

SUPREMO, an MRC phase III randomised trial to assess the role of adjuvant chest wall irradiation in 'intermediate risk' operable breast cancer following mastectomy

# MRC SUPREMO TRIAL (BIG 2-04)

(Selective Use of Postoperative Radiotherapy After  
Mastectomy)

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under the auspices of:

UK Medical Research Council  
Scottish Cancer Trials Breast Group

in association with:

Breast International Group:

Anglo-Celtic Co-operative Oncology Group  
Australia and New Zealand Breast Cancer Trials Group  
Borstkanker Onderzoeksgroep Nederland  
Central East European Oncology Group  
European Organisation for Research and Treatment of Cancer  
GECO Peru  
Hellenic Breast Surgical Society  
International Breast Cancer Study Group  
Irish Clinical Oncology Research Group  
Japanese Breast Cancer Research Group  
National Cancer Institute of Canada –Cancer Trials Group  
National Cancer Research Institute Breast Cancer Studies Group  
Swedish Breast Group  
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approved by: Dr Ian Kunkler



Signed.....

Date: 12/01/2006

## Summary

### SUPREMO

A randomised phase III trial assessing the role of chest wall irradiation in women with intermediate risk breast cancer following mastectomy

### Eligibility

1. pT1, pN1, M0 unilateral histologically confirmed invasive breast cancer.
2. pT2, pN1, M0 unilateral histologically confirmed invasive breast cancer.
3. pT2, pN0 unilateral histologically confirmed invasive breast cancer if grade III histology and/or lymphovascular invasion.
4. Multifocal breast cancer if largest discrete tumour at least 2cm if N0 and grade III histology and/or lymphovascular invasion [see NB (ii)].
5. If the tumour area comprises multiple small adjacent foci of invasive carcinoma then overall maximum dimension taken. This must be greater than 2cm if N0 (see section 7.2) and grade III histology and/or lymphovascular invasion [see NB (iii)].
6. Fit for adjuvant chemotherapy (if indicated), adjuvant endocrine therapy (if indicated) and postoperative irradiation.
7. Undergone total mastectomy (with minimum of 1mm clear margin of invasive cancer and DCIS) and axillary staging procedure.
  - 7.1 If axillary node positive (1-3 positive nodes [including micrometastases >0.2mm-≤2mm]) then an axillary node clearance (minimum of 10 nodes removed) should have been performed. Isolated tumour cells do not count as micrometastases.
  - 7.2 Axillary node negative status can be determined on the basis of either axillary clearance or axillary node sampling or sentinel node biopsy.
8. Written, informed consent.

NB (i) Patients undergoing immediate breast reconstruction are eligible for inclusion.

NB (ii) Multifocal breast cancer if largest focus conforms to the other eligibility criteria. So if N0 disease the primary tumour has to have at least one focus size pT2 with grade 3 histology or lymphovascular invasion (criterion 3) or pT1 or pT2 if N1 (criteria 1 and 2).

NB (iii) Criterion 5 is the definition of what is considered pT2 disease for N0 cases (pT1 is also allowed if N1). Please also see section 7.2 of the protocol for more detailed explanation.

### Exclusions

1. Any pT0, pN0-1, or pT1, pN0 or pT3, pN0-1 or pT4
2. Patients who have 4 or more pathologically involved axillary nodes
3. Patients who have undergone neoadjuvant systemic therapy.
4. Previous or concurrent malignancy other than non melanomatous skin cancer and carcinoma in situ of the cervix
5. Male
6. Pregnancy
7. Bilateral breast cancer
8. Known BRCA1 and BRCA2 carriers
9. Not fit for surgery, radiotherapy or adjuvant systemic therapy
10. Internal mammary nodes visible on sentinel node scintigraphy in the absence of negative histology.
11. Unable or unwilling to give informed consent

### Randomisation

Randomisation to chest wall irradiation or no chest wall irradiation

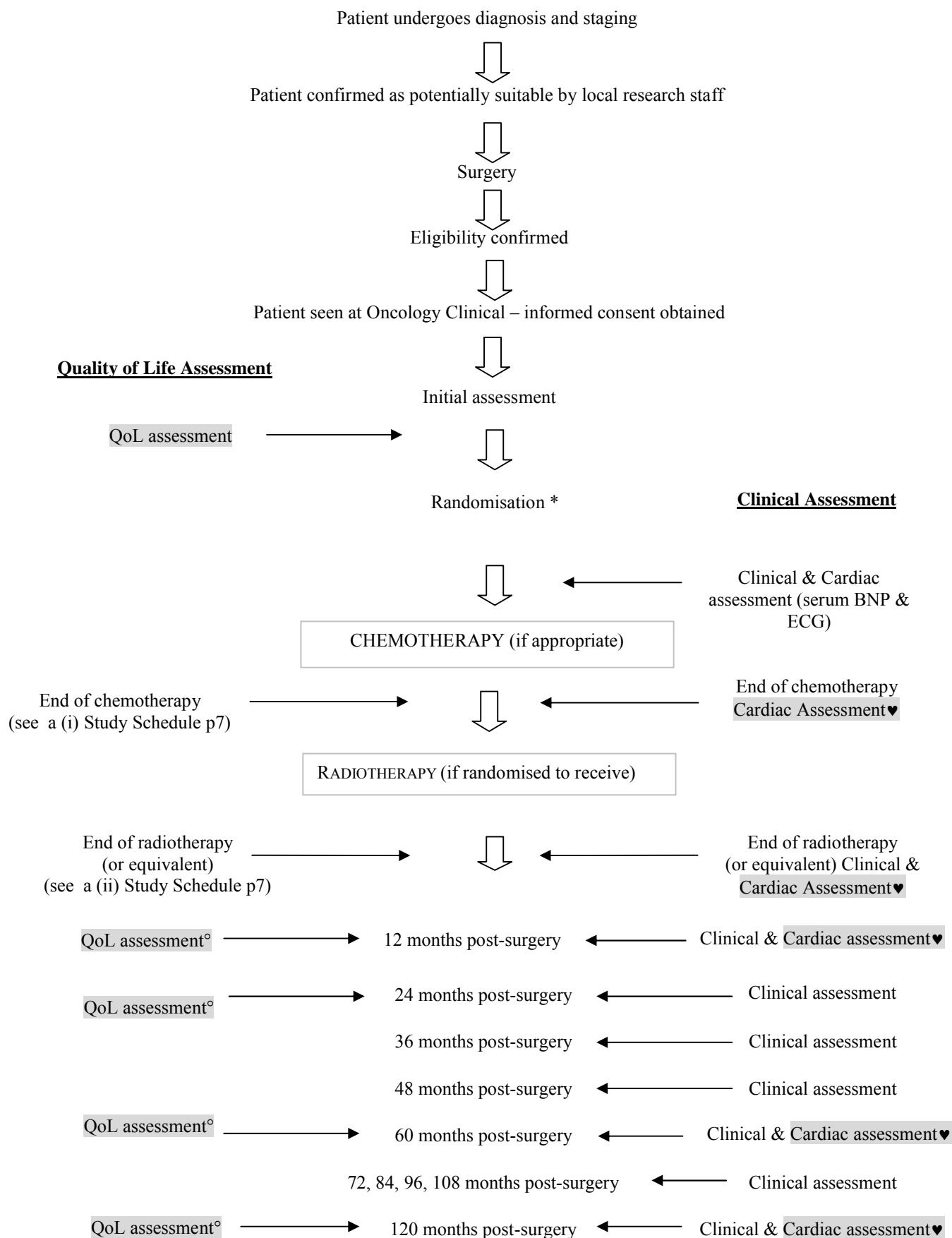
### Primary endpoint:

Overall survival

### Secondary endpoints:

Chest wall recurrence

Regional recurrence  
Disease free survival  
Metastasis free survival  
Cause of death (breast cancer, intercurrent disease [cardiovascular and non-cardiovascular])  
Acute and late morbidity  
Quality of life  
Cost effectiveness  
Follow up: 10 years



\* Randomisation may be done after chemotherapy  
♥ with BNP, serum/plasma, ECG  
° QoL at 12,24,60 and 120 months **post-randomisation**  
■ UK only

Visits( a )	Patients involved	Screening	Post (+/-) chemo pre (+/-) RT	Post (+/-) RT	1 yr	2 yr	3 yr	4 yr	5 yr	6 yr	7 yr	8 yr	9 yr	10 yr
Investigations		Baseline 1	2	3	4	5	6	7	8	9	10	11	12	13
Informed consent	All	X												
Medical history & examination ( b )	All	X	X	X	X	X	X	X	X	X	X	X	X	X
Staging tests	All	X												
Contralateral mammography (minimum requirement)	All	X			X		X		X	X		X		X
Blood sampling	All	X												
Tumour paraffin block from primary tumour and H & E stained section	All	X												
Cardiac symptoms and examination	All	X	X	X	X				X					X
Radiation morbidity	All			X	X	X	X	X	X	X	X	X	X	X
Blood sampling for BNP	Cardiac study only	X	X	X <sup>2</sup>	X				X					X
Electrocardiogram	Cardiac study only	X	X	X	X				X					X
Echocardiogram ( c )	Cardiac study only	X	X	X	X				X <sup>1</sup>					
QOL and EQ5D economic assessment ( d )	QOL study only	X			X	X			X					X

<sup>1</sup>Echocardiogram repeated if serum B type natriuretic peptide (BNP) exceeds threshold value or clinical features warrant it

<sup>2</sup>For patients not randomised to radiotherapy, blood sample 3 months after completion of chemotherapy

(a) Patients in the control arm MUST follow the same follow up schedule as irradiated patients.

(i) For patients receiving chemotherapy, follow up will be immediately pre-radiotherapy or 6 months after surgery for non-irradiated patients. For patients not receiving chemotherapy, follow up will be immediately pre-radiotherapy or 4-6 weeks after surgery in non-irradiated patients.

(ii) For patients receiving chemotherapy, follow up will be on completion of radiotherapy or at 9 months after surgery in non-irradiated patients. For patients not receiving chemotherapy follow up will be on completion of radiotherapy or at 3 months after surgery in non-irradiated patients.

(b) Questioning for symptoms of recurrent breast cancer and examination of loco-regional area other relevant clinical areas for evidence of recurrence depending on clinical features.

(c) In centres where isotope ventriculography is the standard examination for patients requiring anthracycline containing chemotherapy, an echocardiogram will also be required at baseline. Echocardiography will be used for all subsequent time points in the study. The first 100 patients will undergo repeat echos, subsequent patients will only require a baseline echo and if there is subsequent development of new cardiac symptoms or signs.

(d) Pre randomisation pre chemotherapy quality of life assessment will be conducted in the clinic. All subsequent quality of life assessment questionnaires will be mailed to the patient.

# Membership of Steering and Data Monitoring Committees and Trial Management Group

## Trial Steering Committee

Prof. Barry Hancock, Sheffield (Chair)

Dr. Ian Kunkler, Edinburgh (Chief Investigator)

Dr. John Bartlett, Edinburgh

Dr. Peter Canney, Glasgow (Co-Chief Investigator)

Prof. David Dearnaley, Sutton

Dr. Irene Devine, ISD, Edinburgh

Dr. Venetia Franglen, Hereford (Patient Representative)

Prof. Tim Illidge, Manchester

Dr. Richard Jones, Glasgow

Dr. Noelle O'Rourke, Glasgow

Dr. Sarah Perkins, MRC, London

Prof. Robin Prescott, Edinburgh

Dr. Geertjan van Tienhoven, Amsterdam (EORTC representative)

Dr. Galina Velikova, Leeds

## Data Monitoring and Ethical Committee

Dr Christopher Frost, London (Chair)

Professor Nicholas James, Birmingham

Dr Paul Symonds, Leicester

## Trial Management Group

Dr. Ian Kunkler, Edinburgh (Chief Investigator and Chair)

Dr. Edwin Aird, Northwood

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Prof. John Cairns, London

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Dr. David Northridge, Edinburgh

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Mr. Richard Sainsbury, London

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Dr. Geertjan van Tienhoven, Amsterdam (EORTC representative)

Dr. Galina Velikova, Leeds



## 1. INTRODUCTION

International consensus supports the routine use of adjuvant chest wall irradiation in women after mastectomy and systemic therapy for breast tumours  $\geq$  5cm in diameter and with 4 or more histologically involved axillary nodes (Recht et al, 1998) or with a 20% 10 year risk of loco-regional recurrence (LRR) (Goldhirsch et al, 1998). However the value of chest wall irradiation in women at intermediate risk of loco-regional recurrence with 1-3 involved nodes after mastectomy and a 10 year risk of loco-regional recurrence of less than 15% is uncertain. For such patients loco-regional radiotherapy is not standard care in most UK centres or internationally. Clinical trials of postmastectomy radiotherapy (PMRT) in this subgroup are an international priority (NIH consensus statement, 2000; Recht et al, 2001).

From a survey conducted amongst UK clinical oncologists there are wide variations in practice in the use of chest wall irradiation in women with 1-3 involved nodes after an axillary clearance (Kunkler et al, 1999). This may reflect the absence of definitive data from randomised trials assessing the value of adjuvant irradiation in this group of patients. A recent survey among European radiation oncologists of the use of PMRT in women with 1-3 positive nodes showed wide variations among those advocating PMRT from 19% in Italy to 74% in Spain and Portugal (Ceilley et al, 2005).

Of the 15 prospective randomised trials evaluating PMRT for axillary node positive patients receiving adjuvant systemic therapy, all but one show the ability of radiation to reduce LRR. The proportional reduction in risk of LRR remains fairly constant, between one half and two thirds. However, the absolute benefits range widely, from 6% to 21% (Fowble, 1999). The absolute reduction in risk ranged from 10% to 28% for patients with four or more nodes involved and from 3% to 23% for patients with 1-3 involved nodes. For T3 tumours, it ranged even more widely, from 10% to 45%. Whelan et al (2000) in an overview have estimated the impact of loco-regional radiotherapy in current practice from all peer-reviewed published trials (median follow up at least 5 years) among patients receiving adjuvant chemotherapy or tamoxifen (or both) randomised to receive or not to receive radiotherapy. Radiotherapy was associated with a 75% reduction in odds of loco-regional failure, a 31% reduction in odds of tumour recurrence and 17% reduction in the odds of death. The effects of radiotherapy in terms of reducing recurrence and improving survival are similar in size to those of systemic therapy (EBCTCG, 1998).

Loco-regional failure after mastectomy and systemic therapy alone is commonest on the chest wall and considerably less common in the axilla or supraclavicular fossa. Very rarely it occurs in the internal mammary nodes. Most of the survival benefit is thought (but not proven) to be derived from chest wall irradiation.

The Oxford overview (EBCTCG, 2000) suggests that PMRT reduces breast cancer mortality in women with a 20% 10 year risk of loco-regional recurrence by 5%. Smaller but still clinically significant gains in survival might occur in women with 1-3 positive nodes treated by mastectomy, axillary clearance, systemic therapy and chest wall irradiation.

Randomised trials comparing mastectomy and systemic therapy with or without loco-regional irradiation have shown a 9-10% survival benefit at 10 years from the addition of loco-regional irradiation to adjuvant cyclophosphamide, methotrexate and 5 fluorouracil (CMF) in 'high risk' premenopausal women (Overgaard et al, 1997; Ragaz et al, 1997). A similar survival benefit has been shown in postmenopausal women at high risk of local recurrence (Overgaard et al, 1999). The larger trial from Denmark of 1061 premenopausal high risk patients with 1-3 involved nodes shows an 8% gain in overall survival (62% vs 54%) from the addition of comprehensive loco-regional irradiation to systemic therapy. For the 1885 patients with 1-3 involved nodes from a combined analysis of the premenopausal and postmenopausal patients in the Danish Trials (Overgaard, 2000) overall survival at 14 years was 10% higher with the addition of PMRT (50% vs 40%,  $p = 0.0001$ ). While survival benefit was shown in all subgroups of patients, the major benefit accrued to those with 1-3 positive nodes and in patients with tumours 5cm or less. The survival advantage of the addition of radiotherapy to CMF was greater (9%) in small (<21mm) and intermediate size (21-50mm) tumours, compared to 7% in larger tumours (>50mm). There were similar findings in the Danish trial of postmenopausal patients (Overgaard et al, 1999).

