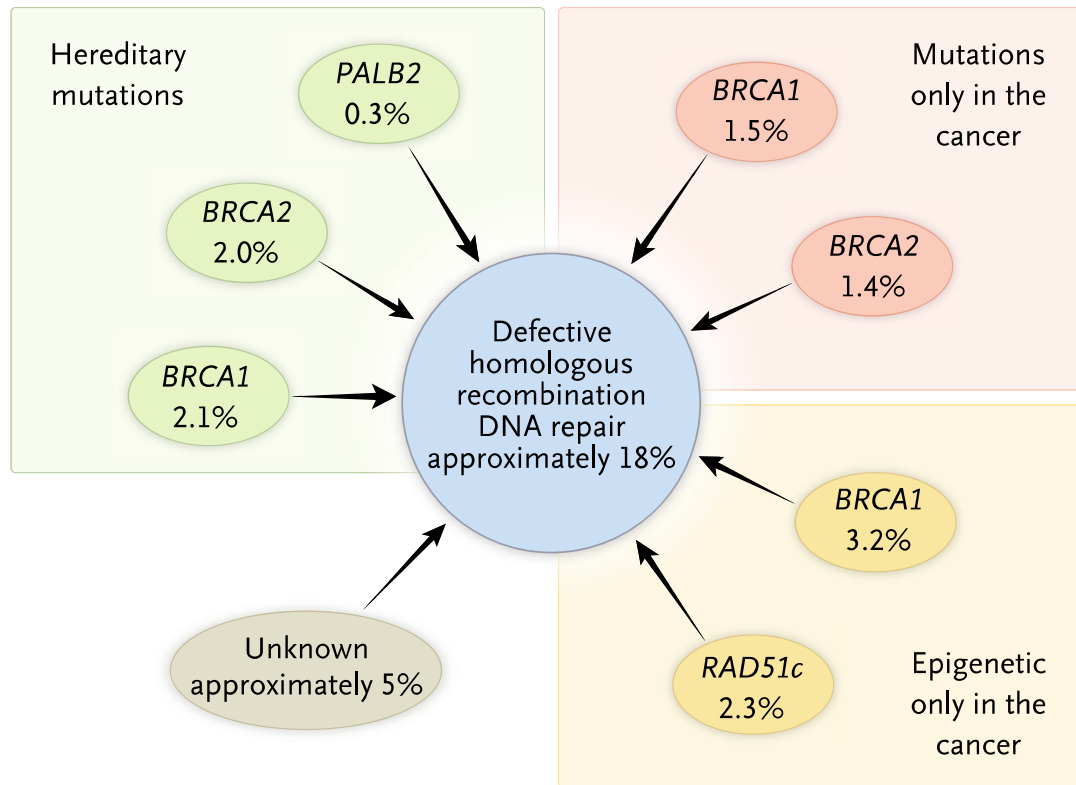
DISCLOSURES

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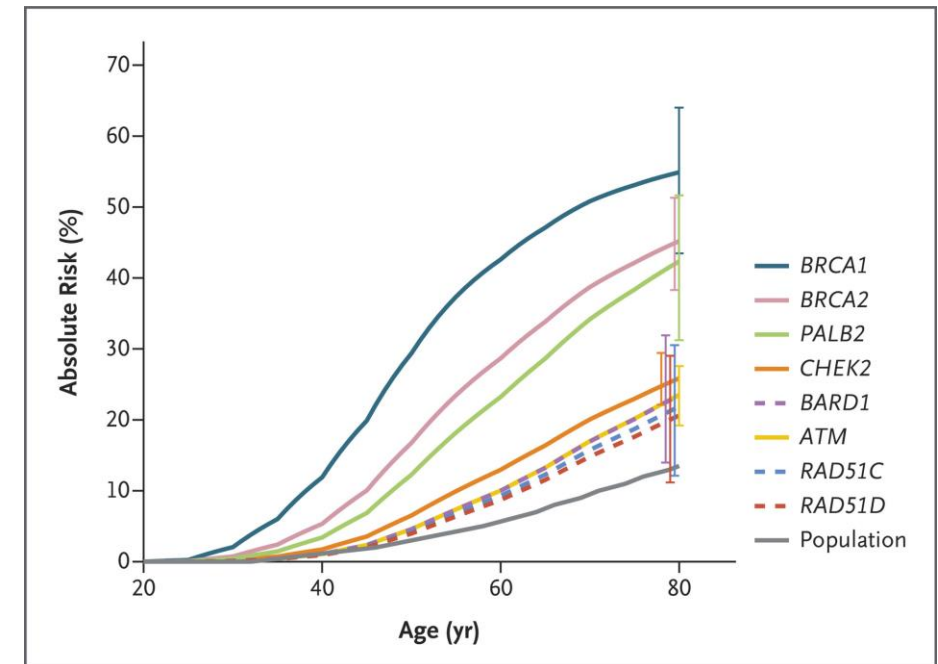
OUTLINE

- Homologous Recombination Deficiency in Breast Cancer
- PARP Inhibitors in Early Breast Cancer
- Current Dilemmas
- Future Perspectives

HOMOLOGOUS RECOMBINATION DEFICIENCY IN BREAST CANCER



Absolute risk of breast cancer in carriers of pathogenic/likely pathogenic variants of putative cancer susceptibility genes



HOMOLOGOUS RECOMBINATION DEFICIENCY IN BREAST CANCER

BRCA1 and *BRCA2* germline mutations vary according to subtype

BRCA1

- ER-/PR-/HER2- phenotype (85%)
- Grade 3
- Pushing borders
- Brisk lymphocytic infiltrate
- Up to 14% of consecutive TNBCs

BRCA2

- ER+/HER2- phenotype (Luminal B – 75%)
- Grade 3
- Pushing borders
- 5%-8% of Luminal cancers

HOW TO EVALUATE HOMOLOGOUS RECOMBINATION DEFICIENCY IN BREAST CANCER

Alterations of HRR genes
(germline, somatic, epigenetic)



DNA sequencing
Methylation assays

The CAUSE of HRD

Assess the cause of HRD by
looking for loss of function of
key HRR genes

Large DNA changes / genomic
instability



Genomic scars (LOH/nTAi/LST)
Mutational signatures
Combinations (HRDetect)

The EFFECT of HRD

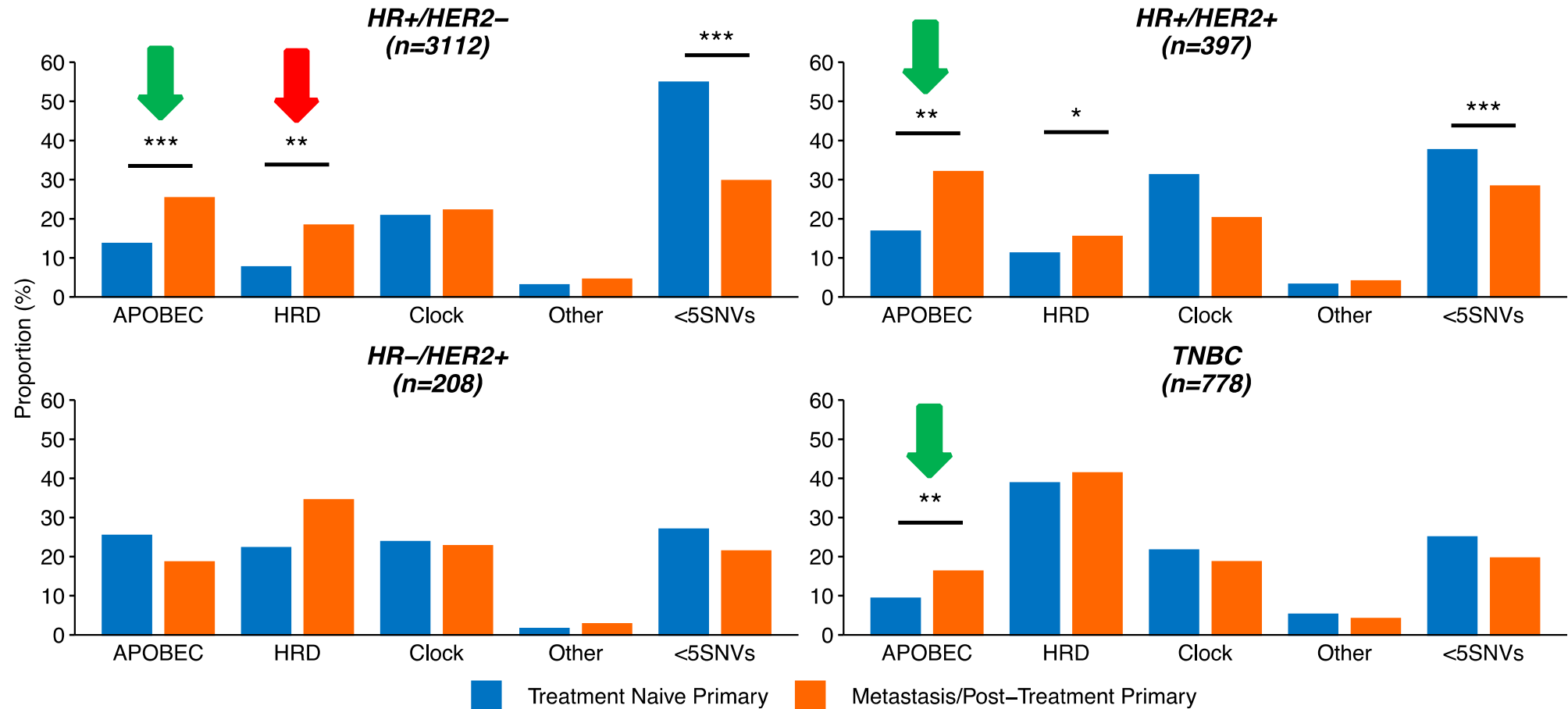
Look for indicators of genomic damage to identify the implications of HRD

