Guideline 17-10

A Quality Initiative of the Program in Evidence-Based Care (PEBC), Cancer Care Ontario (CCO)

Breast cancer reconstruction surgery (immediate and delayed) across Ontario: Patient indications and appropriate surgical options


Report Date: January 5, 2016

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Table of Contents

Section 1: Recommendations ................................................................. 1

Section 2: Guideline - Recommendations and Key Evidence................................. 6

Section 3: Guideline Methods Overview ...................................................... 17

Section 4: Systematic Review........................................................................ 20

Section 5: Internal and External Review.......................................................... 87

References.................................................................................................. 99

Appendix I. Members of the Working Group, the Breast Reconstruction Expert Panel, Report Approval Panel, external reviewers and their conflict of interest declarations. . 111

Appendix II. Search for existing evidence-based guidelines. ......................... 115

Appendix III. Literature Search Strategies...................................................... 116

Appendix IV. Quality assessment of included systematic reviews (AMSTAR). .......... 118
Breast cancer reconstruction surgery (immediate and delayed) across Ontario: Patient indications and appropriate surgical options

Section 1: Recommendations

This section is a quick reference guide and provides the guideline recommendations only. For key evidence associated with each recommendation, see Section 2.

GUIDELINE OBJECTIVES

- To provide clinical guidance with respect to suitability for breast reconstruction, timing of reconstruction, and optimal reconstruction techniques.
- To make recommendations that will inform decisions at the policy and administration level aimed at improving the quality of life of women with breast cancer in Ontario.

TARGET POPULATION

- Women who have been diagnosed with breast cancer who have chosen or been recommended for therapeutic mastectomy.
- Women who are at high risk for breast cancer who have chosen or been recommended for prophylactic mastectomy.

INTENDED USERS

General surgeons practicing breast cancer surgery, plastic surgeons, oncologists, administrators, other referring physicians, and oncology healthcare professionals (e.g., those involved in patient education or psychosocial programs).

RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Recommendation 1: Patient education and preoperative evaluation</th>
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<td>For women who have chosen or been recommended for therapeutic mastectomy:</td>
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<td>- The discussion of immediate or delayed breast reconstruction should be initiated at the time that mastectomy is offered by the general surgeon.</td>
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<tr>
<td>- For women seeking immediate breast reconstruction for ductal carcinoma in situ (DCIS), preoperative evaluation with a general surgeon and a plastic surgeon should be performed.</td>
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<tr>
<td>- For women seeking immediate breast reconstruction for early stage breast cancer who will potentially require adjuvant chemotherapy or radiotherapy (RT), a medical oncologist and/or radiation oncologist should be included in preoperative evaluation, either through a formal consultation or by a multidisciplinary cancer conference.</td>
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<tr>
<td>- For women seeking immediate reconstruction, there should be adequate preoperative imaging of the breasts, aligning with existing guideline recommendations.</td>
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Qualifying Statement

- Please see Cancer Care Ontario guidelines regarding recommendations about the use of mastectomy versus breast-conserving therapy (BCT) in early stage breast cancer (www.cancercare.on.ca).
Recommendation 2: Contraindications for immediate or delayed reconstruction

- Relative medical (non-cancer-related) contraindications for breast reconstruction include:
  1. Morbid obesity (body mass index [BMI] ≥40 kg/m²);
  2. Current smoking status.
- Advance age is not a contraindication to breast reconstruction. There is no evidence that indicated a specific age cut-off as a contraindication; however, the number of people who received reconstruction after 70 years of age was limited.

Qualifying Statements

- If morbid obesity and smoking status have been resolved, then women may be appropriate candidates for breast reconstruction.
- None of the two characteristics listed above are absolute contraindications to reconstruction.
- There is insufficient evidence to indicate whether diabetes is a contraindication to reconstruction.
- Patients with increased (>BMI 30 kg/m²) are at higher risk for complications and are encouraged to lose weight if undergoing delayed reconstruction.