It is possible therefore that while loco-regional radiotherapy may confer most benefit in loco-regional control in larger tumours, a greater survival benefit might be conferred in smaller tumours and fewer numbers of involved nodes (Harris et al, 1999). This hypothesis is supported by a recent retrospective analysis of three European Organisation for Research and Treatment of Cancer (EORTC) adjuvant breast cancer trials (van der Hage et al, 2003). It shows that patients with 1-3 positive nodes gained most in terms of survival (RR 0.48, 99% CI 0.31-0.75,  $p < 0.001$ ). These data should be interpreted with caution since the analysis is retrospective. Long term (20 year) follow up of the Canadian trial of PMRT (Ragaz et al, 2005) shows a 7% gain in overall survival (57% vs 50%) from the addition of locoregional RT to systemic therapy. However in an accompanying editorial Whelan & Levine (2005) comment that in the 1-3 node positive group treated by PMRT, we remain dependent on subgroup analysis and level I evidence is still needed on the benefits of PMRT in this subset of patients. In node negative patients the results of PMRT are conflicting. No survival advantage was found in this subgroup in the Danish randomised trials (Overgaard M, 2002) or in combined analysis of the EORTC trials (van der Hage et al, 2003). A recent retrospective study (Jagsi et al, 2005) of a population of 887 node negative patients who had undergone mastectomy without adjuvant irradiation, showed that size >2cm, margin <2mm, premenopausal status and lymphovascular invasion were independent prognostic factors for loco-regional recurrence (LRR). Ten year LRR was 10% with one risk factor, 17.9% with two risk factors and 40.6% with three risk factors. Furthermore a retrospective comparison of patients treated in a centre in Brussels by postoperative radiotherapy after mastectomy showed a 2.5%-6.9% overall survival benefit compared to a similar population of patients from the US SEER database treated without postmastectomy radiotherapy (Voordeckers et al, 2003). The authors acknowledge the limitations of a retrospective comparison and commend a randomised trial of adjuvant radiotherapy in node negative postmastectomy patients.

Uncertainty remains on the generalisability of the results from the Danish and Canadian trials to clinical practice, however, due to specific features of radiotherapy techniques, treatment volumes, regimes of systemic therapy and extent of axillary surgery which differ from those adopted in many cancer centres. The Danish trials (Overgaard et al, 1997; Overgaard et al, 1999) involved comprehensive irradiation of the axillary, internal mammary and supraclavicular nodes and a combination of photons and electrons to treat the chest wall. Most UK centres do not irradiate the internal mammary nodes and use photons alone to treat the chest wall. The intensity of the adjuvant CMF regime in the Danish trial has been considered suboptimal (Goldhirsch et al, 1998) and the extent of axillary dissection inadequate. Anthracycline containing regimes of adjuvant chemotherapy have proved more effective than adjuvant CMF. They have largely replaced CMF for intermediate risk breast cancer. There are few data on the interaction of anthracycline based adjuvant chemotherapy and PMRT in this group of patients.

The mean number of nodes removed was only seven, probably accounting for the high loco-regional recurrence rate (30%) observed in patients with 1-3 involved nodes. In the British Columbia trial too the loco-regional failure rate (10 year actuarial rate 16% and 15 year actuarial 33%) was higher than in other series with at least 5 years follow up with 1-3 positive nodes (6%-13%) reported by other authors (Recht et al, 1999; Goldhirsch et al, 1998; Kaufmann et al, 1993).

How exactly loco-regional radiotherapy interacts with systemic therapy in contributing to survival is still not clear. Systemic therapy is thought mainly to eradicate systemic micrometastases more effectively than loco-regional disease (Fu, 1985). Loco-regional radiotherapy may be important in preventing secondary dissemination from the residual loco-regional disease and might increase the potential for cure (Arriagada et al, 1995; Ragaz et al, 1997).

Data on the risk of loco-regional recurrence (LRR) in different patient subgroups are limited and conflicting (Recht, 1999). Recht et al (1999) showed that from the ECOG trial data on 2,016 assessable patients that with a median follow up of 12.1 years for disease free survivors, the cumulative 10 year incidence of LRR (including simultaneous distant recurrence) was 13% for patients with 1-3 positive nodes and 29% for those with four or more positive nodes. These figures are lower than the Danish and British Columbia premenopausal trials which showed respectively 30% and 33% LRR for 1-3 nodes and 42% and 46% LRR for four or more positive nodes.

The Scottish Intercollegiate Guidelines Network (SIGN) advocate that postmastectomy radiotherapy should be considered for all premenopausal women at high risk of local recurrence (SIGN, 1998). The SIGN guidelines indicate that risk is a summation of factors, including tumour size (>5 cm), grade, nodal status, lymphatic invasion and involvement of deep margins. It remains unclear, however, what degree of benefit is achieved for particular subgroups of patients at intermediate risk (e.g. those with less than four nodes involved, tumours <5 cm or negative nodes and grade 3 histology or lymphovascular invasion). Nor is it clear what weight should be assigned to other factors, such as tumour size, grade and lympho-vascular invasion.

Some authors have attempted to use combinations of prognostic factors, such as tumour size and number of involved nodes, to define subgroups with more specific risks of LRR than single factors alone. As Recht (1999) points out,

information on such combinations is limited (Fowble et al, 1988; Sykes et al, 1989; Pisansky et al, 1993). Recht et al (1999) in a multivariate analysis of the ECOG data showed tumour size, number of involved nodes and ER status to be predictive of risk of LRR but not age or menopausal status. Other prognostic factors, such as vascular or lymphatic invasion (Recht, 1999; Katz et al, 2000, Voogd et al, 2001), tumour grade (O'Rourke et al, 1994) and extracapsular nodal extension (Katz et al, 2000) increase the risk of recurrence. There may therefore be patients who are axillary node negative with risk factors for local recurrence for whom PMRT might confer a survival advantage in addition to a reduction in risk of loco-regional recurrence.

Recently Taghian et al (2004) have reported from 5758 node positive women enrolled in the B-15,B-16,B-22 and B25 trials that the overall cumulative incidence of locoregional failure was 13.0% in women with 1-3 positive axillary nodes compared to 24.4% and 31.9% in women with 4-9 and  $\geq 10$  nodes after mastectomy and doxorubicin containing adjuvant therapy. In multivariate analysis, age, tumour size, premenopausal status, number of lymph nodes and number of lymph nodes dissected were significant risk factors for LRF as first event. However compared to institutional or population based series, there is a much higher representation of patients who are premenopausal and under the age of 50 in the combined NSABP series (Olivotto, Truong and Chua, 2004). These authors also highlight the fact that the NSABP trials were primarily designed to assess different chemotherapy regimes rather than assess the role of PMRT. This may limit the generalisability of such trial data to clinical practice. The value of PMRT in women with 1-3 positive nodes or node negative but with other risk factors depend on whether the benefits in loco-regional control and survival outweigh treatment related morbidity and mortality. Morbidity may have a significant impact on quality of life. Complications of chest wall irradiation include pneumonitis, cardiac damage and rib fractures.

While data on cardiac morbidity from the Danish premenopausal and postmenopausal trials of PMRT show no excess in morbidity or mortality from ischaemic heart disease in irradiated patients (Hojris et al, 1999); the cardiac volumes irradiated in these trials were minimised by use of electron field techniques used to treat the medial chest wall and internal mammary nodes. This technique is not common outside Denmark. Tangential fields are more commonly used in the UK to treat the chest wall and some of the cardiac volume may be irradiated in order to encompass the chest wall. Techniques for minimising dosage to the heart vary between centres, some using positioning techniques (Canney et al, 1999) and others partial cardiac blocking (Landau et al, 2001). The Oxford overview of trials of postoperative radiotherapy (EBCTCG 1995, EBCTCG 2000) shows that a reduction in breast cancer mortality from radiotherapy is offset by an increase in non breast cancer mortality which is mainly cardiovascular. It is estimated that if radiation induced vascular morbidity could be eliminated an extra 2-4% 20 year survival from radiotherapy might be achieved (EBCTG 2000). The Oxford overview includes many older radiotherapy trials where dosage to the heart was higher using radiotherapy techniques which would now be considered outmoded (Harris et al, 1999). Estimates of treatment morbidity, mortality and quality of life need to be based on contemporary and commonly used radiotherapy techniques.

In addition with the increasing use of potentially cardiotoxic anthracycline containing adjuvant chemotherapy regimes in premenopausal patients with

intermediate risk (1-3 node positive) breast cancer, there are additional risks of chemotherapy induced cardiac morbidity (Bristow et al, 1979; Shapiro et al, 1998) and mortality which may influence the balance of benefits and risks of PMRT.

In summary, a large randomised trial is needed investigating the impact on loco-regional control, survival, quality of life, morbidity and cost effectiveness of postoperative radiotherapy to the chest wall in women at intermediate risk of recurrence following mastectomy, systemic therapy (if indicated) and axillary clearance.

## 2. OBJECTIVES

To determine the effect of:

Ipsilateral chest wall irradiation following mastectomy and axillary clearance for women with operable breast cancer at 'intermediate risk' of loco-regional recurrence.

On the primary endpoint of:

Overall survival

Secondary endpoints:

- Chest wall recurrence
- Regional recurrence
- Disease-free survival
- Metastasis-free survival
- Cause of death (Breast cancer, Intercurrent disease [cardiovascular and non- cardiovascular])
- Acute and late morbidity
- Quality of Life
- Cost effectiveness

## 3. PATIENT ELIGIBILITY

1. pT1, pN1, M0 unilateral histologically confirmed invasive breast cancer.
2. pT2, pN1, M0 unilateral histologically confirmed invasive breast cancer.
3. pT2, pN0 unilateral histologically confirmed invasive breast cancer if grade III histology and/or lymphovascular invasion.
4. Multifocal breast cancer if largest discrete tumour at least 2cm if N0 and grade III histology and/or lymphovascular invasion [see NB (ii)].
5. If the tumour area comprises multiple small adjacent foci of invasive carcinoma then overall maximum dimension taken. This must be greater than 2cm if N0 (see section 7.2) and grade III histology and/or lymphovascular invasion [see NB (iii)].
6. Fit for adjuvant chemotherapy (if indicated), adjuvant endocrine therapy (if indicated) and postoperative irradiation.

7. Undergone total mastectomy (with minimum of 1mm margin clear of invasive cancer and DCIS) and axillary staging procedure.

7.1 If axillary node positive (1-3 positive nodes [including micrometastases >0.2mm-≤2mm]) then an axillary node clearance (minimum of 10 nodes removed) should have been performed. Isolated tumour cells do not count as micrometastases.

7.2 Axillary node negative status can be determined on the basis of either axillary clearance or axillary node sampling or sentinel node biopsy.

8. Written, informed consent.

NB (i) Patients undergoing immediate breast reconstruction are eligible for inclusion.

NB (ii) Multifocal breast cancer if largest focus conforms to the other eligibility criteria. So if NO disease the primary tumour has to have at least one focus size pT2 with grade 3 histology or lymphovascular invasion (criterion 3) or pT1 or pT2 if N1 (criteria 1 and 2).

NB (iii) Criterion 5 is the definition is the definition of what is considered pT2 disease for NO cases (pT1 is also allowed if N1). Please also see section 7.2 of the protocol for more detailed explanation.

#### Exclusion criteria

1. Any pT0, pN0-1, or pT1, pN0 or pT3, pN0-1 or pT4
2. Patients who have 4 or more pathologically involved axillary nodes
3. Patients who have undergone neoadjuvant systemic therapy
4. Previous or concurrent malignancy other than non melanomatous skin cancer and carcinoma in situ of the cervix
5. Male
6. Pregnancy
7. Bilateral breast cancer
8. Known BRCA1 and BRCA2 carriers
9. Not fit for surgery, radiotherapy or adjuvant systemic therapy
10. Internal mammary nodes visible on sentinel node scintigraphy in the absence of negative histology
11. Unable or unwilling to give informed consent

#### 4. TRIAL DESIGN AND STATISTICAL CONSIDERATIONS

Randomised to chest wall irradiation versus no chest wall irradiation

##### 4.1 Null hypothesis

There is no significant difference in overall survival in women at 'intermediate risk' of loco-regional recurrence from operable breast cancer treated by mastectomy, axillary clearance and, if indicated, adjuvant systemic therapy with or without chest wall irradiation.

##### 4.2 Sample size and power

In order to have 80% power to detect a significant difference at the 5% level when the five year survival rates are 75% and 79%, a sample of 3500 patients in total is required. As recruitment will take place over several years and the anticipated survival rates will be subject to error, it is also helpful to express power in relation to the number of deaths in the study at the time of the primary analysis. The hypothesised survival rates correspond to a hazard ratio of 1.22, and for 80% power with this hazard ratio, the necessary number of deaths is 794. To allow for attrition of 5% it is planned to recruit 3700 patients.

#### 4.3 Statistical plan

All analyses will be based upon the principle of intention-to-treat, and two-tailed significance tests and confidence intervals will be used throughout. Analysis of the primary outcome variables will be based principally on the calculation of 95% confidence intervals for the hazard ratios, based on a Cox proportional hazards model. The timing of the first published report is planned to be based on a minimum of 2.5 years of follow up. This will be subject to modification by the Steering Committee on the advice of the Data Monitoring and Ethics Committee.

While the size of the trial limits the analysis of the relationship between systemic therapy and radiotherapy in relation to the endpoints for the trial, it is proposed to conduct an exploratory analysis of this relationship.

## 5. STAGING

Staging will be conducted according to local centre protocol. Staging policies for each centre should be communicated to the trial administrator in advance of trial entry and any changes to staging procedures during the conduct of the trial. Full blood count, liver biochemistry and chest radiograph should be considered.

## 6. GUIDELINES ON SURGERY

### 6.1 Mastectomy and axillary node clearance

6.1.1 A total mastectomy and a minimum of a level II axillary clearance should be carried out (a minimum of 10\* nodes confirmed pathologically)

\* from one or more surgical procedures

or

6.1.2 For axillary node negative patients, a total mastectomy and other axillary surgical procedures are permissible: either an axillary node sample with a minimum of 4 pathologically confirmed nodes

or

sentinel node biopsy if conducted in a centre which has audited evidence of <10% failure to identify the sentinel node in at least 30 patients.

### 6.2 Breast reconstruction

Patients undergoing immediate breast reconstruction are eligible for the trial. Participating centres must state their policy on radiotherapy and immediate reconstruction in advance of the trial and notify any changes in policy during the trial to the trial administrator.

## 7. GUIDELINES ON PATHOLOGY

UICC staging (6th edition) should be used.

7.1.1 The size of the primary tumour should be measured.

7.1.2 All primary tumours should be graded according to the Nottingham modification of the Bloom & Richardson grading system.

7.1.3 The adequacy of the excision margin should be measured. An adequate margin is any margin that is deep, anterior or radial. The margins are to be clear of either invasive or non-invasive disease, that is invasive disease or ductal carcinoma in situ (DCIS). It does not include the presence or absence of lymphatic/vascular invasion

7.1.4 A minimum of 10 axillary nodes should be examined in an axillary clearance.



7.1.5 All submitted axillary nodes in a axillary node sample should be examined

7.1.6 A copy of the pathology report on the primary tumour and axillary node(s) should be sent to the trial administrator.

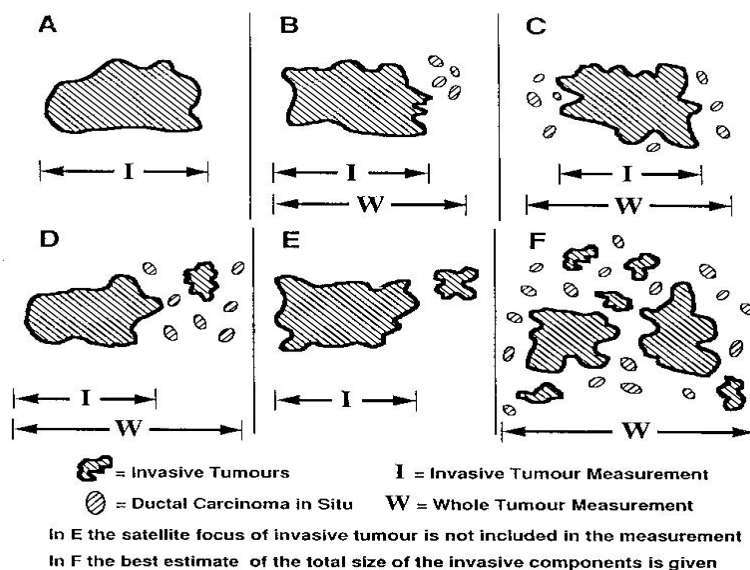
7.1.7 The original reported grade and lymphovascular status will be accepted for the purpose of the trial.