Functional assay

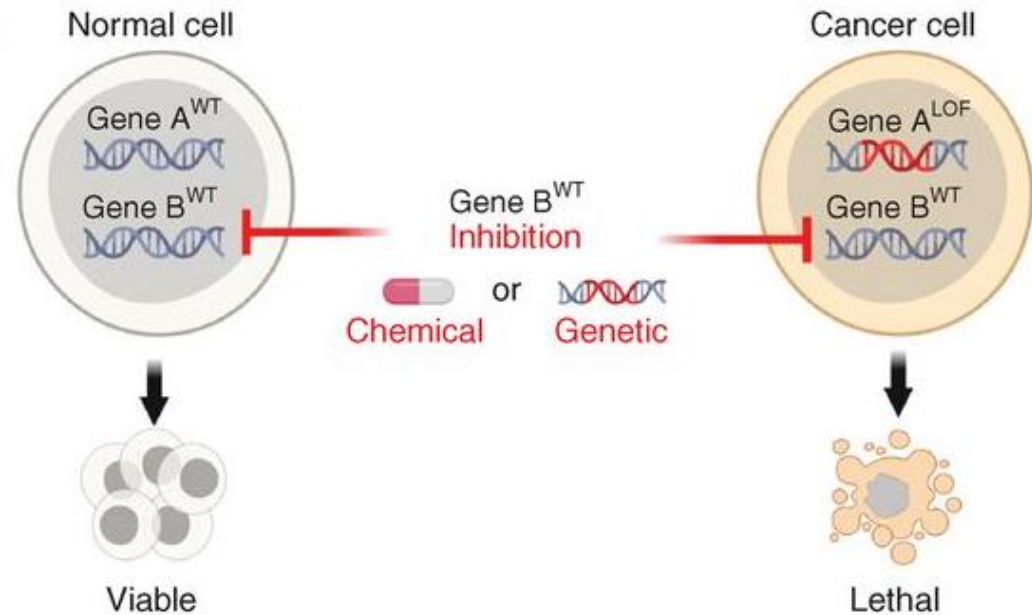
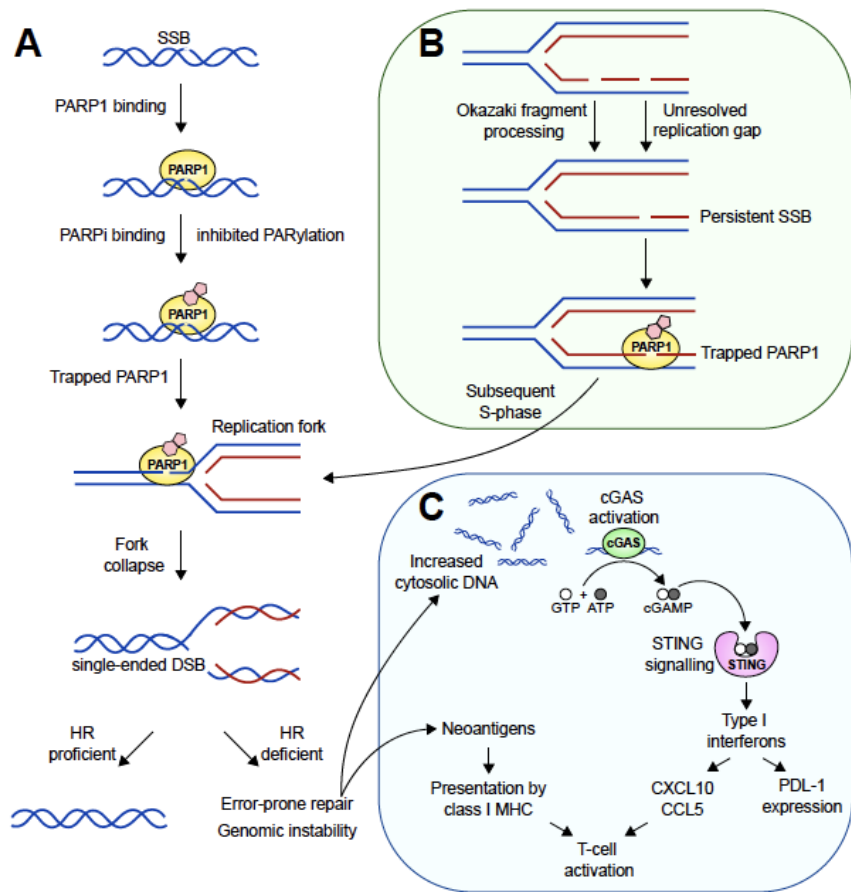


RAD51 methylation

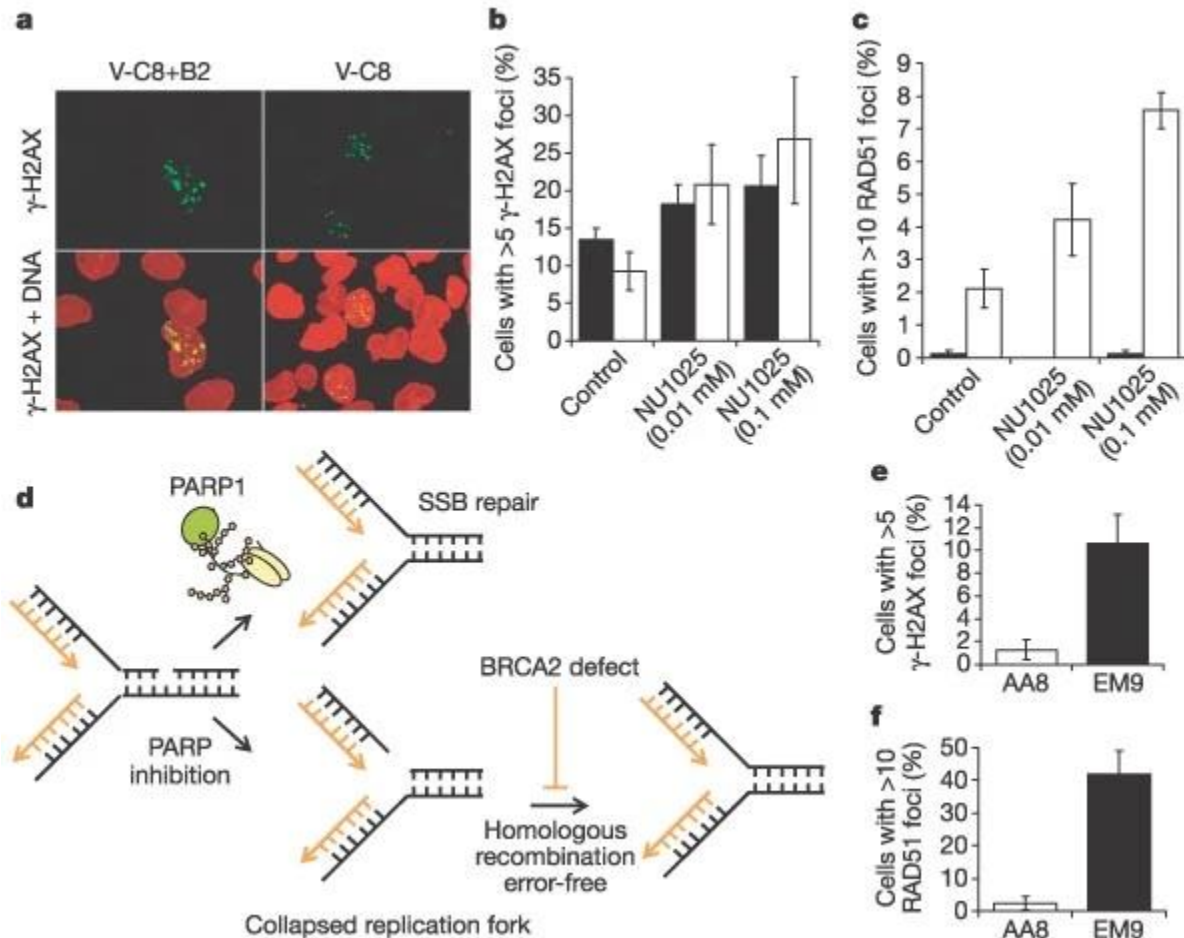
HRD TENDS TO BE HIGHER IN METASTATIC HR+/HER2-, WHILE IT IS STABLE IN TRIPLE-NEGATIVE TUMORS