Recommendation 3: Timing of immediate breast reconstruction

- Immediate reconstruction is an appropriate option for women who are not expected to require postoperative RT. This includes women with:
  o Prophylactic mastectomy for prevention of breast cancer
  o In situ disease (ductal or lobular)
  o Tumour size to breast volume ratio that may preclude the use of BCT
  o RT not recommended (e.g., previous irradiation of breast or chest [Hodgkin disease], severe collagen vascular disease, or Tp53 mutation)
  o Small invasive cancers with extensive microcalcifications or atypia that would preclude BCT and there is a low likelihood of nodal disease.
  o Positive margins following breast-conserving surgery opting for completion mastectomy
  o Recurrent disease following failed initial BCT and not deemed to be at high risk for metastatic disease
- The use of immediate breast reconstruction is not recommended for women expected to require postoperative RT, including women with T3 or T4 tumours, inflammatory breast cancer, or any positive axillary lymph node involvement.

Qualifying Statement

- Women who request immediate breast reconstruction despite requiring postoperative RT should be fully informed of the possibility of increased risk of complications, compromised esthetic outcome from radiation to the immediate reconstruction, possible delay to adjuvant therapy, and the potential for increased need for future revisional surgeries. They should all undergo multidisciplinary evaluation by a medical and radiation oncologist and a plastic surgeon.
**Recommendation 4 : Skin-sparing, nipple-sparing, and areola-sparing mastectomy**

- Skin-sparing mastectomy (SSM), nipple-sparing mastectomy (NSM) and areola-sparing mastectomy (ASM) are incisions utilized simultaneously with immediate breast reconstruction
- SSM or NSM with immediate breast reconstruction can be offered to women at high risk for breast cancer (>25% lifetime risk) undergoing prophylactic mastectomy and women with known DCIS.
- SSM or NSM with immediate breast reconstruction is a reasonable option for women with early breast cancer who are believed to be likely lymph node negative.
- SSM, NSM, and ASM are **not** recommended for women intending to receive post-operative radiation with:
  - early breast cancer who are lymph node positive, inflammatory breast cancer or locally advanced breast cancer who will require postoperative RT.
  - any clinical skin or nipple-areolar complex (NAC) involvement by invasive tumour
- NSM and ASM are **not** recommended for women with Paget disease of the breast or women with a retroareolar tumour.
- NSM or ASM with immediate reconstruction is reserved for patients with minimal ptosis and do not require skin reducing incisions
- Women with multicentric DCIS or early invasive cancer within 2 cm of the NAC who are contemplating NSM may consider a sampling taken from the base of the nipple for pathological assessment. Women found to have tumour involvement in the NAC either intraoperatively or postoperatively should have the nipple resected.

**Qualifying Statements**

- SSM, NSM, and ASM are oncologically safe when the tumour is resected with clear margins.
- Women considering NSM should be made aware that they will experience nipple anesthesia and that there is a risk of nipple necrosis.
- Likelihood of lymph node positivity should be determined by consultation with a breast surgeon with oncology expertise or by a multidisciplinary tumour board discussion. When required, for women with invasive breast cancer and clinically negative nodes, a standalone sentinel lymph node biopsy may evaluate lymph node status prior to definitive mastectomy.

**Recommendation 5 : Delayed breast reconstruction**

- Delayed reconstruction should be offered as an option for any woman undergoing mastectomy who desires reconstruction, has completed any recommended adjuvant chemotherapy and/or RT, and does not have contraindications to breast reconstruction.

**Qualifying Statements**

- For women who have received RT, it is the opinion of the Expert Panel that reconstruction should not occur sooner than one year after mastectomy.
- For women with advanced disease (T4, or N2 or N3), it is the opinion of the Expert Panel that it may be optimal to wait two or three years before undergoing reconstruction when the risk of recurrence is lowered.
**Recommendation 6: Autologous tissue versus implant-based reconstruction**

- Women treated by mastectomy should be made aware that autologous tissue reconstruction and implant-based reconstruction are options for immediate or delayed reconstruction.
- Reconstruction methods should be selected based on patient and surgeon factors, because overall patient satisfaction and willingness to recommend reconstruction to others appear to be similar between autologous tissue and tissue-expander implant (TE/I)-based reconstructions. However, if women are candidates for either reconstruction, then they should be informed that TE/I reconstruction may be accompanied by a higher risk of reconstructive failure or soft tissue infection and that there is a trend toward decreased esthetic satisfaction with TE/I reconstruction over time.
- Latissimus dorsi flap with or without implants is another option to TE/I or abdominal autologous tissue reconstruction.