7.1.8 A password protected website for the trial will be provided giving examples of grading and lymphovascular invasion to facilitate standardisation of reporting between pathologists.

7.1.9 A panel of three pathologists will undertake the review of all cases entered by examining a representative H&E section taken from a tissue block submitted to the trial central laboratory. Each pathologist will review one third of the cases, randomly allocated, and assess grade and lymphatic/vascular invasion. The pathologists will be blinded to the original pathology report. Those cases where the review grade and lymphatic/vascular invasion status is in agreement with those originally reported will be reviewed no further. In those cases where there is disagreement between the reviewing pathologist and the original report there will be a formal review by all three reviewing pathologists to achieve consensus. Criteria for review will conform to current grading guidelines (Elston CW and Ellis IO, 1991).

## 7.2 Multifocal invasive cancer

If the tumour area comprises multiple small adjacent foci of invasive carcinoma then the overall maximum dimension should be taken and must be greater than 2cm if N0 (see Diagram F below):



## 8. GUIDELINES ON RADIOTHERAPY

### General

Within each participating centre the radiotherapy technique should be standardised for all patients participating in the trial. This technique will be communicated to the radiotherapy quality assurance programme. Any change in technique must immediately be notified to the quality assurance programme.

### 8.1 Simulation and field irradiation

8.1.1 All patients should be simulated for the planning of chest wall irradiation.

8.1.2 CT planning to minimise dosage to the heart and lung is recommended. Where full CT planning is not available a simulator CT through the centre of the Planning Target Volume (PTV) is recommended. If this is not possible, an external contour with lung estimate is acceptable.

8.1.3 Treatment should be delivered by a pair of tangential fields with wedges as necessary. Alternative treatments with electron fields are permissible provided an adequate dose distribution is achieved.

8.1.4 Where it is not possible to treat the whole of the mastectomy scar within the tangential fields to limit dosage to lung and/or heart, the use of electron fields to treat the medial and/or lateral parts of the scar outside the tangential photon field should be considered. Care must be taken to avoid overlap of electron and photon fields.

#### 8.1.5 Supraclavicular fossa and upper axilla

Where a level II axillary clearance has been performed and the axillary nodes are pathologically involved, a single direct anterior field covering the supraclavicular fossa and the apex of the axilla is recommended.

The anterior supraclavicular field may be angled 5-10 degrees to avoid the spinal cord. A small larynx lead block may be used but should not shield the medial supraclavicular nodes.

#### 8.1.6 Internal mammary chain

The CTV and PTV should preferably be indicated on the simulator images. As the internal mammary nodes are difficult to identify on CT, the PTV based on the internal mammary artery plus a 2cm margin in lateral directions and 5mm in the dorsal direction should suffice in most cases. The maximum depth of the internal mammary nodes is normally about 4cm.

### 8.2 Position of the patient

The patient will be treated in the supine position. Some form of immobilisation device is recommended such as an arm pole and/or vacuum bag. This position should be reproduced during simulation, acquisition of planning CT and during treatment.

### 8.3 Reproducibility of treatment position

The use of orthogonal laser beams is recommended to assess the reproducibility of daily set up.

### 8.4 Clinical target volume

8.4.1 The clinical target volume encompasses the skin flaps from 5mm below the skin surface and includes the soft tissues down to the deep fascia, but not including the underlying muscle and rib cage.

8.4.2 Reflecting international variations in radiotherapy practice and to maximise participation in the trial:

(a) UK centres, after a level II or III clearance, may elect to irradiate the Medial Supraclavicular Fossa (MSCF) and/or Internal Mammary Chain (IMC), if such is their centre's policy, in patients who have pathologically involved nodes and are randomised to chest wall irradiation. If they choose to do so they must notify the trial centre of their policy and technique prior to randomising patients in the trial.

(b) Non-UK centres after a level II or III clearance may elect to irradiate the Medial Supraclavicular Fossa (MSCF) and/or Internal Mammary Chain (IMC), if such is their centre's policy, in any patient in either arm of the trial. If they choose to do so, they must notify the trial centre of their policy and technique prior to randomising patients in the trial.

8.4.3 The lateral axilla, lateral to the Medial Supraclavicular Fossa (MSCF) and cranial to the tangential fields must not be irradiated. This is to avoid toxicity of combined surgical and radiotherapeutic treatment of this area, in particular the lymphovascular, venous and nervous structures. Since the lower axilla (part of level 1) is laterally adjacent to the breast, it is unavoidable to irradiate part of this in the tangential fields.

### 8.5 Planning target volume

8.5.1 The planning target volume encompasses the skin flaps. While the deep margin encompasses the deep fascia, the treatment volume inevitably includes the pectoralis major and rib cage. Depending on the energy used, build up may be necessary. To restrict the volume of lung and/or heart the surgical scar may have to be left out of the field medially and/or laterally.

8.5.2 The irradiated volume should extend medially to the midline, laterally to the mid axillary line and inferiorly to 1-2cm below the level of the inframammary fold and superiorly to the angle of Louis at the level of the second rib. Care should be taken in setting the upper field margin to avoid irradiation of the axilla.

## 8.6 Treatment planning and reference point

8.6.1 Participating centres are encouraged to adopt 3-dimensional planning for trial patients as soon as it becomes available in their centre on Sim-CT or CT-Sim.

8.6.2 Dose inhomogeneity should not vary by more than 12% in the central slice. This should be between a point outside of lung and the maximum should be an isodose encompassing a 2cm square area (to allow for irregularities in calculation of maximum point dose by planning systems).

8.6.3 The lung density correction must be clearly stated when calculating the dose distribution. Centres should be aware of incorporating lung density correction on an individual plan.

### 8.6.4 Chest wall

Doses must be prescribed to the reference point which lies at or near the centre of the target volume (ICRU 50). This point is half way between the lung surface and the skin surface on the perpendicular bisector of the posterior beam edge. Maximum and minimum doses must also be stated to describe dose homogeneity and must follow ICRU 50 recommendations.

### 8.6.5 Supraclavicular fossa and upper axilla

The dose with photons should be prescribed to Dmax (100% or a depth of 1.5cm using 6 MV photons).

8.6.6 The dose is prescribed to the ICRU 50 reference point for photons and to the 100% isodose for electrons.

8.6.7 Irradiation of large volumes of the heart and lung should be avoided by keeping the central lung distance to 3cm or less measured by computer tomography or simulator. Alternatively, verification of lung depth may be carried out using machine films.

8.6.8 Bolus may be applied to whole or part of the chest wall. Centres must specify their policy for the use of bolus in advance of participation in the trial and notify the trial administrator of any changes in policy during the trial. Centres should specify whether bolus is applied to part (e.g. the scar area) or all of the chest wall and for all or a specified number of fractions and the thickness of bolus used for a given photon energy.

8.6.9 Centres electing to irradiate the internal mammary nodes must use CT planning for this purpose. The internal mammary nodes should be treated with a mixture of photons and electrons, using the electrons of appropriate energy and limited penetration to reduce the dose to the heart.

## 8.7 Sequencing of systemic therapy and radiotherapy

8.7.1 In patients not receiving chemotherapy, radiotherapy should be started within 12 weeks after the date of mastectomy.

8.7.2 In patients receiving chemotherapy, radiotherapy should be started within 6 weeks of the end of chemotherapy.

8.7.3 All chemotherapy should be given before radiotherapy.

8.7.4 Trastuzumab should not be given concurrently with post-mastectomy radiotherapy.

8.7.5 Sequencing of endocrine therapy and chemotherapy may be according to local practice.

## 8.8 Dosage and fractionation

8.8.1 The dose distribution should be shown at least in the plane through the beam axes. The target area (planned target volume [PTV]) in this plane should be outlined.

### 8.8.2 Fractionation regimes

The recommended dose/fractionation regime is:

50 Gy TAD in 25 daily fractions over 5 weeks

Other admissible dose and fractionation schedules are:

45 Gy TAD in 20 daily fractions over 4 weeks

40 Gy TAD in 15 daily fractions over 3 weeks

8.8.3 Breast reconstruction - Breast reconstruction is not a contra-indication to radiotherapy. Centres should state their radiotherapy dose and fractionation policy for patients undergoing radiotherapy after breast reconstruction in the trial. Cancer control should be the overriding concern.

## 8.9 Radiotherapy equipment

8.9.1 Megavoltage photons are recommended. 4-6 MV photons are appropriate for most patients. Electrons of appropriate energy may be used. The choice of energy depends on the thickness of tissue between the skin surface and the underlying deep fascia.

8.9.2 Beam calibration should be carried out in accordance with a specified written protocol, preferably as described in the IPEM absorbed dose protocol (Code of Practice, 1990).

## 9. ACUTE AND LATE RADIATION MORBIDITY

Baseline cardiac risk factors will be collected on all patients. Acute and late morbidity of radiotherapy (see appendix VIII) will be assessed using the EORTC/RTOG scale [Cox et al, 1995]) at the end of the course of radiotherapy or at 3 months for non-irradiated patients who have not received chemotherapy or at 9 months for non-irradiated patients who have received chemotherapy. Subsequent assessments will be carried out at 12, 24, 36, 48, 60, 72, 84, 96, 108, 120 months after surgery.

## 10. GUIDELINES ON ADJUVANT SYSTEMIC THERAPY

- (i) All patients should be considered for optimal adjuvant systemic therapy, if indicated.
- (ii) For each patient, centres will be required to state whether (a) a taxane or anthracycline-containing regimen and (b) hormonal therapy has been used.
- (iii) Choice of adjuvant systemic therapy should take account of tumour grade, lympho-vascular invasion, menopausal status, nodal status and oestrogen receptor status and if appropriate HER2 status.
- (iv) In patients receiving adjuvant systemic therapy an anthracycline-containing regime for at least 3 months or 4 cycles should be encouraged.
- (v) The recommended minimum allowable starting dose per injection of doxorubicin in regimes such as adriamycin and cyclophosphamide (AC) should be 60mg/m<sup>2</sup> and in cyclophosphamide, adriamycin and 5-fluorouracil (CAF) or FAC is 50mg/m<sup>2</sup>.
- (vi) Where doxorubicin is given as a single agent in regimes such as Bonnadonna (4 cycles of adriamycin followed by 8 cycles of CMF) the recommended minimum starting dose per injection is 75mg/m<sup>2</sup>.
- (vii) The recommended allowable starting dose per injection of epirubicin in regimes such as Epirubicin and Cyclophosphamide (EC) is 90 mg/m<sup>2</sup> and in CEF or FEC is 50mg/m<sup>2</sup> when given on days 1 and 8 or 75mg/m<sup>2</sup> when given on day 1 every 21 days.
- (viii) Where epirubicin is given as a single agent in regimes such as EpiCMF, the minimum allowable starting dose per injection is 90mg/m<sup>2</sup>.
- (ix) Taxane-containing regimes are permissible but it is recommended that they also incorporate anthracyclines. Centres will be asked to specify which regime they use.
- (x) It is recommended that all chemotherapy is given first and followed by radiotherapy in patients randomised to radiotherapy.
- (xi) It is recommended that patients with oestrogen or progesterone receptor positive cancers should receive adjuvant endocrine therapy for a minimum of five years. For postmenopausal women tamoxifen or an aromatase inhibitor are advised. It is recommended that premenopausal women should receive tamoxifen, ovarian ablation or a combination or both. Centres will be asked to specify which endocrine therapy will be used.
- (xii) We acknowledge that there may be some patients, particularly the elderly or those with inadequate cardiac function or general medical condition, for whom a combination of classical or intravenous cyclophosphamide, methotrexate and 5 fluorouracil (CMF) may be more appropriate than an anthracycline-containing regime.

(xiii) Patients can receive adjuvant trastuzumab or other biological agents as appropriate, according to local practice, but trastuzumab should not be given concurrently with post mastectomy radiotherapy, due to concerns about enhanced cardiotoxicity. Additional detailed guidance will be provided when the relevant information becomes available to inform practice.

## 11. REGISTRATION AND RANDOMISATION PROCEDURES

### 11.1 Stratification will be by treating centre

Centres should specify their policies of adjuvant treatment and surgical procedures before entering patients into the trial.

### 11.2 Randomisation procedure

11.2.1 Consenting patients treated by mastectomy, axillary surgery and adjuvant systemic therapy, if indicated, for intermediate risk breast cancer will be randomised in SUPREMO to receive or not receive postoperative chest wall irradiation.

11.2.2 Patients will be randomised by permuted blocks with the block length being varied randomly to minimise the effect of entry bias.

11.2.3 Randomisation should occur when radiotherapy is normally discussed. For centres participating in the Cardiac substudy (UK only), patients must be randomised before the start of chemotherapy treatment.

11.2.4 Eligibility and agreement to participate will be recorded on the Screening Log to be retained at each centre. Trial Screening Summary Forms should be completed and returned to the SUPREMO Trial Coordinator at ISD quarterly. Reasons for not entering patients in the randomised controlled trial will be recorded. After surgery eligibility will be confirmed. Patients who are interested will be given a patient information sheet by the centre. Written informed consent to participation will be obtained.

11.2.5 For those patients consenting, the randomisation checklist should be completed by the centre and patients will be randomised through the Edinburgh trials office of the Information Services Division (ISD) Cancer Clinical Trials Team (formerly Scottish Cancer Therapy Network) in the UK and by agreement through other international trial organisations.

11.2.6 Once the patient has been formally entered into the trial, and the treatment allocation has been confirmed by fax to the centre by fax, a letter should be sent to the patient's general practitioner on hospital-headed paper.

## 12. FOLLOW UP ARRANGEMENTS

12.1 Follow up clinic visits will be made postoperatively for at least 10 years:

a - within 3 weeks of completing chemotherapy (if given) before radiotherapy starts or at 6 months in patients not receiving chemotherapy.

b (i)- in patients who have received chemotherapy at the end of the course of radiotherapy or 9 months after date of mastectomy in patients not receiving radiotherapy.

b (ii)- in patients who have not received chemotherapy at the end of the course of radiotherapy or 3 months after the date of mastectomy in patients not receiving radiotherapy.

(c)- at 12, 24, 36, 48, 60, 72, 84, 96, 108, 120 months after date of mastectomy.

12.2 A 'Follow up' form will be completed at each visit. A 'Radiation morbidity' form will also be completed at these times. The acute radiation morbidity form will be completed at the end of the course of radiotherapy only and the late morbidity form will be completed at 12, 24, 36, 48, 60, 72, 84, 96, 108, 120 months after surgery. For non-irradiated patients acute and late radiation morbidity forms are completed at equivalent time points (see 12.1 b (i) and (ii)).

Any recurrences are to be documented on the Follow up form and details of treatment recorded on the Recurrence Form, which will be sent out by the trial administrator when required. Causes of death will be sought from hospital or community medical records.

12.3 Extra follow up visits will be required for patients participating in the cardiac substudy.

12.4 A mammogram of the opposite breast is recommended at least in alternate years for 10 years from the date of mastectomy.

#### 12.5 Serious Adverse Events/ (SAE's)

The SUPREMO trial uses standard radiotherapy schedules and unexpected serious adverse events are unlikely to occur. However all SAEs will be reported to the Data Monitoring and Ethical Committee. Expected adverse events from radiotherapy include skin reactions leading to chest wall tenderness and itching. Skin reactions are usually mild but are occasionally severe. Chest wall pain, usually mild and intermittent can occur. Rarely, radiotherapy may cause inflammation of the lung causing shortness of breath, late cardiac damage or it may cause the ribs to fracture.

### 13. ADMINISTRATION OF THE TRIAL

A full time trial administrator will be appointed who will report to an executive committee responsible for the administration of the trial and to a committee of grant-holders for the trial. A part-time assistant will be appointed to assist the trial administrator. The quality of life study will be supported by a full-time coordinator and a part-time assistant.

### 14. DATA MONITORING



An independent Data Monitoring and Ethical Committee will be established and will meet every 6 months (or as often as they consider appropriate). None of the members of the committee will be involved in the trial. The committee will receive regular reports from the trial administration centre. It will submit its comments and recommendations to the Steering Committee and the Executive Committee.

Monitoring (source data verification) will be carried out by the Cancer Clinical Trials Team in Edinburgh, and two UK collaborating Clinical trials units, on 10% of the patient data and we have allowed for site visits in the UK. In addition we would expect to check 100% of patient consent forms. Higher levels of monitoring will be performed, if requested, by the Data Monitoring Committee, or if particular safety issues are identified by the investigators or the Trial Management group or Steering Committee.