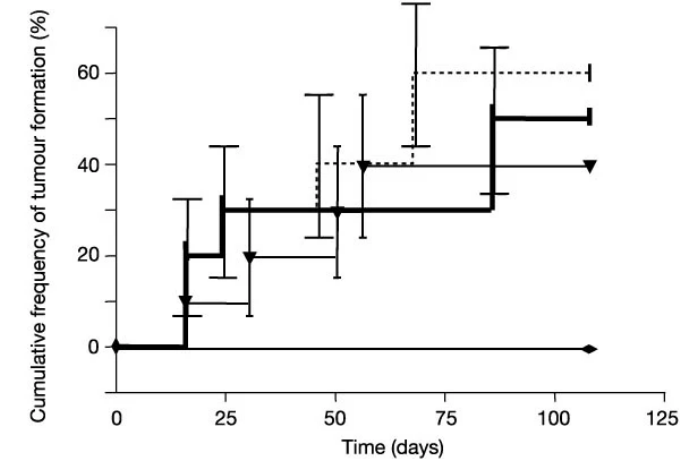
PARP INHIBITORS EXPLOIT “SYNTHETIC LETHALITY” TO TARGET BRCA-DEFICIENT TUMORS



BRCA2 DEFICIENT CELLS ARE KILLED BY PARP INHIBITORS



PARPi selectively blocks the growth of *BRCA2*-deficient tumors



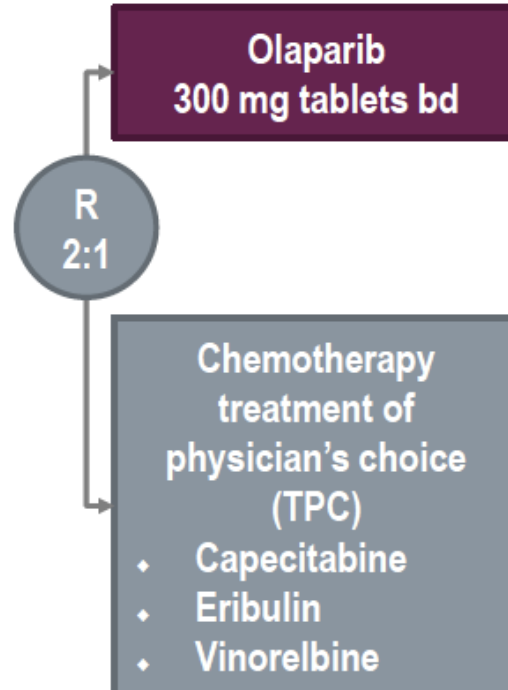
- ... Wild-type xenograft / treatment with vehicle
- └ Wild-type xenograft / treatment with KU0058684
- ▼ BRCA2-deficient xenograft / treatment with vehicle
- ◆ BRCA2-deficient xenograft / treatment with KU0058684

PIVOTAL PHASE III TRIALS TESTING PARP INHIBITION IN ADVANCED BREAST CANCER

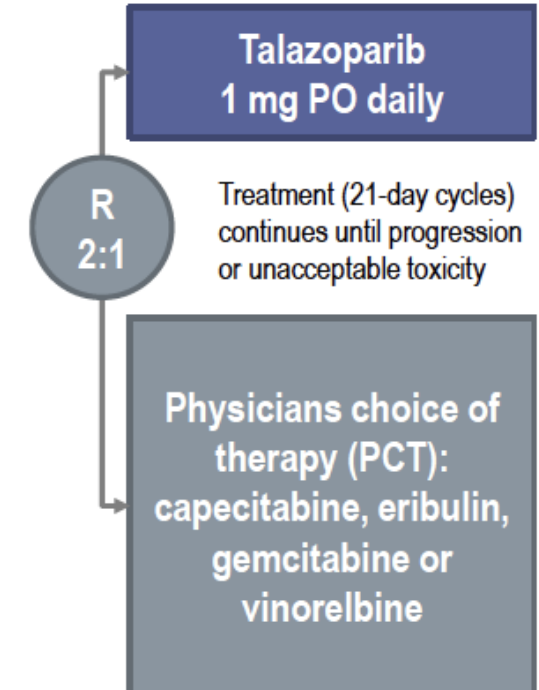
OLYMPIAD

EMBRACA

- HER2-negative metastatic BC
 - ER+ and/or PR+ or TNBC
- Deleterious or suspected deleterious gBRCAm
- Prior anthracycline and taxane
- ≤2 prior chemotherapy lines in metastatic setting
- HR+ disease progressed on ≥1 endocrine therapy, or not suitable
- If prior platinum use
 - No evidence of progression during treatment in the advanced setting
 - ≥12 months since (neo)adjuvant treatment



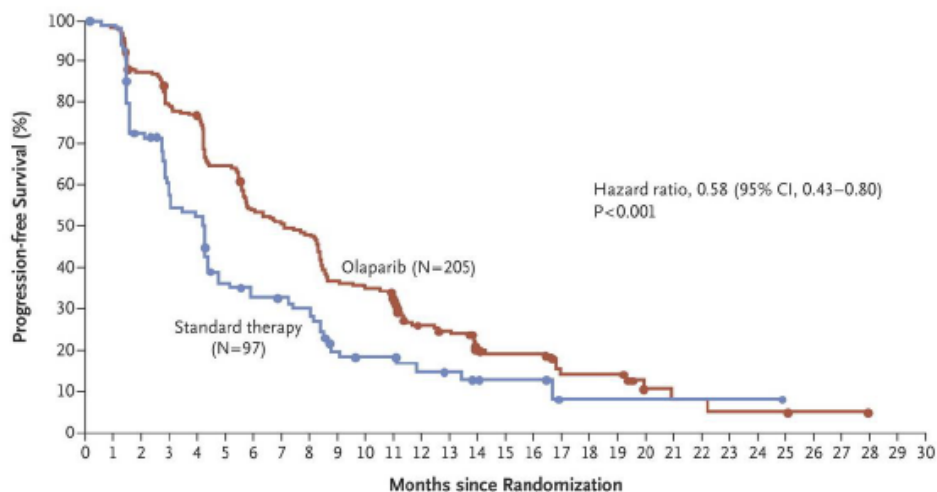
- Patients with locally advanced or metastatic HER2 negative BC and a germline BRCA1/2 mutation
- Stratification factors**
- Number of prior CT regimens (0 or ≥1)
 - TNBC or HR+
 - History of CNS mets or no CNS mets



BOTH OLAPARIB AND TALAZOPARIB IMPROVES PFS IN GERMLINE BRCA1/2-MUT ADVANCED BREAST CANCER

OLYMPIAD

50% TN; A/T pretreated; 71% prior CT for MBC; TN: non-platinum resistant

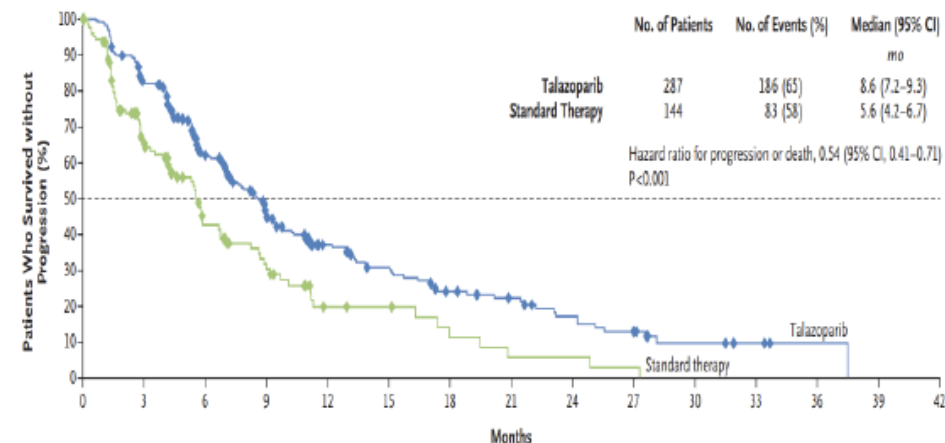


No. at Risk	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Olaparib	205	201	177	159	154	129	107	100	94	73	69	61	40	36	23	21	21	11	11	11	4	3	3	2	2	1	1	1	0		
Standard therapy	97	88	63	46	44	29	25	24	21	13	11	11	8	7	4	4	4	1	1	1	1	1	1	1	1	0	0	0	0		

Median PFS 7.0 vs 4.8 months
HR 0.58, 95% CI: 0.43, 0-80; P<0.001
TNBC: HR 0.43, 95% CI: 0.29, 0.63

EMBRACA

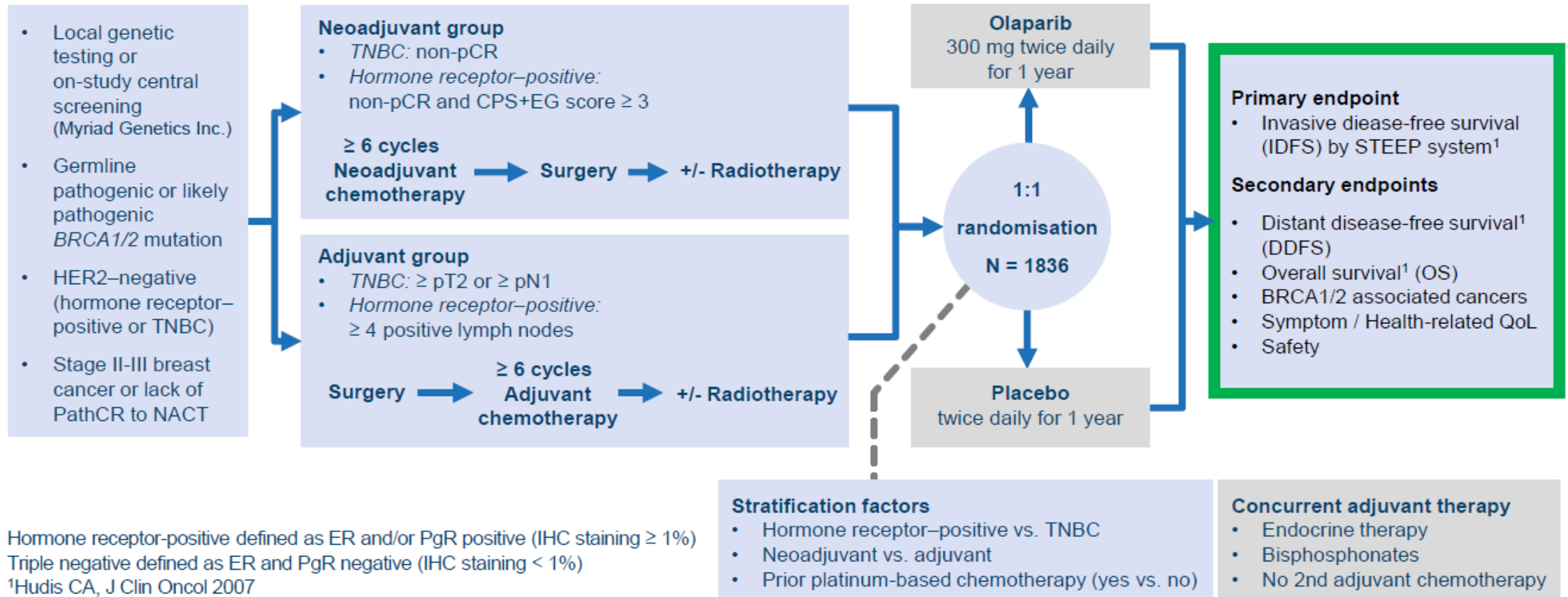
44% TN; A/T pretreated; 62% prior CT for MBC; TN: non-platinum resistant