**Radiation setting:**
- For women who have received prior RT to their breast as part of BCT, mastectomy with immediate autologous tissue reconstruction is the recommended option. Current evidence suggests that reconstruction using TE/I alone may be associated with an increased risk of complications.

**Qualifying Statement**
- Women desiring reconstruction in a previously radiated breast should be informed of the increased risk of complications compared with no radiation.

**Recommendation 7: Types of autologous tissue reconstruction**

- In patients who will undergo unilateral autologous tissue reconstruction, pedicled transverse rectus abdominis myocutaneous (TRAM), free TRAM, or deep inferior epigastric perforator (DIEP) flaps are all recommended options that are supported by positive patient-reported outcomes.
- In patients who will undergo bilateral autologous tissue reconstruction, DIEP flap is preferred over free or pedicled TRAM flap due to less functional disruption to the abdominal wall following surgery.
- Alternative autologous tissue donor types (e.g., gluteal flaps, thigh flaps) are suitable for selected patients in whom abdominal tissue is not available; however, the evidence on these types of reconstructions is very limited.
- All patients should be told of the risk of fat necrosis that can present as a nodule or mass after autologous tissue reconstruction, a benign condition that can mimic breast cancer recurrence. The risk of fat necrosis is likely to be greater following DIEP flaps compared with TRAM flaps.

**Recommendation 8: Acellular dermal matrix**

- With the shortage of high-quality evidence on the use of acellular dermal matrix (ADM), no recommendation can be made for or against the use of ADM as an adjunct to implant-based breast reconstruction.
### Qualifying Statements
- It is the opinion of the Expert Panel that direct-to-implant reconstruction in a *single stage* using ADM may be used as an adjunct to implant-based breast reconstruction to improve esthetic outcomes in selected women who have smaller and non-ptotic breasts.
- Patient selection and surgical technique are critical to good outcomes.
- Other than improved esthetic outcomes, ADM has not been shown to have any other benefit for *two-staged* TE/I reconstruction.
- Esthetic outcomes, especially the inframammary fold, are potentially improved with the use of ADM in implant reconstruction.

### Recommendation 9: Autologous fat grafting
- With the shortage of high-quality studies on the use of fat grafting, no recommendation can be made for or against the use of autologous fat grafting as an adjunct to improve esthetic outcomes in breast reconstruction.

### Qualifying Statements
- Autologous fat grafting is a potential adjunct to improve esthetic outcomes in breast reconstruction following mastectomy; however, more high-quality evidence on the efficacy and safety of this procedure is necessary before its widespread implementation.

### Recommendation 10: Routine screening for breast cancer recurrence following postmastectomy breast reconstruction
- There is insufficient evidence to support the use of postmastectomy surveillance mammography in the reconstructed breast.
- Women should be followed with clinical examination of the chest wall and reconstructed breast as per the regular breast cancer follow-up regimen.
- Diagnostic mammography, ultrasound, and magnetic resonance imaging may be helpful in the evaluation of symptomatic women with a reconstructed breast (e.g., lumps, skin changes).
Breast cancer reconstruction surgery (immediate and delayed) across Ontario: Patient indications and appropriate surgical options:

Section 2: Guideline - Recommendations and Key Evidence

GUIDELINE OBJECTIVES
- To provide clinical guidance with respect to suitability for breast reconstruction, timing of reconstruction, and optimal reconstruction techniques.
- To make recommendations that will inform decisions at the policy and administration level aimed at improving the quality of life of women with breast cancer in Ontario.

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RECOMMENDATIONS, KEY EVIDENCE, AND INTERPRETATION OF EVIDENCE

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<td>• For women seeking immediate reconstruction, there should be adequate preoperative imaging of the breasts, aligning with existing guideline recommendations. Imaging results should be available at the time of surgical consult.</td>
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Qualifying Statement
- Please see Cancer Care Ontario guidelines regarding recommendations about the use of mastectomy versus breast-conserving therapy (BCT) in early stage breast cancer (www.cancercare.on.ca).

Key Evidence
- Although evidence to support these recommendations was not specifically reviewed for this guideline, the recommendations are in agreement with those from other groups (Alberta Health Services [AHS]; Massachusetts; American Society of Plastic
Surgeons [ASPS]; Association of Breast Surgery [ABS]/British Association of Plastic, Reconstructive and Aesthetic Surgeons [BAPRAS]; National Comprehensive Cancer Network [NCCN]; National Institute for Health and Care Excellence [NICE]; New Zealand Guidelines Group [NZGG]).