## 15. ETHICAL APPROVAL

Ethical approval by a Multi-Centre Research Ethics Committee will be needed before the trial can be started. Participants will also need approval of their Local Research Ethics Committee. Approval by the National Cancer Research Network in the UK will be sought. The trial will be carried out according to guidelines of good clinical practice (ICH-GCP) as defined by paragraph 28 and Schedule 1 Part 2 of the Medicines for Human Use (Clinical Trials) Regulations, 2004, and the Clinical Trials Directive (2001/20/ECD) elsewhere in the European Union and follow the principles of research governance.

## 16. PUBLICATIONS POLICY

A writing committee will be established by the grantholders which will be responsible for preparing publications of the trial for submission to peer reviewed journals. Similar writing committees will be established for TRANS SUPREMO, quality of life, cardiac, health economic and other substudies. The writing committee for the main trial will include a representative of the European Organisation for Research and Treatment of Cancer (EORTC) and other collaborating breast trial groups who have made significant contributions to the trial. Names of participating groups that have contributed to the trial will be clearly stated in publications reporting the results of the trial. Names of investigators who have contributed patients to the trial and their centres will be named as an appendix in articles submitted for publication. Articles reporting the results of the main trial and substudies will be circulated, where appropriate, by the writing committees to representatives of collaborating breast trials groups for comment prior to submission. An overview on the publications arising from the trial will be maintained by the Trial Steering Committee, who will be the arbiters in the event of any disagreement relating to publications.

## 17. RADIOTHERAPY QUALITY ASSURANCE PROGRAMME

The purpose of the proposed investigation

The complex nature of modern radiotherapy carries inherent problems both in ensuring reproducibility and accuracy within a radiotherapy unit and, more particularly, when carried out on a multi-centre basis. Specific issues in the treatment of the breast and lymph node pathways arise from the geometry of the treatment volume which varies in contour in all three planes with important radiation sensitive structures underlying the breast and chest wall including the lung and myocardium.

Careful localisation, computerised planning, accurate verification of beam position and meticulous attention to alignment and matching during treatment are essential.

A quality assurance programme is "a mandatory prerequisite when aiming at high dose, high precision radiotherapy" (Horiot et al, 1993) and is an integral component of any radiotherapy trial as defined by the EORTC guidelines for trial protocols in radiotherapy (Bolla et al, 1995).

In this multi-centre randomised trial the quality assurance programme (QA) will enable confirmation that technical guidelines within the protocol have been understood and implemented correctly by participants and that the dose prescription is delivered according to protocol with appropriate documentation.

This will ensure that clinical observations in terms of tumour control and normal tissue damage reflect differences in the randomised schedules rather than departures from trial protocol. Techniques used will be documented. This data will be available should differences in observed end points emerge.

In this way the definition of quality assurance as "all those planned and systematic actions necessary to provide adequate confidence that a product will satisfy given requirements of quality" (Standing Subcommittee on Cancer of the Standing Medical Advisory Committee: Quality Assurance in Radiotherapy, 1991) can be satisfied and the scientific worth of the parent trial be validated.

### Background to the proposed project

The QA programme will build on that developed for the START trial, which has provided a basis for consensus among radiotherapy centres in the UK.

All radiotherapy treatment relies on accurate reproducibility of the beams set up from day to day. This ultimately requires the use of light beams and laser alignments on skin marks on the patient. Inevitable variation occurs from day to day in a fractionated course of treatment which, even in the most rigorous setting, will result in field movements of several millimetres when daily verification films are taken (Westbrook et al, 1991).

Clinical sequelae may therefore arise because of imperfect technique. Inhomogeneity across the chest wall target volume may result in excess normal tissue damage to skin, subcutaneous tissues and ribs, and myocardial damage may result from the treatment of left sided tumours using techniques, which deliver significant doses to the heart. This may well result in an excess mortality from treatment (Cuzick et al, 1987) which can be

reduced with careful attention to treatment technique (Fuller et al, 1991). The use of high doses to the nodal areas through a single anterior field will result in areas of the volume receiving greater than the prescribed tumour dose in larger fractions per day, or, in contrast, underdosage to the deeper parts of the volume if the tumour dose is prescribed to the anterior part of the volume only.

The hazards of shoulder stiffness, rib necrosis and skin fibrosis have been highlighted, but of equal concern is the question of tumour recurrence if inadequate treatment is given. These factors emphasise the importance of meticulous treatment technique in the proposed trial and the need for external quality assurance to avoid major clinical problems and to ensure equivalence of techniques.

### Plan of investigation

The quality assurance programme will, having established precise details of radiation technique in each centre, focus upon measures by the QA team to the centres to verify adherence to treatment protocol and technique.

This follows the guidelines set out by the EORTC (Bolla et al, 1995) and will be co-ordinated by an experienced QA team based at Mount Vernon Hospital (Aird et al, 1995; Venables et al, 2001a; Venables et al, 2001b). It is based on an anticipated accrual to around 40 UK centres over a four year period. The programme will proceed as follows:

1) An initial questionnaire establishing precise details of technique to be used within the centre, together with specimen patient outlines or CT data, when available, to be used for ideal plans to be produced.

- \* Target volume and treatment technique used together with methods of beam matching where appropriate.

- \* Planning of radiation distributions across the treatment volume for homogeneity and prescription points.

- \* Routine QC performed by the centre will be assessed and compared with current Institute of Physics and Engineering in Medicine (IPEM) guidelines.

2) A visit by the quality assurance team prior to a centre entering the study to validate dosimetry in those centres which have not had dosimetry in a breast or chest wall phantom independently verified for the equipment currently being used. The QA programme for START revealed differences of nearly 10% in the delivered dose at the centre of a chest wall phantom (range 0.946-1.036) (8) and the range of delivered dose in patients will be larger than this due to variations in individual patient chest wall density and set up.

Measurements in phantoms allow the range of doses delivered during radiotherapy to be assessed.

3) The plans for the first 5 patients in the radiotherapy arm, from each centre, together with verification images will be collected by the QA team.

4) Subsequently, 1 in 10 plans will be collected by the QA team to ensure continued protocol adherence.

5) In vivo dosimetry will be undertaken in a subset of patients within the trial who will have thermo luminescent dosimetry (TLD) sent from the QA team. These patients will be identified at randomisation. It is anticipated that approximately 1 in 10 patients will have TLD sent from the QA team.

6) Copies of radiation port films or CT plans should be sent for centralised documentation of the amount of heart within the irradiated fields. An electronic medium is preferred. If a participating centre does use film, each patient's film should be scanned preferably into DICOM format. The same is true for the treatment plan. The latter should be sent electronically (preferably batched on a CD).

#### Quality control of individual patients by department

In line with current UK guidelines (yellow book) all patients should have in vivo dosimetry within the first week of treatment. This may be performed using diodes or TLD. Other methods may be appropriate for individual centres and should be discussed with the QA team. The verification method must be independent of the planning system.

Verification of patient positioning should be performed in line with protocol recommendations.

#### Analysis of QA programme

The data from the quality assurance programme will be analysed separately from the main trial. Major discrepancies from trial protocol will be notified to participating centres.

These will include:

- 1) Discrepancies in documentation, dose prescription and dose recording.
- 2) Dose inhomogeneity of more than 12% across chest wall treatment volume (-5% to +7%).
- 3) Hot spots (>100%) at field matchlines.
- 4) Inclusion of >3cm of lung in treatment volume.
- 5) Systematic errors of technique in any stage of treatment from planning through to implementation.

More detailed analysis of the quality assurance data will enable:

1. An independent review of variations in chest wall radiotherapy practice in participating centres.
2. Quantification of dose uniformity during the treatment period.
3. Correlation of physical parameters of radiation with trial end points:

i) The association between dose variation across the treatment volume and tumour control.

ii) Variations in dose homogeneity with rib pain, fracture and necrosis.

## 18. BIOLOGICAL SUBSTUDY (TRANS-SUPREMO)

### Biological Substudy

#### Background

The SUPREMO trial gives us a unique opportunity to expand our knowledge of the molecular mechanisms underlying the relapse of breast cancer and resistance to radiation therapy.

Radiotherapy is currently delivered to almost all women with early breast cancer undergoing conservation treatment, and to those with mastectomy at high risk of local relapse. Without irradiation, 20-40% of women will relapse locally over the succeeding 10-15 years (Cutuli, 2000).

Standard prognostic factors such as tumour size and grade, node status, age, ER status, absence of positive margins, extent of ductal carcinoma-in-situ and vascular invasion, do not define the 60-80% of patients in whom radiotherapy might be safely omitted (Fourquet et al, 2002). Factors mooted as potentially related to local relapse include reduced expression of bcl-2 (Silvestrini et al., 1997), over-expression of the IGF-1 receptor (Turner et al., 1997), expression of VEGF (Linderholm et al., 1998), cathepsin D (Ardavanis, et al, 1998), p53 (Zellars et al., 2000; Haffty, 2002), plasminogen activator inhibitor 1 (Cufer et al., 2002) and c-erb-B2 (Haffty, 2002; Kourkourakis et al., 2003). Other proteins affecting local invasive potential, such as integrins and proteases, and proliferation, such as downstream activities in the Akt and MAP kinase pathways may also be important. One recent study has suggested that an activated wound signature may predict a poor outcome (Nuyten et al., 2004).

Increased risk of local relapse without but not with radiotherapy has been reported in association with positive immunohistochemical staining for p53, increased levels of GST and reduced expression of bcl-2 (Silvestrini et al., 1997). This suggests these factors may identify a group who benefit from radiotherapy. The role of BRCA1, BRCA2 and ATM is unclear in sporadic breast cancer, while cyclin D over-expression might contribute to radioresistance (Xia & Powell, 2002). There are no studies relating radiation response to other DNA repair proteins or factors involved in apoptosis, although several have been suggested to have a role in the development of breast cancer. Other factors involved in both these areas (for example Ku, PARP1, XRCC 1 and 3, Rad51, members of the bcl-2 family and caspases) are likely to have a role in radioresistance.

A recent study has used mRNA microarray expression profiling to identify young patients with node-negative early breast cancer at low and high risk of systemic relapse (van't Veer et al. 2002; van de Vijver et al., 2002). In this technique, mRNA levels were quantified using gene chip technology, and prognostic groups defined by patterns of expression of the subset of 70 genes showing a significant variation (2-fold or greater) between tumours. We hypothesise that a unique signature may be present for both local relapse and radiosensitivity. The aim of the present study is to identify these signatures and validate methods by which such patients can be identified in the clinic using the SUPREMO trial as a test system. The TRANS-SUPREMO study will

allow the evaluation of potential pathways predictive of local relapse and radiosensitivity/resistance in the context of SUPREMO by constructing tissue microarrays from all patients enrolled in this trial. This approach should allow us to identify key molecular pathways for the future identification of patients most likely to benefit from radiotherapy. A similar approach is being used in early breast cancer, where the use of standard prognostic factors to determine who should have adjuvant chemotherapy is being compared with decision making based on molecular signatures in the MINDACT trial.

In TRANS-SUPREMO we will construct tissue microarrays from paraffin blocks from mastectomy specimens from all patients randomised in the study. Some, but not most, centres involved in SUPREMO (from Wales and Holland) are routinely collecting frozen material from tumours. However the delay of 1-2 weeks between mastectomy and obtaining informed consent will preclude collection and storage of fresh or frozen material in the majority of centres. We will also collect whole blood, serum and plasma at randomisation to look for pharmacogenetic and protein markers of relapse/outcome.

Even in a study as large as the proposed SUPREMO study, the relatively small number of informative specimens (i.e. those from patients with relapsed disease) means that only a small number of individual factors can be tested in proteomic studies. Accordingly, we plan a strategy where we will look at the pattern of expression of a profile of plausible biologically-linked factors from defined pathways suggested as potential predictors by the profiling data, and further factors identified from the literature available at the time the proteomics analysis is carried out, as likely to influence local relapse or radioresistance. No systematic review has yet been carried out in either area to identify potentially important predictive factors. However, as discussed above we would anticipate that proteins involved in signal transduction, cell adhesion and invasiveness, and apoptotic pathways, would be prognostic for relapse, and that radioresistance would also be affected by DNA repair and cell cycle control pathways. Given that approximately 300 5micron sections can be cut on every TMA block, we anticipate that up to 100 factors could be tested. Carbone and coworkers, using matrix-adsorbed laser desorption-ionisation time of flight (MALDI-TOF) mass spectroscopy were able to define two prognostic groups of patients with resected non-small cell lung cancer exhibiting a four-fold difference in median survival using 15 mass spectroscopy peaks (Yanagisawa et al., 2003), suggesting that such a hypothesis-driven strategy has a good chance of discovering such profiles of relapse and radioresistance in patients with early breast cancer.

Having identified molecular signatures of risk of relapse and radioresistance, we will investigate this further in the much larger group of women receiving conservation therapy, where identifying those who do not benefit from radiotherapy would have major health service resource implications.

## Aims

To identify molecular factors associated with increased risk of local relapse.

To identify molecular factors contributing to increased radioresistance.

## Methods

### (a) Molecular analysis by tissue microarrays

Tissue micro arrays (TMA) represent a significant step forward in our ability to perform translational research focusing on specific molecular pathways and developing multi-factorial models of prognosis, rather than simplistic screening for single candidate genes.

For each patient a representative tumour-containing fixed tissue block will be requested from the appropriate pathology laboratory. Given the amount of tissue required for these studies it is not foreseen that removal of tissue will compromise the future diagnostic evaluation of patient samples. In cases where the block sent is the only sample available from the patient, consultation with the consultant pathologist of record will be undertaken to ensure that sufficient material remains to allow future diagnostic procedures to be performed. In the rare event that there is concern that removal of cores may compromise future diagnostic testing on the patients' tumour the patient will be excluded from the pathological study. The tissue will be sent by post to the central reference (banking) laboratory. On receipt each tissue block will receive a unique study identification code. Tissue from individual tumours will be stored in tissue arrays and also as standard tissue sections before the blocks are returned if required to the referring pathologist.

Briefly, a section of tissue will be stained using haematoxylin & eosin (H&E) to identify areas of tumour. Three tumour areas will be selected and 6 x 0.6 mm<sup>2</sup> cores of tumour tissue will be removed in total from each block. Experience in the laboratory of the investigator who will hold this tissue bank (JB) has shown that MLSO are able to select these tumour areas with a high degree of accuracy without recourse to a pathologist for each section. These cores of tumour tissue will be transferred to multiple (6) recipient blocks (100-300 cores per block) to form tissue arrays. From each tissue array up to 300 5 µm sections will be taken for analysis of biomarkers. The entire SUPREMO biobank would be stored on between 36-72 TMA blocks.

### (b) Biological Analysis of tissues

The aim of the biological studies associated with the SUPREMO trial is twofold: to define a molecular signature of risk of relapse and radioresistance in patients with operable breast cancer, and to begin to characterise the underlying molecular events which relate to tumour relapse and patient response or failure to respond to the therapies applied in the trial. The "signature" is likely to include proteins and genes active in the key pathways involved in relapse and radioresistance, but these themselves may not be the factors directly responsible for the outcomes, but rather upstream or downstream activities modified as a consequence of the specific events leading to relapse or radioresistance. The signature will be useful both for identifying prognostic models for further studies and indicating avenues for further investigation aimed at modifying the risk of relapse or radioresistance. Currently, as discussed above, we would hypothesise that the risk of relapse is related to growth factors, signal transduction, cell cycle control and cell adhesion and invasiveness, while radiation response will partially overlap this, but also involve DNA (especially double-strand break) repair pathways and

resistance to apoptosis. However, the specific factors analysed will be driven by the results of the mRNA expression array analysis.

Tissue arrays and sections will be analysed using immunohistochemistry (IHC) and fluorescent in situ hybridisation (FISH), to determine protein expression and RNA expression/gene amplification/deletion respectively, using standard methodologies and commercially available reagents. The Recht meta-analysis showed that ER staining was associated with increased risk of loco-regional recurrence and therefore there would be an opportunity to test this hypothesis prospectively within the context of the current trial.

We will identify a panel of antibodies to test in triplicate on the TMA sections from the pathways described. Image analysis tools may be used to score the sections, which will involve 3000 sections on 15 slides for each replicate antibody use. For economies of scale, consistency of staining and reproducibility of scoring these investigations will be performed at the end of the trial when all the samples have been collected, but before the outcome data is available thus blinding the scoring from biases related to knowledge of the clinical course of each patient.

Informed consent to these investigations will be obtained at the beginning of the study when patients are randomised to radiotherapy or no radiotherapy. Since trial patients will not be identified until they have had their mastectomy and axillary clearance, obtaining consent at an earlier stage is not feasible.