No. at Risk (events/cumulative events)	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42
Talazoparib	287 (0/0)	229 (50/50)	148 (53/103)	91 (34/137)	55 (17/154)	42 (9/163)	29 (9/172)	23 (2/174)	16 (5/179)	12 (4/183)	5 (2/185)	3 (0/185)	1 (0/185)	0 (1/186)	0 (0/186)
Standard therapy	144 (0/0)	68 (41/41)	34 (20/61)	22 (8/69)	9 (7/76)	8 (0/76)	4 (3/79)	2 (2/81)	2 (0/81)	1 (1/82)	0 (1/83)	0 (0/83)	0 (0/83)	0 (0/83)	0 (0/83)

Median PFS 8.6 vs 5.6 months
HR 0.54, 95% CI: 0.41, 0.71; P<0.001
TNBC: HR 0.60, 95% CI: 0.41, 0.87

OLYMPIA TRIAL: MOVING PARP INHIBITORS TO EARLY BREAST CANCER



OLYMPIA: BASELINE CHARACTERISTICS

Characteristic	Olaparib (n = 921)	Placebo (n = 915)
Median age, yr (IQR)	42 (36-49)	43 (36-50)
gBRCA mutation(s),* n (%)		
▪ BRCA1	657 (71.3)	670 (73.2)
▪ BRCA2	261 (28.3)	239 (26.1)
▪ BRCA1 and BRCA2	2 (0.2)	5 (0.5)
Prior neo(adjuvant) CT,† n (%)		
▪ Adjuvant	461 (50.1)	455 (49.7)
▪ Neoadjuvant	460 (49.9)	460 (50.3)
▪ Anthracycline + taxane regimen	871 (94.6)	849 (92.8)
▪ Anthracycline, no taxane regimen	7 (0.8)	13 (1.4)
▪ Taxane, no anthracycline regimen	43 (4.7)	52 (5.7)
▪ <6 cycles (neo)adjuvant CT	7 (0.8)	15 (1.6)
▪ Platinum-based (neo)adjuvant CT	247 (26.8)	239 (26.1)
Menopausal status (women only‡), n (%)	n = 919	n = 911
▪ Premenopausal	572 (62.2)	553 (60.7)
▪ Postmenopausal	347 (37.8)	358 (39.3)

*Data missing for n = 1 in each arm. †Regimen not reported in n = 1 (placebo arm). ‡Trial enrolled 6 men (olaparib, n = 2; placebo, n = 4).

Characteristic	Olaparib (n = 921)	Placebo (n = 915)
HR+/HER2-, n (%)	168 (18.2)	157 (17.2)
TNBC, n (%)	751 (81.5)	758 (82.8)
Concurrent ET (HR+ only), n/N (%)	146/168 (86.9)	142/157 (90.4)
Primary BC surgery, n (%)		
▪ Mastectomy	698 (75.8)	673 (73.6)
▪ Conservative surgery only	223 (24.2)	240 (26.2)
▪ Missing	0	2 (0.2)

- Among those treated with neoadjuvant CT only, most common CPS + EG score was 3/4 in HR+/HER2- subgroup (18.5% pbo, 19.1% olap); in TNBC subgroup, ≤2 (31.3% pbo, 32.8% olap) and 3/4 (42.8% pbo, 38.8% olap)
- Among those treated with adjuvant CT only, most common pathologic AJCC stages were IIA (54.9% pbo, 57.3% olap) and IIB (16.5% pbo, 15.2% olap)

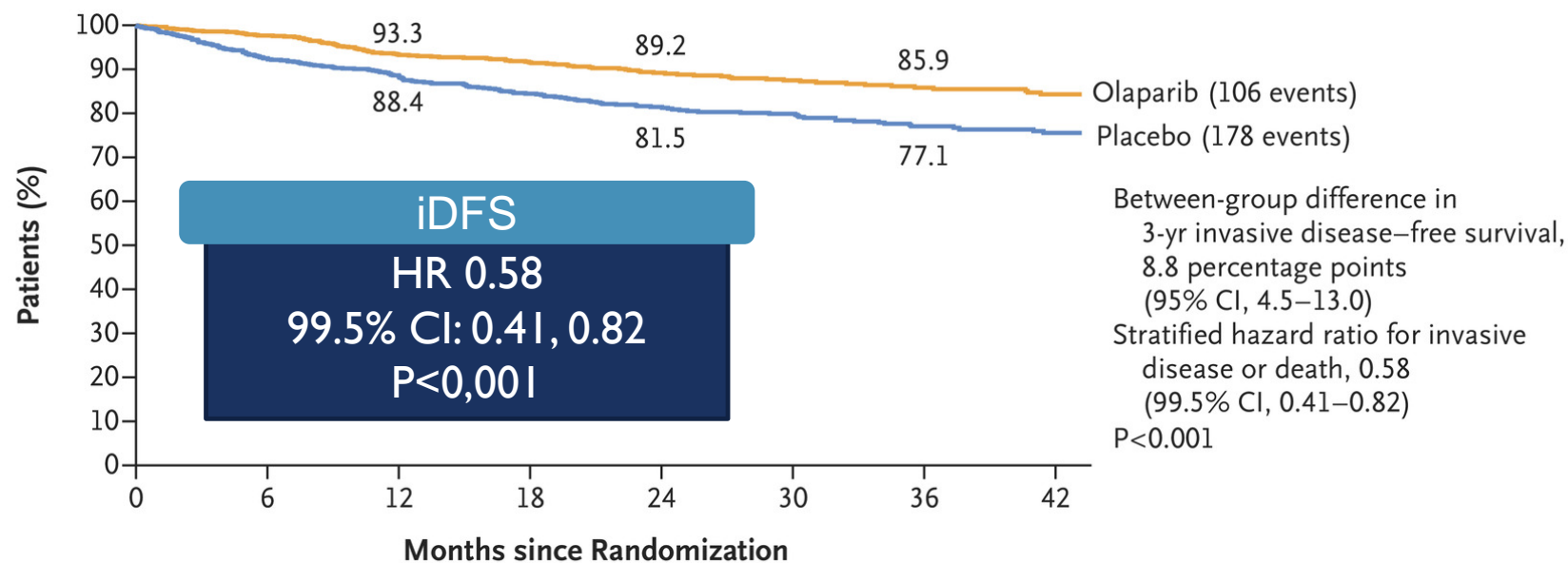
COMMENTS ON THE PATIENT POPULATION

- Very young (median 42-43, 25% > 50)
- 72.3% gBRCA1 mutated
- 82.2% TNBC, no HER2+ (by design)
- 74.7% treated with mastectomy (46.5% bilateral)
- Risk-reducing salpingo-oophorectomy in ~60%

- CPS+EG score unfamiliar to many

(<https://www3.mdanderson.org/app/medcalc/index.cfm?pagename=bcnt>)

OLYMPIA: FIRST INTERIM ANALYSIS FOR IDFS



3-year iDFS rate

Olaparib (n=921) **85.9%**

Placebo (n=915) **77.1%**

Difference: 8.8%
95% CI: 4.5, 13

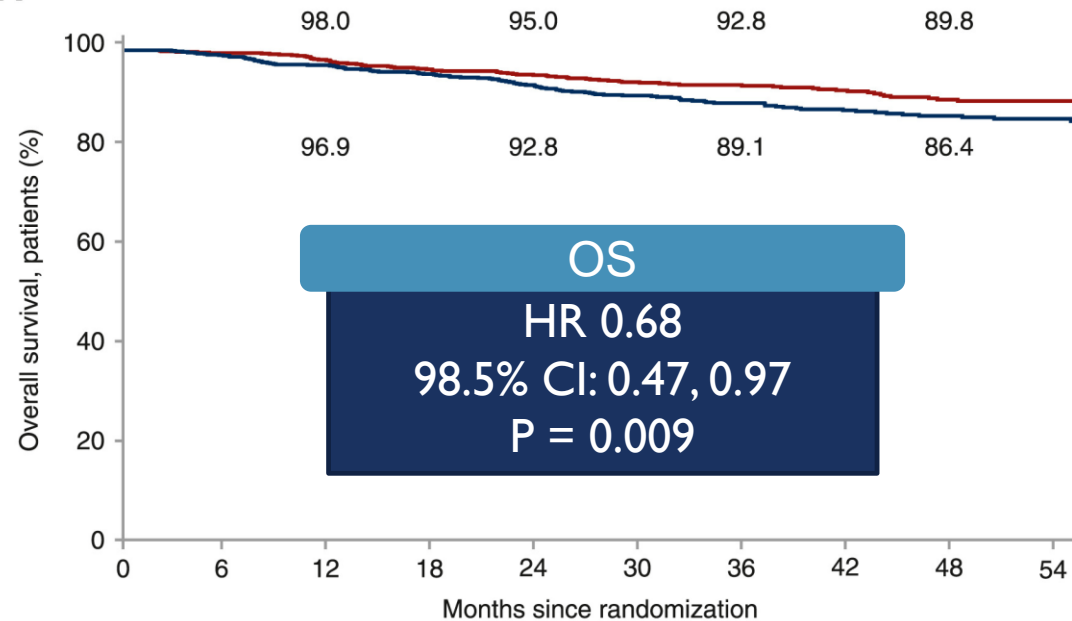
No. at Risk

Olaparib	921	820	737	607	477	361	276	183
Placebo	915	807	732	585	452	353	256	173

2022 Global approvals as post chemotherapy adjuvant therapy in “high risk” HER2-negative gBRCAmut breast cancer regardless of ER status

