

We are pleased about the general agreement that PBI does not increase breast cancer mortality in comparison with WBI and it is therefore a safe treatment option for suitable patients. PBI with TARGIT-IORT within a risk-adapted approach has the convenience of being completed at the time of lumpectomy, has lower acute and late toxicity¹⁻³, is preferred by patients^{4,5}, improves cosmesis and quality of life^{6,7}, is less expensive^{8,9}, and reduces environmental and social costs¹⁰. Common sense would dictate that it should become an accepted treatment option for suitable patients world-wide.

As stated in our paper, we included only *published randomised* trials that compared PBI vs WBI *and* reported 5-year mortality data. Amongst all search results, every trial that fulfilled these criteria was included. The number of deaths and 'proportion of patients with mortality events' were all at a median follow up 5-6 years.

We chose to emphasise the absolute difference (and 95% CI) rather than hazard ratio, as this gives the exact rather than the relative value, and is the most relevant clinical statistic. To put it in perspective, we have also mentioned how the difference is a large proportion of the total mortality: a 25% reduction in mortality with PBI.

With a large number of randomised patients (n=4251), and a low overall mortality (n=207), the observed difference between PBI and WBI was 1.3%, favouring PBI. The p-values tell us that if in reality the difference were zero and PBI and WBI led to identical mortality, then the probability of observing a difference of 1.3% favouring PBI, is p=.05 by the random effects model; the corresponding probability using the fixed effects model is p=.13. Given that both the probabilities are low and taking into consideration that both models found a definite reduction in non-breast-cancer mortality with PBI, but no difference in breast-cancer mortality, it is clear that there is really no meaningful discrepancy between the results of the two models, and both support the conclusions.

Higgins I^2 values for heterogeneity were 15.2%, 6.6% and 9.4% for non-breast-cancer, breast-cancer and total mortality. These low I^2 values demonstrate a low level of variation across the studies due to potential heterogeneity and also counter the final point by showing that the results are not 'largely driven by the TARGIT-A results'.

This meta-analysis confirms that mortality benefit we first reported in the TARGIT-A trial¹¹ is consistent across other trials of PBI. The correspondents ask why this small difference, detectable in modern trials, was not seen before. As previously suggested¹², in older trials over 50% patients died from breast cancer in the first 5 years¹³ and a 1-2% difference wouldn't be detectable until breast-cancer mortality reduced in the later years. On the other hand, in these modern trials, <5% patients die – more than half of these from causes other than breast cancer. So a 1.3% difference is not only statistically detectable, but given the large number of breast cancers being treated, it is clinically important enough for us to consider a change of practice.

References

1. Kraus-Tiefenbacher U, Bauer L, Kehrer T, Hermann B, Melchert F, Wenz F. Intraoperative radiotherapy (IORT) as a boost in patients with early-stage breast cancer -- acute toxicity. *Onkologie*. 2006;29(3):77-82.
2. Sperk E, Welzel G, Keller A, Kraus-Tiefenbacher U, Gerhardt A, Sutterlin M, Wenz F. Late radiation toxicity after intraoperative radiotherapy (IORT) for breast cancer: results from the randomized phase III trial TARGIT A. *Breast cancer research and treatment* 2012;135(1):253-60.
3. Vaidya JS, Joseph DJ, Tobias JS, Bulsara M, Wenz F, Saunders C, Alvarado M, Flyger HL, Massarut S, Eiermann W, Keshtgar M, Dewar J, Kraus-Tiefenbacher U, Sutterlin M, Esserman L, Holtveg HM, Roncadin M, Pigorsch S, Metaxas M, Falzon M, Matthews A, Corica T, Williams NR, Baum M. Targeted intraoperative radiotherapy versus whole breast radiotherapy for breast cancer (TARGIT-A trial): an international, prospective, randomised, non-inferiority phase 3 trial. *The Lancet* 2010;376(9735):91-102.
4. Corica T, Joseph D, Saunders C, Bulsara M, Nowak AK. Intraoperative radiotherapy for early breast cancer: do health professionals choose convenience or risk? *Radiat Oncol* 2014;9:33.

5. Alvarado MD, Conolly J, Park C, Sakata T, Mohan AJ, Harrison BL, Hayes M, Esserman LJ, Ozanne EM. Patient preferences regarding intraoperative versus external beam radiotherapy following breast-conserving surgery. *Breast cancer research and treatment* 2014;143(1):135-40.
6. Welzel G, Hofmann F, Blank E, Kraus-Tiefenbacher U, Hermann B, Sutterlin M, Wenz F. Health-related quality of life after breast-conserving surgery and intraoperative radiotherapy for breast cancer using low-kilovoltage X-rays. *Annals of surgical oncology* 2010;17 Suppl 3:359-67.
7. Corica T, Nowak AK, Saunders C, Bulsara M, Taylor M, Vaidya JS, Baum M, Joseph D. Cosmesis and Breast-Related Quality of Life Outcomes After Intraoperative Radiation Therapy for Early Breast Cancer: A Substudy of the TARGIT-A Trial. *International journal of radiation oncology, biology, physics* 2016;DOI: 10.1016/j.ijrobp.2016.04.024.
8. Alvarado MD, Mohan AJ, Esserman LJ, Park CC, Harrison BL, Howe RJ, Thorsen C, Ozanne EM. Cost-effectiveness analysis of intraoperative radiation therapy for early-stage breast cancer. *Annals of surgical oncology* 2013;20(9):2873-80.
9. Vaidya JS, Wenz F, Bulsara M, Tobias JS, Joseph D, Saunders C, Brew-Graves C, Potyka I, Morris S, Vaidya HJ, Williams NR, Baum M. An international randomised controlled trial to compare targeted intra-operative radiotherapy (TARGIT) with conventional post-operative radiotherapy after conservative breast surgery for women with early stage breast cancer (The TARGIT-A trial). *Health technology assessment* 2016;in press.
10. Coombs NJ, Coombs JM, Vaidya UJ, Singer J, Bulsara M, Tobias JS, Wenz F, Joseph DJ, Brown DA, Rainsbury R, Davidson T, Adamson DJ, Massarut S, Morgan D, Potyka I, Corica T, Falzon M, Williams N, Baum M, Vaidya JS. Environmental and social benefits of the targeted intraoperative radiotherapy for breast cancer: data from UK TARGIT-A trial centres and two UK NHS hospitals offering TARGIT IORT. *BMJ open* 2016;6(5):e010703.
11. Vaidya JS, Wenz F, Bulsara M, Tobias JS, Joseph DJ, Keshtgar M, Flyger HL, Massarut S, Alvarado M, Saunders C, Eiermann W, Metaxas M, Sperk E, Sutterlin M, Brown D, Esserman L, Roncadin M, Thompson A, Dewar JA, Holtveg HM, Pigorsch S, Falzon M, Harris E, Matthews A, Brew-Graves C, Potyka I, Corica T, Williams NR, Baum M, TARGIT-trialists'-group. Risk-adapted targeted intraoperative radiotherapy versus whole-breast radiotherapy for breast cancer: 5-year results for local control and overall survival from the TARGIT-A randomised trial. *Lancet* 2014;383(9917):603-13.
12. Vaidya JS, Wenz F, Bulsara M, Tobias JS, Joseph D, Baum M. Radiotherapy for breast cancer, the TARGIT-A trial - Authors' reply. *Lancet* 2014;383(9930):1719-20.
13. Haybittle JL, Brinkley D, Houghton J, A'Hern RP, Baum M. Postoperative radiotherapy and late mortality: evidence from the Cancer Research Campaign trial for early breast cancer. *BMJ* 1989;298(6688):1611-14.