Although our major interest is in local recurrence, this data set will be available for investigation of other phenomena such as risk of distant relapse, second primary malignancy etc. by other workers.

#### (c) Statistical power of tissue microarrays

Currently there is no model on which to base power calculations for hierarchical analyses of protein expression using tissue microarrays, nor are there previous series where large panels of antibodies have been used to establish prognostic signatures in this fashion. However, extrapolating from expression profiling studies (Dettling and Buhlmann, 2002) and mass spectroscopy studies (Yanagasiwa et al., 2003), where sample sizes required to produce highly significant results have typically been of the order of 60-80 patients, suggests that the number of events we anticipate (225 and 75 respectively in the no radiotherapy and radiotherapy cohorts) will provide sufficient power for this analysis.

A low stringency test of the univariate prognostic significance of each factor investigated by antibody staining will be carried out via CART classification tree modelling. All factors selected by this method will be subjected to analysis with a logistic discrimination model to identify those factors which together give the highest level of significance in discriminating between high and low risk of relapse.

#### (d) Other biological material

Plasma/serum and whole blood (for tumour and patient DNA) will be obtained from patients and stored for future studies of predictive biochemical markers.



(e) Quality assurance

A pathology steering committee including international representation has been established for the purposes of quality assurance.

(f) Trial management

The TRANS-SUPREMO sub-study will be supervised by a Trial Management Group comprising Allan Price, University of Edinburgh (Radiation Oncologist); John Bartlett, University of Glasgow (Biochemist); Geraldine Thomas, University of Swansea (Pathologist); Niall Anderson, University of Edinburgh (Statistician); Ian Kunkler, University of Edinburgh (Principal Investigator Main Study); Irene Devine (Principal Trial Coordinator) and Joanna Dunlop (Trial Coordinator), ISD Cancer Clinical Trials Team and appropriate international representation.

## 19. QUALITY OF LIFE SUBSTUDY (UK only)

### Background

Multimodal breast cancer therapy improves survival but also contributes to physical, sexual and psychological sequelae. These have been extensively documented for the first year of treatment and follow up. There are also late effects of treatment, such as the normal tissue effects of radiotherapy, the effect on body image of mastectomy and on sexual functioning from chemotherapy. Therefore it is essential to tease out the contribution of specific therapies on key aspects of quality of life.

The SUPREMO Quality of Life (QoL) study is designed to provide designated secondary endpoints to the trial. We will assess the subjective impact of mastectomy and chemotherapy, with or without additional radiotherapy to the chest wall over a ten-year period. Using a standardised approach it will be possible to compare the impact of the different treatment arms and to inform the balance between local tumour control rates and adverse treatment effects in terms of QoL.

The contribution of mastectomy and chemotherapy to QoL outcomes has been well documented (Ganz et al 1992, 1998; Hopwood 2002) but the additional effect of radiotherapy in mastectomy patients is unknown. Several studies help to inform on likely effects. On the one hand, Wallace et al (1993) found few effects of radiotherapy on QoL in a small study of conservatively treated patients. There was a significant increase in nausea, tiredness, sleep disturbance and skin irritation on completion of radiotherapy but with a minimal impact on daily lives. Anxiety and depression were not increased at 6 months but one in three women did not feel radiotherapy was worthwhile.

In a much more robust study, Berglund and colleagues (1991) assessed patients 2-10 years after treatment in a randomised comparison of adjuvant chemotherapy or postoperative radiotherapy. Differences between the treatments were generally small. Radiotherapy patients had significantly greater problems with decreased stamina, symptoms related to their scar and anxiety; chemotherapy patients had significantly more problems with smell aversion. Findings were against the hypothesis that chemotherapy would be associated with late consequences in the physical, mental and social domains compared to radiotherapy.

Stanton et al (2001) emphasised the need to assess functional aspects of QoL in relation to specific treatments for breast cancer. In a study of conservatively treated patients receiving radiotherapy, the authors found that treatment related functional status, and in particular breast pain, had an important predictive effect on QoL, overriding treatment related cosmesis.

Breast pain was also a predictor of depression, significantly so for women 5 years or more post diagnosis, and for physical health status. Arm oedema had a similar effect on QoL (Krishnan et al 2001). Therefore the effect of local treatment on functional status should be a primary QoL outcome in the SUPREMO trial.

Others (Ganz et al 1998) have found that mental health was comparable with general population samples when assessed several years post-treatment.

Recently the short-term effects of adjuvant chemotherapy have been assessed in 2062 women entering the START trials. Chemotherapy had a significant effect on global health, body image, sexual functioning and depression, when type of surgery, age and time since diagnosis were controlled for (Hopwood et al 2002).

It seems likely that the additional effects of radiotherapy in the SUPREMO trial will be small but may be significant for fatigue, physical functioning and chest wall pain and appearance. The expected outcome with respect to mental health is unclear, but data from the above studies suggest that, in general, rates of depression and anxiety rates are not significantly increased. Therefore, large samples would be needed to search for a small effect.

### Rationale for QoL measurement

The main priority guiding the QoL approach is to select measures that are standardised and scientifically robust so that the data obtained are valid and reliable. There is an important opportunity to use measures that have been selected for other national breast cancer trials that would allow comparison of results. This is increasingly important for the process of informed decision making for future patients, and to facilitate familiarity with QoL data for clinicians and nurses helping patients with these decisions.

The key effects of treatment and relapse on QoL are hypothesised to be on general symptoms such as fatigue, chest wall symptoms, appearance of the chest wall and psychological distress. Physical functioning, role and social functioning and specific adverse effects of treatment will also be recorded.

The QoL domains of importance will therefore include the following:

- \* a core quality of life measure to detect general effects of treatments on QoL
- \* a breast cancer module to reflect specific symptoms and effects relating to the effects of treatment
- \* a body image scale to assess the impact of treatment on appearance and attractiveness following surgery, chemotherapy and radiotherapy
- \* a measure of anxiety and depression that indicates clinical levels of distress

Therefore a preference for measures used in the ABC and START Trials emerged. There is sound knowledge of their performance and of analysis methods and interpretation of outcome data. Detailed manuals support the EORTC scales. Scoring procedures and reference data are available for the BIS and threshold scores for the HADS are widely available. Patients in the START trials with excellent compliance rates have supported this combination of scales. They do not appear to be burdensome to patients, providing care is taken to avoid those who are seriously ill.

## Measures

1. Quality of life: the EORTC core quality of life instrument EORTCQLQ-C30 (Aronson et al, 1993). This is a 30 item cancer questionnaire comprising five functional scales (physical, role, cognitive, emotional and social), global quality of life, three symptom scales (fatigue, pain, nausea and vomiting) and a number of single items.

2. Breast cancer specific module EORTC BR-23. This is a 23 item questionnaire designed to be used together with EORTC QLQ-C30. It comprises scales related to chemotherapy specific side effects, shoulder-arm problems, body image, sexuality and future perspective (Sprangers et al, 1997).

3. Body image: The Body Image Scale - BIS (Hopwood et al 2001)

This is a 10-item scale designed specifically for use with cancer patients to assess aspects of attractiveness, sexual attractiveness and feelings or satisfaction with appearance. (4 items are included in the BR23 and will not be duplicated).

The BIS has very good psychometric properties and has been used in the ABC and START trials, as well as European breast cancer trials. A threshold score for a morbid level of body image concerns has not been derived but there is extensive reference data for subgroups of patients receiving mastectomy or conservative surgery, with or without chemotherapy or tamoxifen (Hopwood et al 2001, Hopwood et al 2002).

4. Psychological Distress: The Hospital Anxiety and Depression Scale – HADS (Zigmond & Snaith 1983)

The HADS is a 14-item scale (7 items for depression and 7 items for anxiety) designed to measure affective disorder in cancer patients. Threshold scores have been derived that enables the prevalence of clinical levels of anxiety or depression to be estimated. A comparison of instruments showed the HADS to be superior in measuring anxiety and depression when compared with a psychiatric interview (Ibbotson et al 1994) and it is the most widely used self-report measure of psychological distress used with cancer patients.

5. An open-ended question, inviting comments from patients will be added at the end of the questionnaire booklet.

## Endpoints

Primary QoL endpoints will be:

1. Fatigue (QLQ-C30)
2. Physical functioning subscale (EORTC QLQ-C30)
3. Chest wall, shoulder and arm symptoms (EORTC BR23)
4. Body image (BIS)
5. Anxiety and depression (HADS)

Descriptive data will be obtained for the following domains from the EORTC:

- Role functioning
- Social functioning
- Sexual functioning
- Pain, nausea and vomiting

It is hypothesised that the experimental arm will result in an increase in symptoms/decrease in function in the primary outcome domains (either singly or in combination) compared with the control arm. This will need to be considered against the benefit, if seen, in local disease control.

### Breast Reconstruction

Breast reconstruction is not a specific QoL outcome parameter but we need to be able to provide descriptive data for these patients. Therefore date and type of reconstruction (immediate or delayed), autologous tissue graft (TRAM or LD Flap) or implant reconstruction will be annotated in the clinical forms. The most important QoL aspect of reconstruction is body image: this will be adequately captured by the body image scale and data are available for comparison from other published work using the same scale (AL-Ghazal SK et al (2000). Minimal additional QoL parameters for this group will be HADS anxiety and depression and the EORTC breast cancer module (BR23).

### Plan of study

There will be a detailed multicentre study of the patients' quality of life after chemotherapy and after additional radiotherapy in the experimental arm. A subset of centres will take part in the QoL study and, in these centres QoL assessments will form an integral part of the trial for all consenting patients. Centres will choose whether or not to opt in to the QoL protocol but the geographic (and socio-economic) distribution of participating centres will be monitored to ensure that they are representative of the trial as a whole.

Selected hospitals will be asked to participate if an imbalance occurs. This method has been used successfully in the START Trial and no intervention by the Trials office was required.

The assessments will take the form of serial patient self-report questionnaires, using validated measures that have been used successfully in the ABC and START Trials. Baseline QoL compliance in the START Trial, involving over 2000 patients, was 98.5% and has remained high at 6 months follow up.

### Eligibility:

All patients from selected centres who:

- \* are entered into the SUPREMO Trial
- \* consent to take part in the QoL study

- \* are willing and able to complete the questionnaires

#### Sample size and statistical considerations

Although guidelines have been suggested for the size of score changes that represent clinically significant differences in QoL scores for EORTC QLQ-C30 (Osoba et al, 1998; King, 1996), these vary for the subscales and further research is ongoing. For this trial, sample size was considered as an estimation problem rather than a problem of testing of significance.

With 200 evaluable patients per group the proportion of patients exhibiting a particular side effect or specified degree of morbidity on a QoL domain will be estimated with a standard error of 3.5% or less. The corresponding difference between the groups will be estimated with a standard error of 5% or less. The standard error of the difference in the means for any continuous variable will be 0.1 standard deviations. In order that QoL may be monitored to this level of precision for five years after randomisation, the target for entry will be double the nominal figure (800 patients in total), which allows for attrition due to death or withdrawal of cooperation at a rate of 13% per year.

All reasonable efforts will be made to ensure full and correct completion of the self-report questionnaires. The QoL booklet will contain standardised instructions for completion. When individual items are missing, the following procedures, which have been used in other studies, will be adopted:

- \* where the item missing is a single QoL item it will be recorded as missing
- \* where the missing item forms part of a brief scale or subscale, a pro-rata procedure will be used depending on the total number of items in the subscale:

There are known age effects for psychological distress, body image, breast symptoms, sexual and physical functioning and these will be controlled for in the analysis.

#### Timing of assessments

##### Baseline:

After obtaining informed consent, the first assessment for all patients will be completed in the clinic prior to randomisation with explanation of the questionnaires by a member of staff.

##### Follow-up:

All follow-up questionnaires will be mailed from the Trials office, by the QoL study co-ordinator, to minimise staff burden and allow patients to complete the forms in their own time, away from the treatment setting. Subsequent follow up for QoL assessment will be at, 1, 2, 5 and 10 years from randomisation as in the protocol.

Close links will be kept with the Breast team and patients' general practitioners to check that the patient is alive and fit to participate, prior to future mailings. This is important given the emphasis on long-term follow-up.

## Patients experiencing a relapse

Patients who have experienced a relapse will be asked to continue to complete questionnaires, although it is appreciated that some will not do so. At each due assessment point patients will be asked to complete a quality of life assessment unless they do not wish to continue in the QoL protocol.

## Statistical aspects

The principal statistical method used will be a repeated measures of analysis of covariance as this makes allowance for observations that are missing and through providing overall tests of treatment by time interaction and the main treatment effect, avoids some of the problems arising from multiple testing.

## Trial management

Staff: Quality of Life Study Co-ordinators: This part of the trial will run under the guidance of Dr Galina Velikova. The staff running the QoL study will be based in the trials office managing the trial, to ensure that close links are maintained with the main trial database and correct, up-to-date patient information is available to the QoL study for follow-up purposes. One full time co-ordinator and one part-time co-ordinator will be required.

In the hospitals: It is intended that each participating hospital will identify a person responsible for the conduct of the QoL trial. This person will explain the study to the patient and ensure that the patient knows how to complete the QoL questionnaire booklet, will check that it is completed correctly and that it is forwarded to the trials office.

## Informed consent and ethical issues

Ethical approval for the QoL substudy will be obtained at the same time as submitting the main trial protocol. The local investigator is responsible for obtaining each patient's signed informed consent prior to the administration of the baseline questionnaire.

Patients with clinically significant scores on the HAD scale (combined score above 19) on two consecutive occasions within 6 months (or one occasion beyond this interval) should be further assessed clinically. This will be explained in the Patient Information Sheet. Patients will be asked to consent to information about the HADS score being passed on to their doctor and also to the oncology centre of randomisation.

## 20. CARDIAC SUBSTUDY (UK only)

Recent studies of radiation toxicity in the treatment of breast cancer show that the effects on normal tissues can constitute a significant clinical problem and particularly increased cardiac mortality may offset any potential survival benefit (Cuzick et al 1994; Host et al 1986; Rutqvist & Johansson 1990; Rutqvist et al 1992; Trott 1991; Gagliardi et al 1996; Haybittle et al 1989). There are no data on lesser degrees of late cardiac damage, but it seems likely that non-fatal ischaemic heart disease must also be induced. An excess of cardiac deaths starts to manifest itself at about 7 years post radiotherapy and increase year on year thereafter (Rutqvist et al 1992). Thus, reported values are dependent on length of follow up.

The maximum heart distance is the distance from the posterior field border of the tangential fields to the most anterior border of the heart on the simulator film and correlates well with the volume of myocardium included in the target volume (Canney, unpublished data).

Hurkmans et al (2000) used the relative seriality model to calculate the Normal Tissue Complication Probability (NTCP) for heart damage for increasing values of the maximal heart distance. If this parameter is less than 1.5cm the NTCP for cardiac toxicity was calculated to be < 1%. The dose used for this calculation was 50 Gy in 25 fractions. It is important to note that the value of 1.5cm may not apply for different doses, fraction sizes or patients receiving cardiotoxic systemic therapy.

There has been no prospective assessment of potential cardiac morbidity in patients having cardiotoxic treatments as adjuvant therapy for breast cancer. In particular combinations of cardiotoxic agents may introduce additional risks of late morbidity or mortality.

### B type natriuretic peptide

B type Natriuretic Peptide (BNP) is synthesized in the myocardium and increased levels are found in serum in patients with left ventricular dysfunction. B type natriuretic peptide (BNP) has a high negative predictive value for the diagnosis of left ventricular systolic dysfunction (McDonagh et al, 1998).

The power to predict normal cardiac function by a low plasma value is further enhanced when combined with the standard 12 lead electrocardiogram (Vrtovec et al, 2003). These clinical investigations merit assessment in the setting of breast cancer therapy.

To prospectively assess cardiac toxicity patients will be divided into the following groups:

1. Anthracycline-containing adjuvant combination chemotherapy + left sided radiotherapy
2. Anthracycline-containing combination chemotherapy + right sided radiotherapy
3. Non-anthracycline-containing combination chemotherapy/ other adjuvant systemic therapy + left sided radiotherapy
4. Non-anthracycline-containing combination chemotherapy/ other adjuvant systemic therapy + right sided radiotherapy



5. Anthracycline-containing chemotherapy and no radiotherapy
6. Non-anthracycline combination chemotherapy/other systemic therapy and no radiotherapy

Primary aim: to assess the role of B type natriuretic peptide in identifying left ventricular dysfunction (LVD) in patients undergoing adjuvant radiotherapy and/or chemotherapy. A subsidiary aim is to store blood for evaluation of potential future markers of cardiac function.