OLYMPIA: PLANNED EVENT DRIVEN OVERALL SURVIVAL INTERIM ANALYSIS (2022)

A



Olaparib, 75 deaths
Placebo, 109 deaths

Difference: 4-year OS rate
3.4% (95% CI -0.1% to 6.8%)

Difference: 3-year OS rate
3.8%^a (95% CI 0.9% to 6.6%)

Stratified hazard ratio, 0.68
(98.5% CI 0.47-0.97)
P = 0.009

OS
HR 0.68
98.5% CI: 0.47, 0.97
P = 0.009

No. at risk	0	6	12	18	24	30	36	42	48	54
Olaparib	921	862	844	809	773	672	560	437	335	228
Placebo	915	868	843	808	752	647	530	423	333	218

4-year OS rate

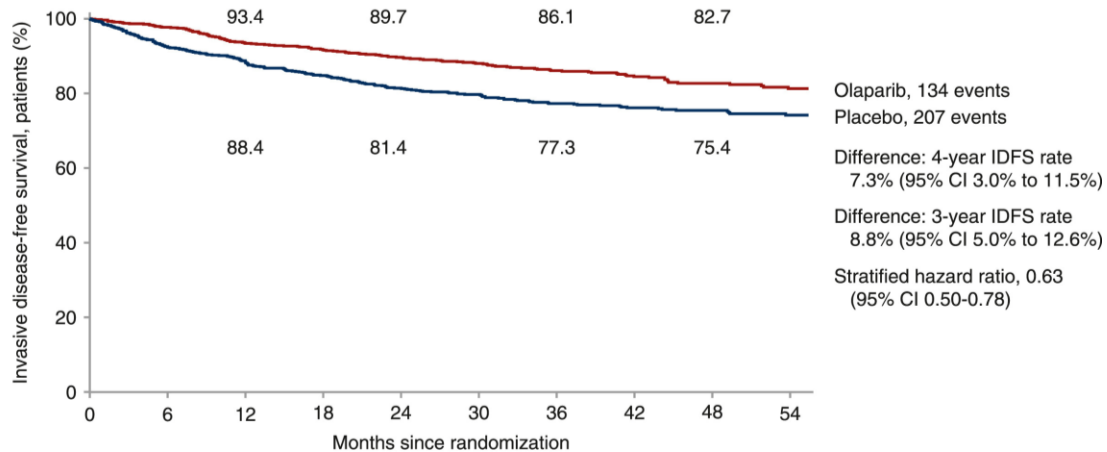
Olaparib
(n=921) **89.8%**

Placebo
(n=915) **86.4%**

Difference: 3.4%
95% CI: -0.1, 6.8

OLYMPIA: UPDATED IDFS AND DDFS

Updated iDFS



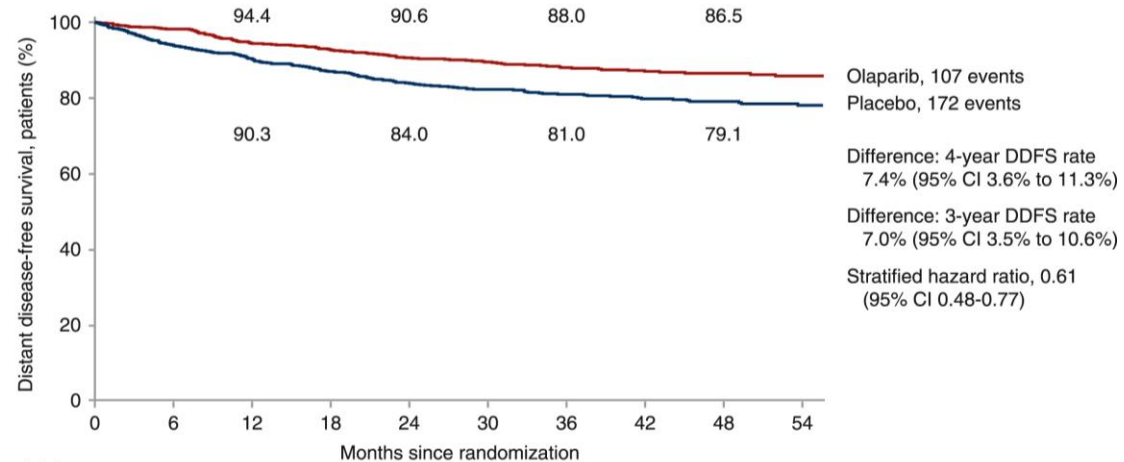
No. at risk	0	6	12	18	24	30	36	42	48	54
Olaparib	921	825	777	738	694	603	495	382	293	204
Placebo	915	807	765	715	656	571	459	370	293	187

iDFS

HR 0.63

95% CI: 0.50, 0.78

Updated DDFS



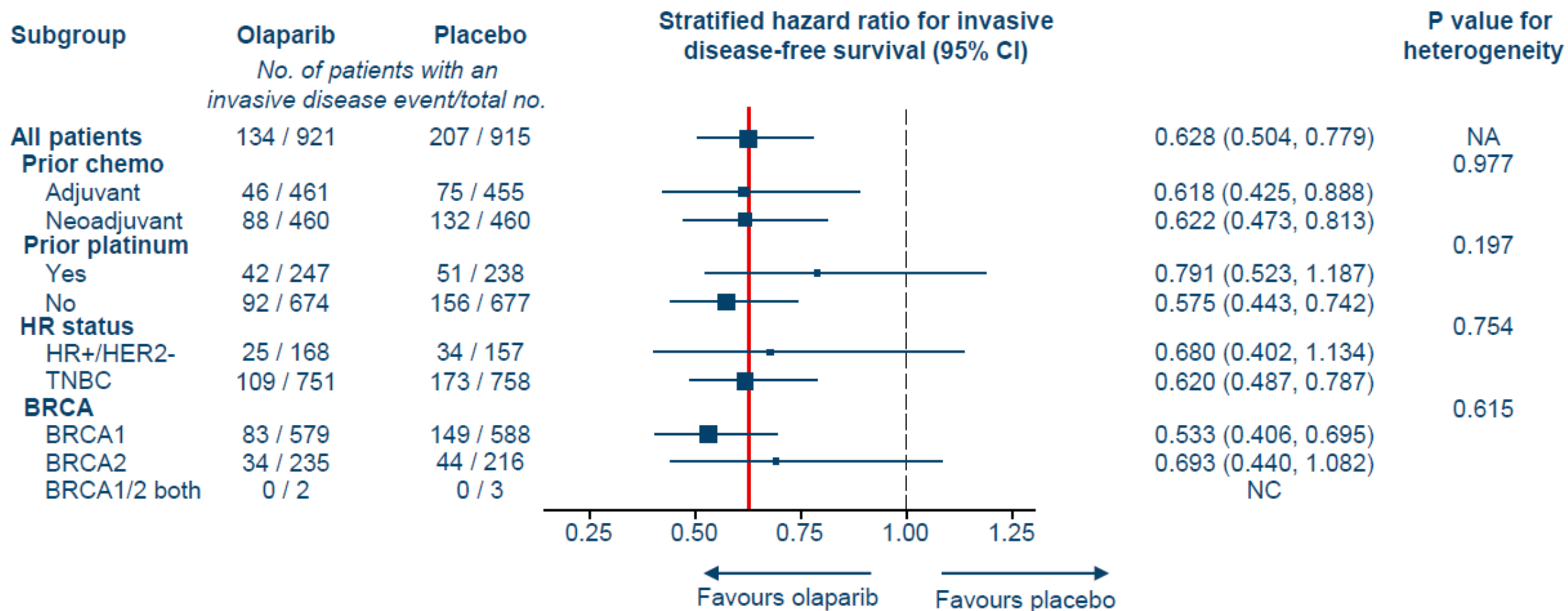
No. at risk	0	6	12	18	24	30	36	42	48	54
Olaparib	921	828	784	746	698	609	501	391	302	209
Placebo	915	818	777	728	670	582	471	379	300	193