Schedule of investigations: ECG and blood for B type Natriuretic Peptide to be obtained: 1. Before radiotherapy or chemotherapy started. 2. Within 3 weeks of completing chemotherapy (if given) and before any radiotherapy starts 3. On completion of radiotherapy, or at 6 months post surgery in patients who do not undergo radiotherapy or chemotherapy. 4. At 1, 5 and 10 years after surgery or at relapse of breast cancer.

Plan of investigation: Consenting patients will have a baseline history (including personal and family history or personal history of cardiac disease cardiac symptomatology), clinical examination, serum cholesterol, electrocardiogram and assessment of left ventricular function by echocardiography (or radio-isotope ventriculography where this is routinely used). For patients in centres where isotope ventriculography is the standard investigation for patients undergoing anthracycline containing chemotherapy, an echocardiogram will also be carried out at baseline. Echocardiography and not isotope ventriculography will be the follow up investigation at all subsequent time points. Baseline and follow up clinical data at the same time points as the schedule of investigations (see above) will be recorded on a standard proforma kept in the patients notes. The proforma based on the cardiovascular data fields –body mass index, history of hypertension, alcohol history, smoking history, diabetes, family history of cardiac disease, peripheral vascular disease, exercise history, cholesterol profile. A copy will be sent to the trial office. Data collection for the various time points of the cardiac substudy including blood pressure, cardiac symptoms of chest pain, breathlessness, ankle swelling and palpitations will be collected by a research nurse in each UK centre.

All ECGs will be reported by the local department and a copy of the report sent to the trial office. Plasma BNP, ECG and clinical assessment will be done at each follow up visit. Blood from patients will be collected in chilled EDTA tubes and plasma/serum separated by local biochemistry labs before storing at -70°C. A whole blood sample will be sent immediately to a central laboratory for analysis of BNP levels. Centres will be notified of abnormal results in writing with a copy sent to the trial office.

If there is any significant rise in serum BNP during the study period, the patient will be recalled for clinical and cardiac assessment by the investigator and referred, if necessary, to a cardiologist. The local investigator will request echocardiography in the participating centre to assess cardiac function. It is recommended that patients with new and increasing cardiac symptomatology, abnormal ECG and/ or a raised serum BNP levels are referred to a cardiologist for assessment and appropriate treatment. Advice on the management of individual patients will be available from the Chief Investigator (Dr. Peter Canney) and the trial cardiologists (Dr. Martin Denvir, Dr. Theresa McDonagh and Dr. David Northridge). In order to assess whether BNP has a similar

threshold for detecting LVD in this clinical setting to that observed in other studies, the first 100 patients enrolled in designated centres taking part in the cardiac study will undergo echocardiography and ECG at each time point thereafter. Patients enrolled into the cardiac substudy after this will not be required to undergo these serial echocardiograms. It is recognized that radio-isotope ventriculography would be the most reproducible method to assess changes in left ventricular systolic function but lack of availability in all centres and expense preclude this.

In patients randomized to chest wall irradiation, the maximum heart distance at simulation will be measured on beam's eye view.

Statistical considerations: Assuming a 0.5% per annum rate of heart failure in non-exposed patients, if anthracycline containing regimes increase this to 1.5% p.a., and 70% of patients receive such treatment, then with 1000 patients recruited and 25% attrition, there will be 90% power to obtain a statistically significant result at the 5% level at 5 years.

## 21. HEALTH ECONOMIC SUBSTUDY (UK only)

**Aim:** the economic study will assess the cost effectiveness of adjuvant irradiation.

While the initial treatment costs for those receiving chest wall irradiation will be higher, if the irradiation is successful the better outcomes for patients might be expected to be associated with lower future resource use. Irradiation might use sufficiently few additional resources that when combined with the savings in future treatment costs that it is cost-reducing. However, it is more likely that the net effect of irradiation will be to increase costs overall. Thus it is anticipated that the focus of the economic evaluation will be on the incremental cost per quality-adjusted life-year (QALY) from irradiation.

**Eligibility:** all patients entered into the trial from the UK

**Sample size:** Since it is difficult to estimate the underlying distribution of costs to calculate an appropriate sample size, it is proposed to cost the treatment received by all UK trial participants and the future costs of those in either arm of the trial with suspected or actual recurrence or morbidity. The estimation of QALYs will be based on data gathered from the sub-sample taking part in the Quality of Life study.

### Effectiveness

In the event that health outcomes are generally better with irradiation, the key economic question is what is the cost of achieving these improved outcomes (and how does this compare with other potential uses of these resources). Cost-effectiveness will be assessed by calculating the incremental cost per life year gained and the incremental cost per additional quality-adjusted life-year (QALY). The EQ5D (EuroQol, <http://www.euroqol.org/>) will be used in order to quality-adjust survival (Brooks, 1996). This measure is widely used in economic evaluation and is readily collected using a self-completed questionnaire. It comprises five simple questions (mobility, self care, ability to undertake usual activities, pain/discomfort, and anxiety/depression) each with only three possible responses. The EQ5D will be given to patients in the quality of life study along with the other quality of life questionnaires, that is, at baseline and follow-up at one, two, five and ten years post-randomisation. QALYs will be estimated using an established set of EQ5D values (Dolan, 1997).

### Resource use

An NHS perspective is adopted for the estimation of costs. The economic evaluation requires the following patient-level information: details of chest wall irradiation for patients in the irradiation arm; and subsequent breast cancer related use of health care resources by patients in both arms

Unit cost data is required for irradiation and subsequent resource use. Differences in future resource use will arise primarily if there are differences in recurrence rates. With respect to subsequent resource use it is differences in resource use which matter, rather than the total cost. Thus it will only be necessary to collect unit cost data for those elements of health care that differ

between the two arms. Detailed costing will be undertaken initially in two or three centres in order to develop a protocol to be applied in all centres. Towards the end of the study detailed patient-level information on the use of health care resources will be combined with the centre-specific unit costs.

#### Analysis

A particular feature of this trial is the large number of centres. Multilevel modelling will be used to take account of the clustering of cost data by centre (Manca et al, in press).

Patient-specific information on quality of life and survival will then be used to estimate the difference between arms in terms of QALYs and this will be related to the cost data in order to estimate the incremental cost per additional QALY.

For the purposes of cost-effectiveness analysis the appropriate time horizon is the lifetime of the patients. Thus the data collected during the five year follow-up of patients will be used to extrapolate the QALY difference between the arms.

Finally the sensitivity of the results to key parameters will be assessed (Briggs et al, 2002), and cost-effectiveness acceptability curves will be plotted to demonstrate the likelihood that a particular intervention is cost-effective for a range of monetary valuations of additional QALYs (Fenwick et al, 2004).

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## Appendix I

### Patient information sheet (main trial and TRANS-SUPREMO)

#### Invitation to participate in the SUPREMO trial

#### Patient Information Sheet

We would like to invite you to take part in the SUPREMO breast cancer trial (Selective Use of Postoperative Radiotherapy aftEr MastectOmy). The SUPREMO trial aims to establish the benefits of postoperative radiotherapy to the chest wall in patients such as yourself who are at intermediate risk of recurrence. To help you decide if you would like to take part, please read this information sheet. It gives you details of what will be involved if you decide to take part in the trial, and also who to contact if you would like to discuss any aspect of the trial.

You have recently been diagnosed with early breast cancer that has been completely removed by surgery. Anti-cancer drugs in the form of chemotherapy or hormonal therapy (or a combination of both) will also be given as part of your treatment. Another therapy that is currently offered to some patients with your type of cancer is radiotherapy to treat the site of your recent operation to remove your breast (mastectomy). The aim of radiotherapy is to reduce the risk of local recurrence of breast cancer. In addition, when given in conjunction with anti-cancer drug treatment, it may also improve long-term survival. Postoperative radiotherapy is routinely given to patients at higher risk of recurrence than you (for example when 4 or more lymph nodes are involved or the tumour is large). In patients (such as yourself) where there are less than four lymph nodes under the armpit involved by cancer or there are no lymph nodes involved but there are other features of the cancer which increase the risk of the cancer recurring, it is not clear whether postoperative radiotherapy is needed. The SUPREMO trial aims to establish the benefits of postoperative radiotherapy to the chest wall in patients such as yourself who are at intermediate risk of recurrence. Half of the patients in the trial will receive radiotherapy and half will not receive radiotherapy to the chest wall. In every other aspect the treatments will be the same.

Like many treatments, radiotherapy has side effects, both short-term and long-term. Most patients develop redness of the skin in the treated area. This normally heals within a month of completion of radiotherapy. It can rarely (1% of patients) cause an inflammation of the lung which can cause shortness of breath over the first month or two and occasionally long-term. Rib fractures may occur in the longer term (1-2% of patients). It should be emphasised that these serious complications are rare. The trial will look at possible risks of radiotherapy over the ten year follow-up period.

We would like to ask you to take part in our study to help us decide whether radiotherapy is helpful for women with your particular type of cancer. Your

specialist has indicated that she or he thinks that you are suitable to take part in the SUPREMO study.

What will I have to do if I take part?

The trial will involve 3700 women. If you agree to take part you will be asked to give your written consent to participation. To determine whether or not you will receive radiotherapy, your specialist will telephone the central office in Edinburgh that runs the SUPREMO trial.

The study office will check some details about you, your disease and the treatment you have been prescribed and will use a computer to allocate your treatment. You will have the same chance of receiving radiotherapy as not receiving it. Your specialist will be told whether you have been allocated a course of radiotherapy. You will also be seen twice in the first year after surgery in hospital clinics for a routine examination. You will subsequently be reviewed annually by a doctor, for 10 years or more, who will assess your medical condition. You will be asked particular questions in relation to the treatment that you have received. A breast X-ray (mammogram) of your other breast is recommended at least every two years for 10 years following your surgery. During the trial you will be asked to keep a record of all health and social services that you receive.

If you decide not to take part in the study you will receive the usual high standard treatment that is currently employed for patients with early breast cancer. You may be offered radiotherapy and you will be followed up at the surgical outpatient clinics in the usual way.

What does radiotherapy involve?

Radiotherapy to the chest wall (the site of your mastectomy) is normally carried out over a period of 3-5 weeks, normally as an outpatient. Radiotherapy involves the treatment of your chest wall with beams of Xrays. The detail of your radiotherapy planning and treatment will be discussed with you by a clinical/ radiation oncologist. For the planning of radiotherapy you will be asked to lie on a couch. A series of measurements will be taken from your chest wall area by a team of radiographers. A CT scan may form part of this planning process. Planning takes about 20-40 minutes to complete. When you are treated you will again be asked to lie on the couch so that the team of radiographers will be able to set you up in the same position as you were in at your planning session. A small dose of radiotherapy will be delivered to your chest wall from the treatment machine. Your specialist may in addition recommend radiotherapy on the same side to a part of the glandular area above your collarbone (known as the medial supraclavicular fossa) or to the glandular area beneath your breast bone (known as the internal mammary chain). The radiotherapy is normally given to the chest wall in a small dose each day. Treatments are normally given for about 10-15 minutes per day on weekdays. No treatment is given over the weekends.

Radiation to the chest wall is not a contra-indication for a possible breast reconstruction. The surgeon shall of course take into consideration the fact that tissue in the area for the breast reconstruction has been irradiated when advising which reconstruction technique should be used. Furthermore, if a breast reconstruction has already been performed at the time of the mastectomy operation (immediate reconstruction) then this is not a contra-



indication for chest wall irradiation. Radiotherapy after breast reconstruction (where an implant has been used) may, in the long-term, cause the implant to harden and change shape as a result of the formation of scar tissue following the radiotherapy. This can be treated by removing the scar tissue and changing the implant at a later date.

What are the possible risks of taking part?

Like all treatments there may be side effects with radiotherapy. Radiotherapy may cause skin reactions leading to chest wall tenderness and itching. These develop in the latter part of the course of radiotherapy and usually settle within one month of the treatment finishing. Chest wall pain, which is usually mild and intermittent, can occur. Rarely, radiotherapy may cause inflammation of the lung causing shortness of breath or it may cause the ribs to fracture. Studies have shown that 10-30 years after radiation treatment there can be an increased chance of heart problems. For this reason the position of the heart in relation to the radiation fields is nowadays very carefully determined at the time of the treatment planning so that no, or as little as possible of heart tissue lies in the radiation fields. If you undergo breast reconstruction it is possible that radiotherapy to the chest wall may in the long-term cause some shrinkage of the breast.

The possible risk of not being given radiotherapy is that there may be a slightly higher chance of breast cancer returning compared to women who have received radiotherapy. However in women with 1-3 affected lymph nodes or non-involved lymph nodes but other risk factors for local recurrence and the type of surgery that you have had, the chances of the disease recurring at the site of your operation are small. If the disease did recur at the site of your mastectomy, a course of radiotherapy to your chest wall would be considered.

Are there any benefits to taking part?

Whether or not you decide to take part in the study you will receive the highest standards of care. You will have increased contact with specialist nurses. The information that we get from the study will help us gain knowledge about the best way of treating breast cancer. It will help us to measure the advantages of radiotherapy in women with the type of breast cancer that you have.

#### TRANS-SUPREMO

If you agree to be entered into the SUPREMO trial we would like to do some further research on your breast cancer tissue. With your permission we would like to send a part of your breast cancer to a central laboratory where we can analyse the tissue for some special molecular features. We would also like to retain a tiny piece of your breast cancer tissue and use this in the future for research to help understand more about breast cancer and radiotherapy treatments. After removing this sample we will return the rest of the cancer tissue to your hospital. Tissue would be stored in a way such that

it would not be identifiable and no one would be informed about specific findings relating to you.

We do not at present know all the molecular markers or genes we will be looking at but the tissue we collect could be analysed for the presence of many different proteins and genes inside the breast cancer cells. We will be looking at proteins or genes that we think might help improve our ability to treat breast cancer and in particular to help predict if some cancers are best treated with radiotherapy, whilst others are not. Because the samples are not identifiable results of this research will have no influence on your treatment but doctors taking part in the study will be informed of the general findings of this research. If you do not want your tissue used in this way please tell us. You can still take part in the main trial.

We would also like to do further research on your blood, including your genetic information (DNA). Recently we have become aware that some people have genes or proteins in their blood which mean they respond better to different forms of cancer therapy or which can identify if their cancer is more likely to recur. We need to do further research to identify those genes or proteins which might be important in this study. With your permission we would like to send a sample of your blood to a central laboratory where we can analyse it for genes (using your DNA) or proteins. Your tissue and DNA would be stored in a way such that it would not be identifiable and no one would be informed about specific findings relating to you.

We do not yet know precisely all the molecular markers or genes we will be looking at but, as with your cancer, we will be looking at proteins or genes that we think might help improve our ability to treat breast cancer and in particular to help predict if some cancers are best treated with radiotherapy, whilst others are not. Because the samples are not identifiable, results of this research will have no influence on your treatment, nor will anyone be able to access them, but doctors taking part in the study will be informed of the general findings of this research. If you do not want your blood or DNA used in this way please tell us. You can still take part in the main trial.

It is possible that other scientists or doctors may want to use this material to improve diagnosis and treatment of cancer, but their request will have to be considered and approved by an ethics committee before they are allowed to do so.

Tumour and other material collected during this study will not be sold to third parties or used for commercial gain. Intellectual property rights (knowledge gained from the trial) that may arise as a result of findings from this research could be exploited commercially. The rights to any intellectual property will reside with the investigators.

Do I have to take part?

No, taking part is voluntary. If you would prefer not to take part you do not have to give a reason. Your doctor would not be upset and your treatment would not be affected. If you take part but later change your mind you can withdraw from the study at any time without giving a reason and without

hindrance or detriment to your future treatment. We will give you a copy of your consent form to keep.

### Confidentiality

All the study data will be confidential to the research team. You will not be identified in any published study results. All study data will be handled under the auspices of the MRC- Trial Management Group and treated confidentially in compliance with the Data Protection Act (1998).

### What do I do now?

You will be contacted by a member of the research staff in a day or so. Please let him/her know if you are interested in taking part.

We would want to inform your General Practitioner that you are taking part and, with your permission, we will send him/her a copy of your consent form.

Thank you very much for considering taking part in our research. Please discuss this information with your family, friends or GP if you wish.

Dr Ian Kunkler Chief Investigator, SUPREMO trial

Local contact name(s) and phone number(s):

If you would like to speak to a doctor who is independent of the trial, please  
Contact: \_\_\_\_\_

## Appendix II Informed consent form (main trial and TRANS-SUPREMO)

SUPREMO breast cancer trial

Selective Use of Postoperative Radiotherapy after Mastectomy

# Informed Consent Form

Patient identification number for this trial:.....

Name of patient: .....

Name of clinician .....

Hospital: .....

Please initial boxes

1. I have read and understood the patient information sheet provided and have had sufficient time to decide whether to take part in both the clinical trial and research study (TRANS-SUPREMO). I have had the opportunity to ask questions and consider the answers given.
2. I understand that participation in the trial is voluntary and that I may withdraw from the trial at any time of my own accord and without giving any reason and without my medical care or legal rights being affected.
3. I understand that sections of any of my medical notes may be looked at by research staff from the Information Services Division (ISD) Cancer Clinical Trials Team, and other collaborating UK Clinical trials units for the purpose of data monitoring, where it is relevant to my taking part in research. I give permission for these individuals to have access to my records.
4. I understand that data will be passed to the ISD Cancer Clinical Trials Team and that this information will include my name, date of birth, hospital number and NHS number (or Community Health Index number) from which it is possible to identify me as an individual.
5. I agree that my General Practitioner will be informed of my participation in this study and will be advised of any clinically significant information that comes to light.

☐☐☐☐☐

I confirm that I have explained the nature of this trial and the research study (TRANS-SUPREMO) to the above named patient and that she has understood the explanation given to her.

Clinician's signature: ..... Date: .....

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I hereby freely give my consent to take part in the SUPREMO trial

Patient's signature: ..... Date: .....

---

I hereby freely give my consent to take part in the TRANS-SUPREMO study and I donate:

tumour tissue	<input type="checkbox"/>	
serum/plasma	<input type="checkbox"/>	(Please initial boxes)
and DNA	<input type="checkbox"/>	

for these studies. (We will only be able to collect material if you initial these boxes.)

Patient's signature: ..... Date: .....

(A separate signature for TRANS-SUPREMO is required for legal reasons).

---

Signature on this form does not affect your legal rights, you may take part in the main trial and decline to take part in the TRANS-SUPREMO research study.

Copies: 1 for patient, 1 for researcher, 1 for trials office, 1 to be kept with hospital notes

## Appendix III

### Patient information sheet (Quality of Life substudy)

#### Invitation to participate in the SUPREMO trial Quality of Life study

#### Patient Information Sheet

We would like to invite you to take part in the SUPREMO (Selective Use of Postoperative Radiotherapy after Mastectomy) Quality of Life substudy. To help you decide if you would like to take part, please read this information sheet. It gives you details of what will be involved if you decide to take part in the trial, and also who to contact if you would like to discuss any aspect of the trial.

As part of the SUPREMO trial we are asking women to fill in questionnaires so that we can learn about the effects of treatment in more detail. Your specialist has indicated that s/he thinks that you are suitable to take part in the SUPREMO Quality of Life study.

What will I have to do if I take part?

If you agree, you will be asked to complete a questionnaire before starting your treatment and again one year, two years, five years and ten years later. The questionnaires will be explained to you on the first occasion by a member of staff who will answer any questions you have about how to fill it in.

The questionnaires have been carefully developed with the help of doctors, nurses and women like yourself. They contain questions about a range of physical symptoms and activities, your emotional wellbeing and other aspects of your everyday life. We also want to know how you feel about your appearance after treatment to the chest wall and any side effects you experience. There are no 'right' or 'wrong' answers – we simply want to find out about the experience of treatment for women in this trial. Each questionnaire will take about 30 minutes to complete.

In addition, as part of the assessment of the cost effectiveness of radiotherapy in the trial we would like you to complete, at the same time as the quality of life assessments, a short questionnaire known as EQ5D. This has 5 questions on mobility, self care, ability to undertake usual activity, pain/discomfort and mood. The questionnaire takes only a few minutes to complete. This additional information will allow us to take account of the quality of life of patients in the overall economic evaluation of radiotherapy after a mastectomy.

Are there any benefits to taking part?

The opportunity for interaction with a trials/research nurse can be considered a benefit.

Do I have to take part?

No, taking part is voluntary. If you would prefer not to take part you do not have to give a reason. Your doctor would not be upset and your treatment would not be affected in any way. If you take part, but later change your mind, you can withdraw from the study at any time without giving any reason and without hindrance or detriment to your future treatment. We will give you a copy of your consent form to keep.

### Confidentiality

All the study data will be confidential to the research team. You will not be identified in any published study results. All study data will be handled under the auspices of the MRC- Trial Management Group and treated confidentially in compliance with the Data Protection Act (1998).

What do I do now?

You will be contacted by a member of the research staff in a day or so. Please let him/her know if you are interested in taking part.

We would want to inform your General Practitioner that you are taking part in this study. With your permission we will send him/her a copy of your consent form. If the scores on The Hospital Anxiety and Depression (HAD) scale suggest that you are distressed then we will inform your GP.

Thank you very much for considering taking part in our research. Please discuss this information with your family, friends or GP if you wish.

Dr Ian Kunkler

Chief investigator, SUPREMO trial

Local contact name(s) and phone number(s):

If you would like to speak to a doctor who is independent of the trial, please contact: \_\_\_\_\_

# Appendix IV Informed consent form (Quality of Life substudy)

SUPREMO breast cancer trial  
Selective Use of Postoperative Radiotherapy after Mastectomy

## Quality of Life study Informed Consent Form

Patient identification number for this trial:.....

Name of patient: .....

Name of clinician .....

Hospital: .....

Please initial boxes

1. I have read and understood the Quality of Life patient information sheet provided and have had sufficient time to decide whether to take part in the study. I have had the opportunity to ask questions and consider the answers given.
2. I understand that participation in the study is voluntary and that I may withdraw at any time of my own accord and without giving any reason and without my medical care or legal rights being affected.
3. I agree that my General Practitioner will be informed of my participation in this study and will be advised of any clinically significant information that comes to light.
4. I agree to researchers from the Information Services Division (ISD) Cancer Clinical Trials Team telephoning my GP to confirm I am fit and well to receive questionnaire booklets to be sent out by post. I understand that my full name and address will be collected for this purpose only.

☐☐☐☐

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I confirm that I have explained the nature of this study to the above named patient and that she has understood the explanation given to her.

Clinician's signature: ..... Date: .....

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I hereby freely give my consent to take part in the SUPREMO quality of life study.

Patient's signature: ..... Date: .....

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(Signature on this form does not affect your legal rights. You may take part in the main trial and decline to take part in the Quality of Life substudy.)

Copies: 1 for patient, 1 for researcher, 1 for trials office, 1 to be kept with hospital notes

## Appendix V

### Patient information sheet (Cardiac substudy)

#### Invitation to participate in the SUPREMO trial Cardiac sub-study

#### Patient Information Sheet

We would like to invite you to take part in the SUPREMO breast cancer trial (Selective Use of Postoperative Radiotherapy aftEr MastectOmy) cardiac sub-study. To help you decide if you would like to take part, please read this information sheet. It gives you details of what will be involved if you decide to take part in the cardiac substudy, and also who to contact if you would like to discuss any aspect of the substudy.

#### Introduction

Like many treatments radiotherapy and chemotherapy have side effects, both short term and long term. One of the long-term side effects of radiotherapy for breast cancer and of certain forms of chemotherapy (known as anthracyclines) is damage to the heart. It should be emphasised that this complication is rare. The total doses of anthracyclines are limited to reduce the risk of cardiac damage. Where possible the dose to the heart from radiotherapy is also limited. However, we have relatively little information on the frequency of cardiac damage in patients receiving either radiotherapy or anthracycline chemotherapy alone, or together. The SUPREMO cardiac substudy will help us to collect this information.

Conventionally, damage to the heart is detected by measuring the electrical activity of the heart. This is known as an electrocardiogram (or ECG). An ECG is a non-invasive painless test. It involves placing small adherent pads temporarily to your chest and recording the electrical activity of your heart. It takes only a few minutes.

The pumping action of the heart can also be assessed by passing sound waves through the heart. This is known as echocardiography. More recently B type natriuretic peptide (BNP), a chemical substance produced by the heart when it is damaged, has been used to assess the health of the heart. BNP can be measured on a simple blood test. In this research study we will be assessing the value of BNP and other blood markers in detecting any damage to the heart at the earliest possible stage.

Recently we have become aware that some people have particular proteins in their blood which mean they respond better to different forms of cancer therapy or which can identify if their cancer is more likely to recur. We need to do further research to identify those proteins. It may also be possible to use a sample of your blood, at a later date, to identify markers that could provide an early warning if the cancer is recurring. At the time we take a blood sample for measuring BNP we would like to take extra blood (about 2 tablespoonfuls) to study these proteins. If you do not want your blood used in this way please tell us. You can still take part in the cardiac sub study.

What will I have to do if I take part?

If you agree to take part in this study, you will be asked about any cardiac symptoms (such as chest pain), family history of heart disease, risk factors for heart disease (such as smoking, high blood pressure, high cholesterol) and your height, weight, pulse rate and blood pressure will be recorded. You will be asked to have a blood test for cholesterol, BNP (and other markers if appropriate). You will also have an Echocardiogram and ECG on entry to the study. These tests (with the exception of the echocardiogram) will be repeated at 5 subsequent clinic visits, which will be: 1) within 3 weeks of completing chemotherapy (if given) but before radiotherapy (if given) starts, 2) on completion of radiotherapy, and at one, five and 10 years after surgery or for those patients who experience recurrence of their cancer, at the time of this recurrence. At each of these visits we would collect no more than 2-3 tablespoons of blood. You will be informed if your centre is taking part in a sub-section of the cardiac sub-study in which repeat echocardiograms are required at 5 subsequent clinic visits.

If the level of BNP rises significantly, we will notify your oncologist, and recommend to him/her that you have an echocardiogram and ECG to give us further information about the function of your heart. A copy of your ECG and echocardiogram will be sent to the study team for assessment. If your ECG or echocardiogram or blood test are abnormal you will be referred to a heart specialist for further assessment and possible treatment

Are there any risks to participating in the study?

We do not anticipate any side effects relating to the blood test for BNP or to measuring your heart function.

Are there any benefits to taking part?

The information that we obtain from the study will help us gain knowledge about the impact of cancer treatment on your heart. You will have regular monitoring of how your heart is working. You will have increased contact with specialist nurses.

Do I have to take part?

No, taking part is voluntary. If you would prefer not to take part you do not have to give a reason. Your doctor would not be upset and your treatment would not be affected in any way. If you take part but later change your mind you can withdraw from the study at any time without giving a reason and without hindrance or detriment to your future treatment. We will give you a copy of your consent form to keep.

Confidentiality

All the study data will be confidential to the research team. You will not be identified in any published study results. All study data will be handled under the auspices of the MRC- Trial Management Group and treated confidentially in compliance with the Data Protection Act (1998).

What do I do now?

You will be contacted by a member of the research staff in a day or so. Please let him/her know if you are interested in taking part.

We would want to inform your General Practitioner that you are taking part in this study. With your permission, we will send him/her a copy of your consent form.

Thank you very much for considering taking part in our research. Please discuss this information with your family, friends or GP if you wish.

Dr Ian Kunkler Chief Investigator, SUPREMO trial

Local contact name(s) and phone number(s):

If you would like to speak to a doctor who is independent of the study, please contact: \_\_\_\_\_

## Appendix VI Informed consent form (Cardiac substudy)

SUPREMO breast cancer trial

Selective Use of Postoperative Radiotherapy after Mastectomy

### Cardiac Substudy

#### Informed Consent Form

Patient identification number for this trial:.....

Name of patient: .....

Name of clinician .....

Hospital: .....

Please initial boxes

1. I have read and understood the Cardiac Study patient information sheet provided and have had sufficient time to decide whether to take part in this study. I have had the opportunity to ask questions and consider the answers given.
2. I understand that participation in the study is voluntary and that I may withdraw at any time of my own accord and without giving any reason and without my medical care or legal rights being affected.
3. I understand that sections of any of my medical notes may be looked at by research staff from the Information Services Division (ISD) Cancer Clinical Trials Team, and other collaborating UK Clinical trials units for the purpose of data monitoring, where it is relevant to my taking part in research. I give permission for these individuals to have access to my records.
4. I agree that my General Practitioner will be informed of my participation in this study and will be advised of any clinically significant information that comes to light.
5. I agree to donate serum/plasma for this study which will be stored for future research to learn about, prevent or treat cancer.

☐☐☐☐☐

I confirm that I have explained the nature of this study to the above named patient and that she has understood the explanation given to her.

Clinician's signature: ..... Date: .....

I hereby freely give my consent to take part in the SUPREMO cardiac study.

Patient's signature: ..... Date: .....

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(Signature on this form does not affect your legal rights, you may take part in the main trial and decline to take part in this part of the trial)

Witness to written consent

Name: ..... Signature: .....

Relationship to patient: ..... Date: .....

Copies: 1 for patient, 1 for researcher, 1 for trials office, 1 to be kept with hospital notes

## Appendix VII Letter to general practitioner covering main trial and sub-studies

Dear Colleague,

### **SUPREMO trial (Selective Use of Postoperative Radiotherapy after Mastectomy)**

I am writing to let you know that your patient:

Mrs/Ms.....  
of .....

has agreed to take part in a national randomised trial (SUPREMO) to assess the role of postoperative chest wall irradiation after mastectomy and axillary surgery for early breast cancer. Eligibility is restricted to women with intermediate risk breast cancer (ie with 1-3 histologically involved nodes or histologically negative nodes with high grade histology and/or lymphovascular invasion. Adjuvant systemic therapy with chemotherapy and/or endocrine therapy is given as appropriate. At present adjuvant chest wall irradiation is not standard therapy for this group of patients. In women with > 4 involved nodes there is good evidence that loco-regional irradiation after mastectomy given with systemic therapy improves overall survival. However the role of loco-regional irradiation in women at lower risk of loco-regional recurrence is unclear. We wish to discover whether the addition of radiotherapy will improve overall survival in women at intermediate risk of recurrence. In addition we will be assessing the impact of chest wall irradiation on quality of life, cardiac morbidity and use of health service resources.

#### Sub-studies

Cardiac risk factors, including measurement of serum cholesterol, will be documented by a doctor/research nurse at baseline. Blood levels of B type natriuretic peptide (BNP) will be measured to help assess the impact of chemotherapy and radiotherapy on cardiac function in conjunction with electrocardiography (ECG) and, if necessary, echocardiography. If cardiac symptoms or signs warrant or serum BNP rises significantly above threshold levels patients will be referred for additional cardiac assessment to a cardiologist. The last BNP measurement along with a further clinical cardiac assessment and ECG will be carried out at 10 years after surgery.

At baseline a specimen of your patient's tumour and serum will be stored for future measurement of molecular markers of radiosensitivity. A portion of serum taken for the measurement of BNP will also be stored for measurement of future markers of cardiac damage.

Medical history and examination will be conducted on entry to the study after chemotherapy (if given) but before radiotherapy (if given), after radiotherapy, (if given), at 6 months after surgery and annually for 10 years. A mammogram is recommended at least every two years for a total of 10 years after the date of surgery.

Quality of life assessment up to 10 years, apart from the baseline assessment in the clinic, will be conducted by postal questionnaire.

The study has been approved by the Multi-centre Ethics Committee and your local ethical committee. It is anticipated that 3700 patients will be randomised over a four year period. A Data Monitoring Committee will meet at least six monthly to review study progress and safety. A copy of the final trial report will be forwarded to you.

For your interest a copy of the information sheets about the trial (including the biological substudy (TRANS-SUPREMO), quality of life and cardiac substudies, if relevant) are enclosed. If you have any questions about the trial, you may wish to contact Chief Investigator, Dr Ian Kunkler, or the local Principal Investigator:

Dr .....

Address:.....

.....