DDFS

HR 0.61

95% CI: 0.48, 0.77

OLYMPIA: SUBGROUP ANALYSIS OF IDFS



OLYMPIA: TREATMENT-RELATED ADVERSE EVENTS AND QOL

AE in ≥10% of Patients, n (%)	Olaparib (n = 911)		Placebo (n = 904)	
	Any Grade	Grade ≥3	Any Grade	Grade ≥3
Nausea	518 (56.9)	7 (0.8)	211 (23.3)	0
Fatigue	365 (40.1)	16 (1.8)	245 (27.1)	4 (0.4)
Anemia	214 (23.5)	79 (8.7)	35 (3.9)	3 (0.3)
Vomiting	206 (22.6)	6 (0.7)	74 (8.2)	0
Headache	180 (19.8)	2 (0.2)	152 (16.8)	1 (0.1)
Diarrhea	160 (17.6)	3 (0.3)	124 (13.7)	3 (0.3)
Decreased neutrophil count	146 (16.0)	44 (4.8)	59 (6.5)	7 (0.8)
Decreased WBC count	143 (15.7)	27 (3.0)	52 (5.8)	3 (0.3)
Decreased appetite	119 (13.1)	2 (0.2)	53 (5.9)	0
Dysgeusia	107 (11.7)	0	38 (4.2)	0
Dizziness	104 (11.4)	1 (0.1)	67 (7.4)	1 (0.1)
Arthralgia	84 (9.2)	2 (0.2)	107 (11.8)	2 (0.2)

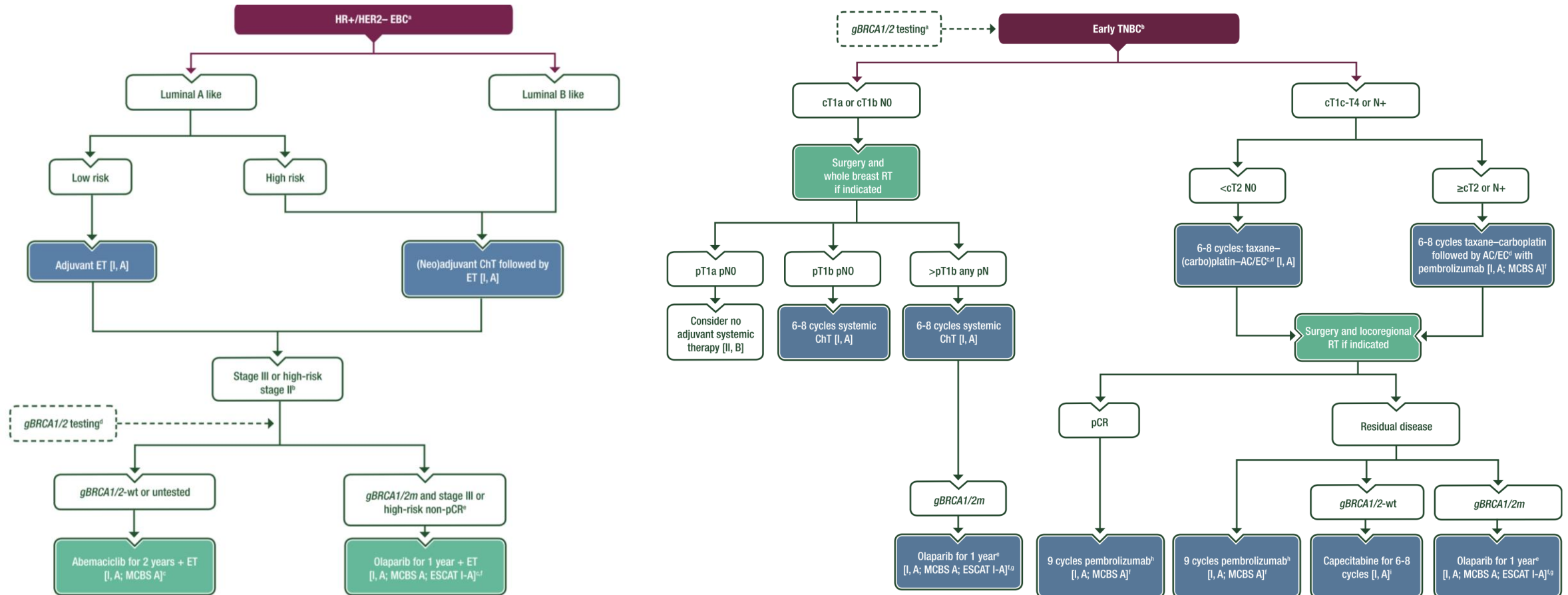
- In the olaparib arm, anemia was the most frequent AE at grade ≥3 in >1% patients
 - Transfusions: olaparib, 5.8%; placebo, 0.9%
- Median percentage of intended dose received: olaparib, 94.8%; placebo, 98.9%
- For the olaparib vs placebo arms:
 - Dose reductions: 25.0% vs 5.2%
 - Discontinuations due to AEs: 9.9% vs 4.2% (with olaparib, most commonly due to nausea, 2.0%; anemia, 1.8%; fatigue, 1.3%; decreased neutrophil count, 1.0%)
- No declines or clinically significant differences observed between arms in global health quality during tx

OLYMPIA: TREATMENT-RELATED ADVERSE EVENTS AND QOL

Safety Outcome, n (%)	Olaparib (n = 911)	Placebo (n = 904)
Any AE	835 (91.7)	753 (83.3)
Serious AE	79 (8.7)	76 (8.4)
AE of special interest	30 (3.3)	46 (5.1)
▪ MDS/AML	2 (0.2)	3 (0.3)
▪ Pneumonitis	9 (1.0)	11 (1.2)
▪ New primary malignancy	19 (2.1)	32 (3.5)
Grade ≥3 AE	221 (24.3)	102 (11.3)
Grade 4 AE	17 (1.9)	4 (0.4)
AE leading to permanent discontinuation	90 (9.9)	38 (4.2)

AEs leading to death: olaparib, n = 1 (cardiac arrest); placebo, n = 2 (AML, ovarian cancer)

ADJUVANT OLAPARIB IS NOW APPROVED (LEVEL 1A) FOR BOTH HR+/HER2- AND TNBC



PRACTICAL CONSIDERATIONS

1. Should all women with breast cancer now be tested at diagnosis for germline BRCA1/2 alterations?
2. Overlapping indications in the adjuvant setting
 - a) **Olaparib and pembrolizumab**: TNBC with residual after neoadjuvant chemo-immunotherapy
 - b) **Olaparib and capecitabine**: TNBC with residual after neoadjuvant chemotherapy
 - c) **Olaparib and abemaciclib**: High-risk early stage or locally advanced node-positive HR+/HER2- breast cancer

Q1. SHOULD ALL WOMEN WITH BREAST CANCER NOW BE TESTED AT DIAGNOSIS FOR BRCA1/2 ALTERATIONS?

ASCO Special Articles



Germline Testing in Patients With Breast Cancer: ASCO–Society of Surgical Oncology Guideline

Isabelle Bedrosian, MD¹; Mark R. Somerfield, PhD²; Maria Isabel Achatz, MD, PhD³; Judy C. Boughey, MD⁴; Giuseppe Curigliano, MD, PhD^{5,6}; Sue Friedman, DVM⁷; Wendy K. Kohlmann, MS⁸; Allison W. Kurian, MD, MSc⁹; Christine Laronga, MD¹⁰; Filipa Lynce, MD¹¹; Barbara S. Norquist, MD¹²; Jennifer K. Plichta, MD, MS¹³; Patricia Rodriguez, MD¹⁴; Payal D. Shah, MD¹⁵; Marc Tischkowitz, MD, PhD¹⁶; Marie Wood, MD¹⁷; Siddhartha Yadav, MD¹⁸; Katherine Yao, MD¹⁹; and Mark E. Robson, MD¹⁹

BRCA1/2 mutation testing should be offered to all newly diagnosed patients with breast cancer ≤ 65 years and select patients >65 years based on personal history, family history, ancestry, or eligibility for poly(ADP-ribose) polymerase (PARP) inhibitor therapy



SPECIAL ARTICLE

Early breast cancer: ESMO Clinical Practice Guideline for diagnosis, treatment and follow-up[☆]

S. Loibl^{1,2}, F. André³, T. Bachelot⁴, C. H. Barrios⁵, J. Bergh⁶, H. J. Burstein⁷, M. J. Cardoso^{8,9}, L. A. Carey¹⁰, S. Dawood¹¹, L. Del Mastro^{12,13}, C. Denkert¹⁴, E. M. Fallenberg¹⁵, P. A. Francis¹⁶, H. Gamal-Eldin¹⁷, K. Gelmon¹⁸, C. E. Geyer¹⁹, M. Gnant²⁰, V. Guarneri^{21,22}, S. Gupta²³, S. B. Kim²⁴, D. Krug²⁵, M. Martin²⁶, I. Meattini^{27,28}, M. Morrow²⁹, W. Janni³⁰, S. Paluch-Shimon³¹, A. Partridge⁷, P. Poortmans^{32,33}, L. Pusztai³⁴, M. M. Regan³⁵, J. Sparano³⁶, T. Spanic³⁷, S. Swain³⁸, S. Tjulandin³⁹, M. Toi⁴⁰, D. Trapani⁷, A. Tutt^{41,42}, B. Xu⁴³, G. Curigliano^{44,45} & N. Harbeck⁴⁶, on behalf of the ESMO Guidelines Committee^{*}

Germline testing and subsequent genetic counselling for PVs in BRCA1/2 should be offered to patients who meet the respective national criteria and to those who are candidates for adjuvant olaparib therapy [I, A; ESCAT score: I-A].

Q2A. OLAPARIB VS PEMBROLIZUMAB IN NON-PCR

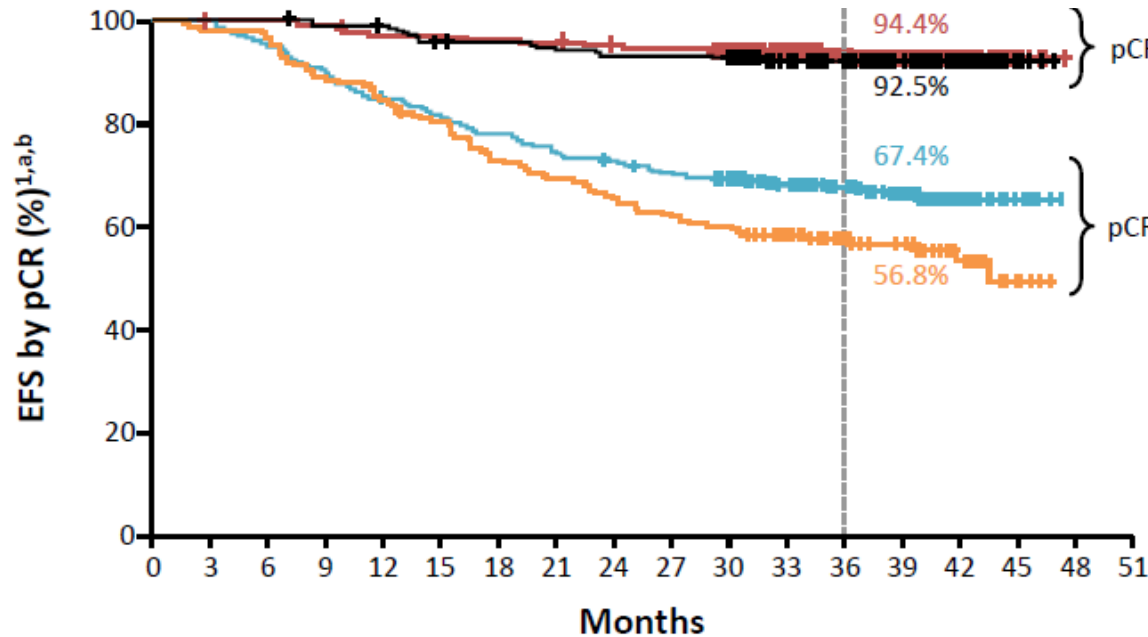
3-year EFS
(Total population)²

Hazard ratio:

0.63

95% CI: 0.48, 0.82

P<0.001



Outcomes are excellent if pCR

Role of adjuvant ICI is unknown

There is still an unmet need in the treatment of patients with no pCR

No. at risk:

Pembro + CT / pembro responder

PBO + CT / PBO responder

Pembro + CT / pembro non-responder

PBO + CT / PBO non-responder

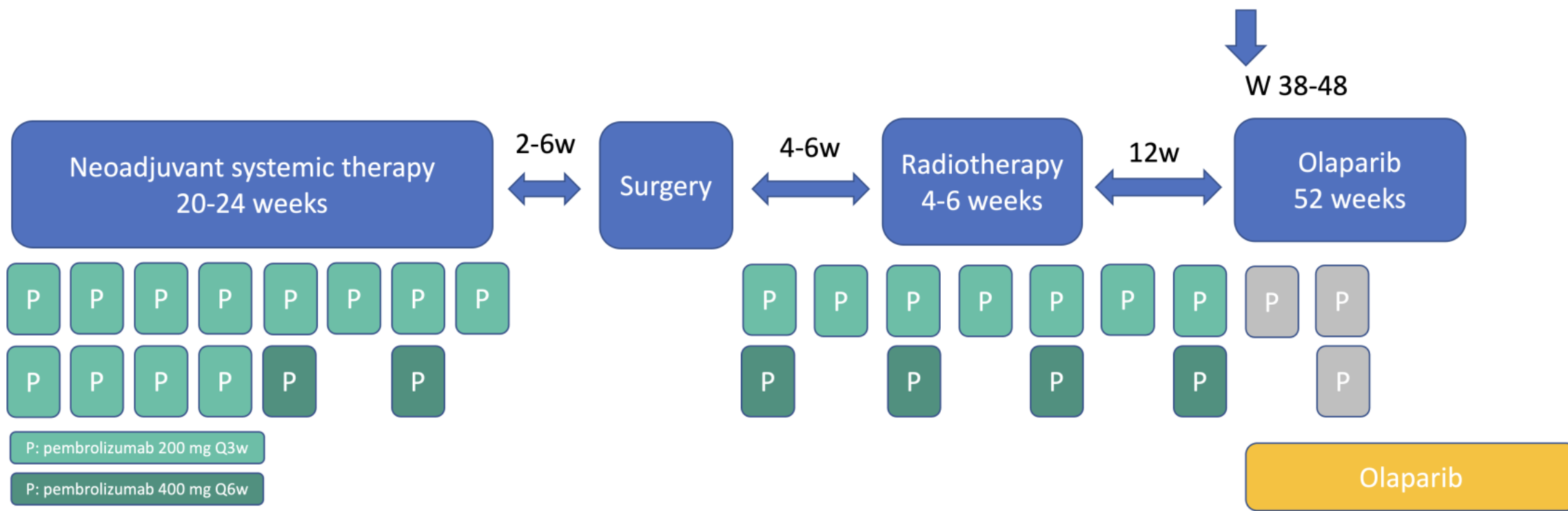
494	494	494	489	483	482	478	477	472	470	460	387	307	220	122	18	0	0
217	217	217	216	214	207	206	203	200	200	197	165	130	87	56	9	0	0
290	287	275	262	245	236	224	215	209	201	192	164	126	83	43	10	0	0
173	169	165	152	144	135	122	116	110	104	100	85	65	53	27	8	0	0

Q2A. OLAPARIB VS PEMBROLIZUMAB IN NON-PCR

- **Continue pembrolizumab and abstain from adjuvant olaparib:**
 - 32.6% EFS events at 36 months
- **Discontinue pembrolizumab and prioritize olaparib single agent:**
 - Optimal duration of pembrolizumab in early TNBC is unknown
 - Trials needed to investigate whether shorter duration is non-inferior
- **Combine pembrolizumab and olaparib:**
 - No efficacy and safety data on combination in the early setting. Reassuring safety data reported with PARPi + PD-1/PD-L1 combinations in the advanced setting (MEDIOLA, KEYLYNK-009, DORA trials)
 - Off-label, problem with access / reimbursement
- **Option for sequential approach?**

Q2A. OLAPARIB VS PEMBROLIZUMAB: OPTION FOR SEQUENTIAL APPROACH?

In Olympia, olaparib could be initiated up to 12 weeks after the last local treatment



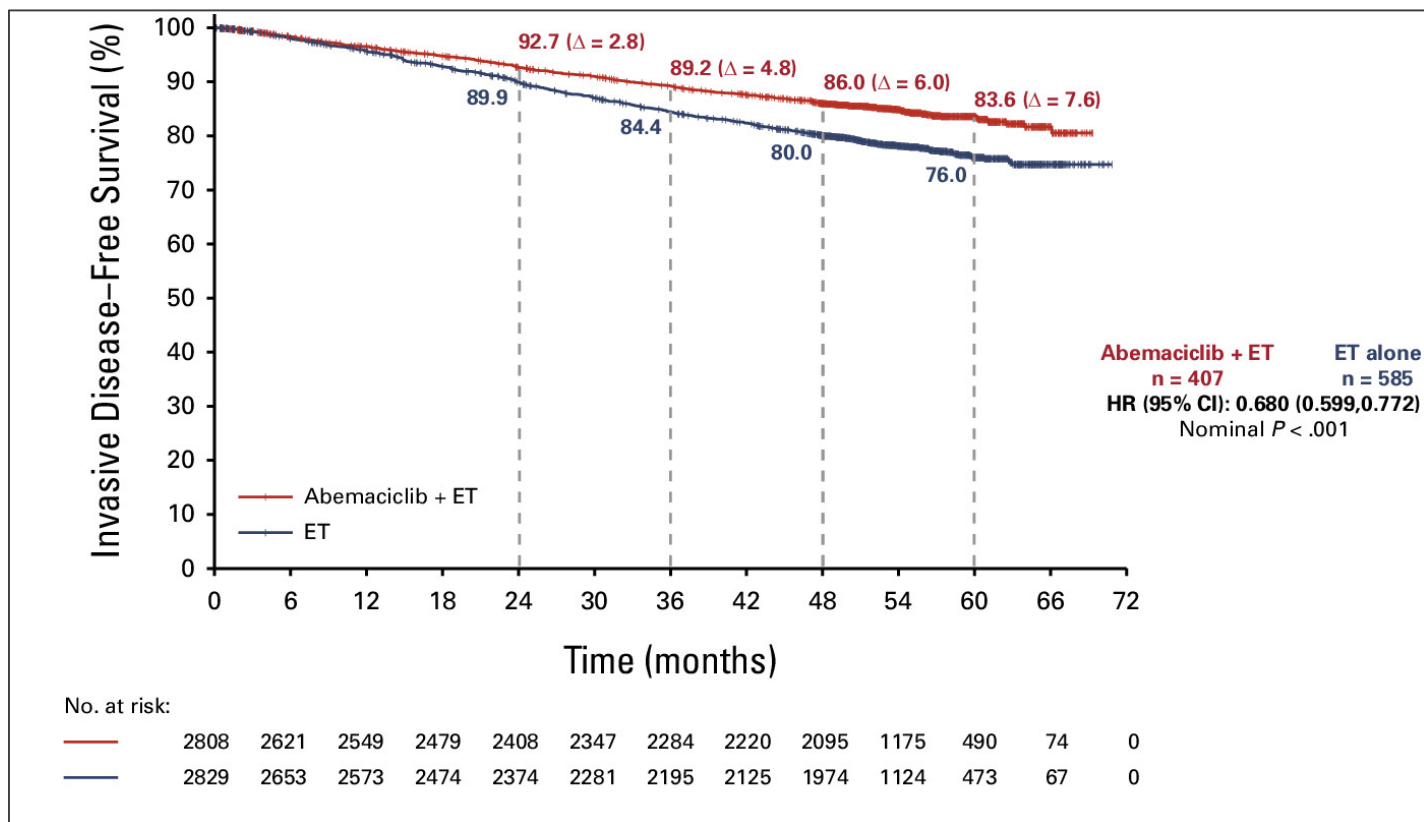
Q2B. OLAPARIB VS CAPECITABINE IN NON-PCR TNBC