Tel: .....Email:

Yours sincerely,

Dr Ian Kunkler on behalf of the SUPREMO trial study team

Dr Ian Kunkler, Consultant in Clinical Oncology, University Department of Clinical Oncology, Western General Hospital, University of Edinburgh, Crewe Road, Edinburgh, EH4 2XU. Telephone +44 (0)131 537 2214; Fax:+44 (0)131 275 7512



## Appendix VIII

### RTOG/EORTC acute radiation morbidity scoring system

Organ	0	1	2	3	4
Skin	No change over baseline	Follicular, faint or dull erythema/ epilation/ dry desquamation/decreased sweating	Bright erythema, patchy moist desquamation/moderate oedema	Confluent moist desquamation other than skin folds, pitting oedema	Ulceration, haemorrhage, necrosis
Lung	No change	Mild symptoms of dry cough or dyspnoea on exertion	Persistent cough requiring narcotic, anti-tussive agents/dyspnoea with minimal effort but not at rest	Severe cough unresponsive to narcotic antitussive agent or dyspnoea at rest/clinical or radiological evidence of acute pneumonitis/ intermittent oxygen or steroids may be required	Severe respiratory insufficiency/ continuous oxygen or assisted ventilation
Heart	No change over baseline	Asymptomatic but objective evidence of ECG changes or pericardial abnormalities without evidence of other heart disease	Symptomatic with ECG changes and radiological findings of congestive heart failure or pericardial disease/no specific treatment required	Congestive heart failure, angina pectoris, pericardial disease responding to therapy	Congestive heart failure, angina pectoris, pericardial disease, arrhythmias not responsive to nonsurgical measures

## RTOG/EORTC late radiation morbidity scoring system

Organ	0	1	2	3	4	5
Skin	None	Slight atrophy; pigmentation change; some hair loss	Patchy atrophy; total hair loss	Marked atrophy; gross telangiectasia	Ulceration	Death directly related to Radiation Late Morbidity
Lung	None	Asymptomatic or mild symptoms	Moderate symptomatic fibrosis or pneumonitis (severe cough); Low grade fever; patchy radiographic changes	Severe symptomatic fibrosis or pneumonitis; Dense radiographic changes	Severe respiratory insufficiency/ Continuous O2/Assisted Ventilation	Death directly related to Radiation Late Morbidity
Heart	None	Asymptomatic or mild symptoms; transient T wave inversion & ST change; sinus tachycardia > 110 (at rest)	Moderate angina on effort; Mild pericarditis; normal heart size; persistent abnormal T wave and ST changes; low ORS	Severe angina; pericardial effusion; constrictive pericarditis; moderate heart failure; cardiac enlargement; ECG abnormalities	Tamponade/Severe heart failure/Severe constrictive pericarditis	Death directly related to Radiation Late Morbidity
Bone	None	Asymptomatic. No growth; reduced bone density	Moderate pain or tenderness; growth retardation; irregular sclerosis	Severe pain or tenderness; complete arrest of bone growth; dense bone sclerosis	Necrosis/Spontaneous fracture	Death directly related to Radiation Late Morbidity

## Appendix IX TNM Clinical Classification

### T - Primary tumour

TX: Primary tumour cannot be assessed

T0: No evidence of primary tumour

Tis: Carcinoma in situ,  
Tis (DCIS): Ductal carcinoma in situ  
Tis (LCIS): Lobular carcinoma in situ  
Tis (Paget): Paget's disease of the nipple with no tumour.

Note: Paget disease associated with a tumour is classified according to the size of the tumour.

T1: Tumour 2.0 cm or less in greatest dimension  
T1mic: Microinvasion 0.1 cm or less in greatest dimension

Note: Microinvasion is the extension of cancer cells beyond the basement membrane into the adjacent tissues with no focus more than 0.1cm in greatest dimension. When there are multiple foci of microinvasion, the size of only the largest focus is used to classify the microinvasion. (Do not use the sum of all individual foci.) The presence of multiple foci of microinvasion should be noted, as it is with multiple larger invasive carcinomas.

T1a: More than 0.1 cm but not more than 0.5 cm in greatest dimension

T1b: More than 0.5 cm but not more than 1.0 cm in greatest dimension

T1c: More than 1.0 cm but not more than 2.0 cm in greatest dimension

T2: Tumour more than 2.0 cm but not more than 5.0 cm in greatest dimension

T3: Tumour more than 5.0 cm in greatest dimension

T4: Tumour of any size with direct extension to chest wall or skin, only as described in T4a to T4d

Note: Chest wall includes ribs, intercostal muscles, and serratus anterior muscle but not pectoral muscle.

T4a: Extension to chest wall

T4b: Oedema (including peau d'orange) or ulceration of the skin of the breast, or satellite skin nodules confined to the same breast

T4c: Both 4a and 4b above

T4d: Inflammatory carcinoma

Note: Inflammatory carcinoma of the breast is characterised by diffuse, brawny induration of the skin with an erysipeloid edge, usually with no

underlying mass. If the skin biopsy is negative and there is no localised measurable primary cancer, the T category is pTX when pathologically staging a clinically inflammatory carcinoma (T4d). Dimpling of the skin, nipple retraction, or other skin changes, except those in T4b and T4d, may occur in T1, T2, or T3 without affecting the classification.

## N - Regional lymph nodes

- NX: Regional lymph nodes cannot be assessed (e.g., previously removed)
- N0: No regional lymph node metastasis
- N1: Metastasis in movable ipsilateral axillary lymph node(s)
- N2: Metastasis in fixed ipsilateral axillary lymph node(s), or in clinically apparent\* ipsilateral internal mammary lymph node(s) in the absence of clinically evident axillary lymph node metastasis
- N2a: Metastasis in axillary lymph node(s) fixed to one another or to other structures
- N2b: Metastasis only in clinically apparent\* internal mammary lymph nodes and in the absence of clinically evident axillary lymph node metastasis
- N3: Metastasis in ipsilateral infraclavicular lymph node(s) with or without axillary lymph node involvement, or in clinically apparent\* ipsilateral internal mammary lymph node(s) and in the presence of clinically evident axillary lymph node metastasis; or, metastasis in ipsilateral supraclavicular lymph node(s) with or without axillary or internal mammary lymph node involvement
- N3a: Metastasis in infraclavicular lymph node(s)
- N3b: Metastasis in internal mammary and axillary lymph node(s)
- N3c: Metastasis in supraclavicular lymph node(s)

\* [Note: Clinically apparent = detected by clinical examination or by imaging studies (excluding lymphoscintigraphy).]

## M - Distant metastasis

- MX: Distant metastasis cannot be assessed
- M0: No distant metastasis
- M1: Distant metastasis

## pTNM Pathological classification

### pT – Primary Tumour

The pathological classification requires the examination of the primary carcinoma with no gross tumour at the margins of resection. A case can be classified pT if there is only microscopic tumour in a margin.

The pT categories correspond to the T categories.

Note: When classifying pT the tumour size is a measurement of the invasive component. If there is a large in situ component (eg 4cm) and a small invasive component (eg 0.5cm), the tumour is coded pT1a.

### PN – Regional Lymph nodes

The pathological classification requires the resection and examination of at least the low axillary lymph nodes (level I) (see page 132). Such a resection will ordinarily include 6 or more lymph nodes. If the lymph nodes are negative, but the number ordinarily examined is not met, classify as pN0. Examination of one or more sentinel lymph nodes may be used for pathological classification. If classification is based solely on sentinel node biopsy without subsequent axillary lymph node dissection it should be designated (sn) for sentinel node, eg pN1(sn). (see page 11 of the Introduction)

pNX: Regional lymph nodes cannot be assessed (not removed for study or previously removed)

pN0: No regional lymph node metastasis\*

[Note: \*cases with only isolated tumour cells (ITCs) in regional lymph nodes are classified as pN0. ITC are single tumour cells or small clusters of cells not more than 0.2 mm in greatest dimension, that are usually detected by immunohistochemistry or molecular methods but which may be verified on H&E stains. ITCs do not typically show evidence of metastatic activity, e.g., proliferation or stromal reaction. (See page 11 of the Introduction)]

pN1mi: Micrometastasis (larger than 0.2 mm but none larger than 2.0 mm in greatest dimension)

pN1: Metastasis in 1 to 3 ipsilateral axillary lymph node(s), and/or in ipsilateral internal mammary nodes with microscopic metastasis detected by sentinel lymph node dissection but not clinically apparent\*\*

pN1a: Metastasis in 1 to 3 axillary lymph node(s), including at least one larger than 2mm in greatest dimension.

pN1b: internal mammary lymph nodes with microscopic metastasis detected by sentinel lymph node dissection but not clinically apparent\*\*

pN1c: Metastasis in 1 to 3 axillary lymph nodes and internal mammary lymph nodes with microscopic metastasis detected by sentinel lymph node dissection but not clinically apparent.

pN2: Metastasis in 4 to 9 ipsilateral axillary lymph nodes, or in clinically apparent\* ipsilateral internal mammary lymph node(s) in the absence of axillary lymph node metastasis

\*\* [Note: Not clinically apparent = not detected by clinical examination or by imaging studies (excluding lymphoscintigraphy)]

\* [Note: Clinically apparent = detected by clinical examination or by imaging studies (excluding lymphoscintigraphy) or grossly visible pathologically]

pN2a: Metastasis in 4 to 9 axillary lymph nodes including at least one that is larger than 2.0 mm)

pN2b: Metastasis in clinically apparent internal mammary lymph node(s) in the absence of axillary lymph node metastasis

pN3: Metastasis in 10 or more ipsilateral axillary lymph nodes; or in ipsilateral infraclavicular lymph nodes; or in clinically apparent ipsilateral internal mammary lymph node(s) in the presence of one or more positive axillary lymph nodes; or, in more than 3 axillary lymph nodes with clinically negative microscopic metastasis in internal mammary lymph nodes; or, in ipsilateral supraclavicular lymph nodes

pN3a: Metastasis in 10 or more axillary lymph nodes (at least one larger than 2.0 mm) or, metastasis in infraclavicular lymph nodes

pN3b: Metastasis in clinically apparent internal mammary lymph nodes in the presence of positive axillary lymph node(s); or, metastasis in more than 3 axillary lymph nodes and in internal mammary lymph nodes with microscopic metastasis detected by sentinel lymph node dissection but not clinically apparent

pN3c: Metastasis in supraclavicular lymph node(s)

pM – Distant Metastasis

The pM categories correspond to the M categories.

Source: UICC TNM Classification of Malignant Tumours Sixth Edition 2002 Edited by L.H.Sobin and Ch. Wittekind

## Appendix X Collaborating Organisations

### Contacts:

Anglo-Celtic Co-operative Oncology Group;  
Prof. Robert C F Leonard

Australia and New Zealand Breast Cancer Trials Group;  
Dr. Boon Chua

Borstkanker Onderzoeksgroep Nederland;  
Dr. Nicola Russell

Central East European Oncology Group:  
Prof. Jacek Jassem

European Organisation for Research and Treatment of Cancer:  
Dr. Geertjan van Tienhoven

GECO Peru  
Dr. Henry Gomez Moreno

Hellenic Breast Surgical Society;  
Prof. Christos Markopoulos

International Breast Cancer Study Group  
Prof. Aron Goldhirsch

Irish Clinical Oncology Research Group;  
Dr. Brian Moulton

Japanese Breast Cancer Research Group;  
Dr. Masakazu Toi

National Cancer Institute of Canada –Cancer Trials Group;  
Prof. Tim Whelan

National Cancer Research Institute Breast Cancer Studies Group  
Prof. Robert Coleman

Swedish Breast Group;  
Prof. Per-Olof Malmstrom

Swiss Group for Clinical Cancer Research  
Dr Olivia Pagani

## Appendix XI Compatibility with Other Studies

Given the number of breast cancer trials running in the UK it is important to avoid the problem of “over-burdening” patients with trial choices. The SUPREMO trial should be compatible with most current non-interventional breast cancer studies and will not be applicable to the same patient population as any treatment trials for non-invasive or metastatic disease.

### Quality of Life Substudy

However patients entered into the SUPREMO Quality of Life sub-study should not be enrolled into another trial’s QoL sub-study.

Similarly, if they have already been enrolled into an ongoing QoL study of another trial they should not be entered into SUPREMO QoL substudy.

The following treatment trials are compatible with SUPREMO;

### TACT2

Trial of accelerated adjuvant chemotherapy with capecitabine in early breast cancer.

If appropriate, patients can be randomised into both TACT2 and SUPREMO at any time points. However patients being considered for entry into the SUPREMO cardiac substudy where consent needs to be obtained before chemotherapy starts so that baseline clinical assessment, cardiac investigations and blood tests can be carried out before chemotherapy. As SUPREMO is not a systemic therapy trial, the 2-month time restriction for recruitment into another trial, as detailed in the TACT2 protocol, does not apply.

### OPTION

Ovarian Protection Trial In Oestrogen Non-responsive Premenopausal Breast Cancer Patients Receiving Adjuvant or Neo-adjuvant Chemotherapy.

### SPROG

Prospective randomised comparison of G-CSF (filgrastim) secondary prophylaxis versus conservative management of chemotherapy-induced neutropenia to maintain dose intensity in chemotherapy for breast cancer.

Both ACTION (Adjuvant chemotherapy in older women) and SOFT (Suppression of Ovarian Function) trials should be compatible with SUPREMO.



## Appendix XII Abbreviations

AC	Adriamycin and Cyclophosphamide
ANZBCTG	Australian and New Zealand Breast Cancer Trials Group
BNP	B Type Natriuretic Peptide
CAF	Cyclophosphamide, Adriamycin and 5-fluorouracil
CD	Compact Disk
CEF	Cyclophosphamide, Epirubicin and 5-fluorouracil
CI	Confidence Interval
CMF	Cyclophosphamide, Methotrexate and 5-fluorouracil
CT	Computed Tomography
CT-Sim	Computed Tomography- simulator
CTV	Clinical Target Volume
DCIS	Ductal Carcinoma In Situ
DICOM	Digital Imaging and Communications in Medicine
Dmax	Maximum Dose
EBCTCG	Early Breast Cancer Trialists' Collaborative Group
EC	Epirubicin and Cyclophosphamide
ECG	Electrocardiogram
ECHO	Echocardiogram
ECOG	Eastern Cooperative Oncology Group
EORTC	European Organisation for Research and Treatment of Cancer
EpiCMF	Epirubicin and Cyclophosphamide, Methotrexate and 5-fluorouracil
LCIS	Lobular Carcinoma In Situ
ER	Oestrogen Receptor
FAC	5-fluorouracil, Adriamycin and Cyclophosphamide
FEC	5-fluorouracil, Epirubicin and Cyclophosphamide
GP	General Practitioner
Gy	Gray
H&E	Haematoxylin & Eosin
GCP	Good Clinical Practice
ICRU 50	International Commission on Radiation Units
IGF-1	Insulin-Like Growth factor-1
IMC	Internal Mammary Chain
IPEM	Institute of Physics and Engineering in Medicine
ISD	Information Services Division
LRF	Loco-regional Failure
LRR	Loco-regional Recurrence
LVD	Left Ventricular Dysfunction
MSCF	Medial Supraclavicular Fossa
MV	Mega Voltage
NIH	National Institutes of Health

NSABP	National Surgical Adjuvant Breast and Bowel Project
NHS	National Health Service
PMRT	Postmastectomy Radiotherapy
PTV	Planning Target Volume
QA	Quality Assurance
QC	Quality Control
QALY	Quality-Adjusted Life-Year
QoL	Quality of Life
RR	Relative Risk
RT	Radiotherapy
RTOG	Radiation Therapy Oncology Group
SAE	Serious Adverse Event
SEER	Surveillance Epidemiology and End Results
SIGN	Scottish Intercollegiate Guidelines Network
START	Standardisation of Breast Radiotherapy Trial
TAD	Target Absorbed Dose
TLD	Thermo Luminescent Dosimetry
TNM	Tumor, Node, Metastasis (Clinical Classification)
UICC	International Union Against Cancer
VEGF	Vascular Endothelial Growth Factor
TRAM	Transverse Rectus Abdominis Muscle
DNA	Deoxyribonucleic Acid
mRNA	Messenger Ribonucleic Acid
RNA	Ribonucleic Acid
MAPK	Mitogen-Activated Protein Kinase
GST	Glutathione S-Transferase
ATM	Ataxia Telangiectasia Mutated
PARP	Poly (ADP-ribose) Polymerase
ADP	Adenosine Diphosphate
TMA	Tissue Microarray
MALDI-TOF	Matrix-Adsorbed Laser Desorption-Ionisation Time Of Flight
MLSO	Medical Laboratory Scientific Officer
IHC	Immunohistochemistry
FISH	Fluorescent In Situ Hybridisation
CART	Classification And Regression Trees
BIS	Body Image Scale
HADS	Hospital Anxiety and Depression Scale
LD flap	Latissimus Dorsi flap
EQ	EuroQol
NTCP	Normal Tissue Compliance Probability
EDTA	Ethylenediamine Tetraacetic
sn	Sentinel node
ITC	Isolated Tumour Cell
HER2	HER2/neu protein
ICH-GCP	International Conference on Harmonisation of Good Clinical Practice
GCP	Good Clinical Practice