- CREATE-X was not conducted in a setting of either neoadjuvant carboplatin or chemo-immunotherapy
- Not focused in gBRCAm biological subset of TNBC
- PARPi superior to capecitabine as majority chemotherapy comparator in gBRCAm MBC (OLYMPIAD and EMBRACA)
- Combination has no adequate safety data

	N TNBC (Basal)	Capecitabine iDFS	Capecitabine OS
CREATE-X (v. obs, sig DFS, OS)	286 (N/A)	69.8% 5-year DFS (all)	78.9% 5-year (all)
GEICAM_CIBOMA (v. obs, NS)	876 (647)	79.6% 5-year DFS (all)	86.2% 5-year (all)
EA1131 (v. platinum, NSD)	410 (308)	49% 3-year IDFS (basal)	66% 3-year (basal)

Q2C. OLAPARIB VS ABEMACICLIB IN HIGH-RISK HR+/HER2-

monarchE: abemaciclib improves iDFS at 5-year follow up



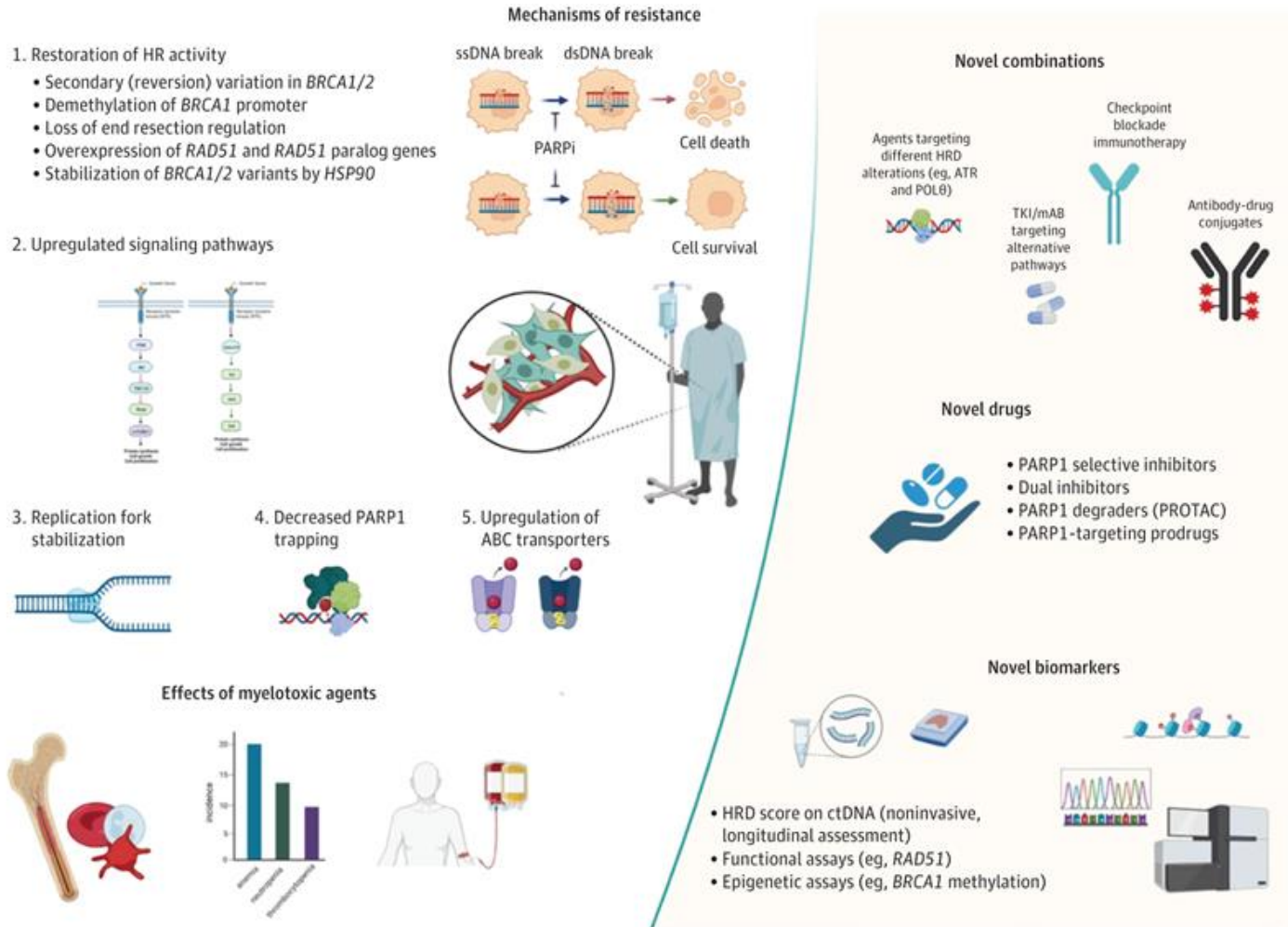
5-year iDFS
 HR, 0.680
 95% CI: 0.599, 0.772
 P < 0.001

OS
 No difference in OS
 (at 5-year analysis)

Q2C. OLAPARIB VS ABEMACICLIB IN HIGH-RISK HR+/HER2-

- Abemaciclib improves iDFS at longer follow up but without overall survival benefit yet seen
- Olaparib improves iDFS with early and sustained separation of survival curves in a mechanism based biomarker selected population of HER2-negative breast cancer
- Inadequate safety data to support use of a combination of abemaciclib with olaparib
- Data from metastatic setting suggest BRCA-mediated resistance to CDK4/6i
- Sequential approach?

LIMITATIONS AND FUTURE DIRECTION OF PARP INHIBITORS IN BREAST CANCER



Understand and address resistance to PARPi in high recurrence risk gBRCA1/2 mutation carriers

Reduce toxicity to improve “low risk” and even “prevention” feasibility (PARP1-selective inhibitors)

Investigate potential for use in other forms of HR-deficient breast cancer

Improve biomarkers to detect breast cancer that is HR-deficient

KEY ONGOING STUDIES INVESTIGATING PARP INHIBITORS IN EARLY BREAST CANCER

Registration identifier	Phase	Primary endpoint(s)	Disease(s)	Mutation status	Prior PARPi	N	Class(es)	Interventional cohort drug(s)
NCT05582499	I/II	pCR rate	BC	N.R.	//	716	PARPi + CDKi	Fluzoparib + Dalpiciclib/Fluzoparib + Chemotherapy
NCT05332561 (COGNITION-GUIDE)	II	iDFS	BC (TNBC cohort)	s/gBRCA1/2, gPALB2	//	240	PARPi	Olaparib
NCT05761470	II	pCR rate	HER2- BC	HRD	//	66	PARPi + IO	Fluzoparib + Camrelizumab + Chemotherapy
NCT02849496	II	PFS	HER2- BC	BRCA1/2	Not allowed	81	PARPi + IO	Olaparib + Atezolizumab
NCT04481113	I	MTD	HR+/HER2- BC	N.R.	Not allowed	8	PARPi + CDKi	Niraparib + Abemaciclib
NCT05834582	II	pCR rate	TNBC	gBRCA 1/2	Not allowed	60	PARPi	Fluzoparib + Chemotherapy
NCT03911453	I	PD-LI expression	TNBC	N.R.	Not allowed	20	PARPi	Rucaparib
NCT05498155	II	pCR rate	TNBC	s/gBRCA 1/2	Not allowed	50	PARPi + IO	Olaparib ± Durvalumab
NCT04584255	II	pCR rate TILs change	HER2- BC	gBRCA1/2, gPALB2	Not allowed	62	PARPi + IO	Niraparib + Dostarlimab

Abbreviations: N = enrollment; PFS = progression free survival; N.R. = not required; PARPi = adenosine diphosphate polymerase inhibitor; sBRCA = somatic BRCA; gBRCA = germline BRCA; HR = hormone receptor; TNBC = triple negative breast cancer; ADC = antibody-drug conjugate; IO = immunotherapy; HRD = homologous recombination deficiency; pCR = pathological complete response

CONCLUSIONS (...personal...)

- Germline *BRCA1* and *BRCA2* status is now an important systemic therapy defining-biomarker in early (and advanced) breast cancer → **PLEASE TEST YOUR PATIENT!**
- **Adjuvant olaparib improves iDFS, DDFS and OS** in HER2-negative gBRCA early disease
- **In TNBC with residual disease:** olaparib benefits unknown following KEYNOTE-522 regimen but lack of pCR is associated with substantial risk favors use of olaparib post surgery
- **In TNBC with residual disease:** OS adjuvant and MBC response and PFS data support choice of olaparib over capecitabine in gBRCAm specific context
- **In high risk ER+/HER2- disease:** ITT IDFS, DDFS and an OS benefit favour olaparib over abemaciclib but sequencing after 12 months olaparib could be considered