**Interpretation of Evidence**

The primary outcomes considered in the development of these recommendations are quality of life and equitable access to care. The recommendations are based on the expert opinion of the Expert Panel that women should be well informed about care options and that multidisciplinary preoperative evaluation is a quality indicator of multidisciplinary breast cancer care for women with DCIS or early stage disease seeking immediate reconstruction.

**Recommendation 2: Contraindications for immediate or delayed reconstruction**

- Relative medical (non-cancer related) contraindications for breast reconstruction include:
  1. Morbid obesity (body mass index [BMI] ≥40 kg/m²);
  2. Current smoking status.
- Advanced age is not a contraindication for breast reconstruction. There is no evidence that indicated a specific age cut-off as a contraindication; however, the number of people who received reconstruction after 70 years of age was limited.

**Qualifying Statements**

- If morbid obesity and smoking status have been resolved, then women may be appropriate candidates for breast reconstruction. Patients with increased BMI (>30 kg/m²) are at higher risk for complications and are encouraged to lose weight if undergoing delayed reconstruction.
- None of the two characteristics listed above are absolute contraindications to reconstruction.
- There is insufficient evidence to indicate whether diabetes is a contraindication to reconstruction.

**Key Evidence**

- A study of 15,937 women by the National Surgical Quality Improvement Program (NSQIP) demonstrated that morbidly obese (BMI ≥40 kg/m²) women had significantly increased major surgical complications, medical complications, wound healing problems, and return to the operating room compared with nonobese and mildly obese (BMI 30 to 39.0 kg/m²) women [1,2].
- A prospective single-centre study of 558 women undergoing microsurgical abdominal flap reconstruction by Seidenstuecker et al. reported higher rates of flap and donor site complications in smokers compared with nonsmokers [3]. Similar results were reported in an analysis of the NSQIP database by Fischer et al. Evidence regarding the safety of implant-based reconstruction in active smokers is very limited.
- A systematic review by Walton et al. reviewed six observational studies and concluded that breast reconstruction was safe and feasible and provided significant improvements in quality of life for older women [4].

**Interpretation of Evidence**

The primary factors driving these recommendations are patient safety and informed decision making. The overall certainty of the evidence for morbid obesity, active smoking status, and
older age (>50 years) is low to moderate. The decision to undergo breast reconstruction must take into account the balance between the psychosocial benefits of reconstruction and the harmful physical effects from complications. Due to the high risk of complication from breast reconstruction in women with morbid obesity and women who are active smokers, the harms are likely to outweigh the potential quality-of-life benefits of reconstruction in these women. The Expert Panel believes that the potential benefits of breast reconstruction may be greater than the potential harms for older women who desire reconstruction and do not have other contraindications.

**Recommendation 3: Timing of immediate breast reconstruction**

- When immediate reconstruction is an appropriate option for women who are not expected to require postoperative RT. This includes women with:
  - Prophylactic mastectomy for prevention of breast cancer
  - In situ disease (ductal or lobular)
  - Tumour size to breast volume ratio that may preclude the use of BCT
  - RT not recommended (e.g., previously irradiation breast or chest [Hodgkin disease], severe collagen vascular disease, or TP53 mutation)
  - Small invasive cancers with extensive microcalcifications or atypia that would preclude BCT and there is a low likelihood of nodal disease.
  - Positive margins following breast-conserving surgery opting for completion mastectomy
  - Recurrent disease following failed initial BCT and not deemed at high risk for metastatic disease
- The use of immediate breast reconstruction is not recommended for women expected to require postoperative RT, including women with T3 or T4 tumours, inflammatory breast cancer, or any positive axillary lymph node involvement.

**Qualifying Statement**

- Women who request immediate breast reconstruction despite requiring postoperative RT should be fully informed of the possibility of increased risk of complications, compromised esthetic outcome from radiation to the immediate reconstruction, possible delay to adjuvant therapy, and the potential for increased need for future revisional surgeries. They should all undergo multidisciplinary evaluation by a medical and radiation oncologist and a plastic surgeon.

**Key Evidence**

- A small randomized controlled trial (RCT) [5] and a cross-sectional survey study [6] reported that women who underwent immediate reconstruction had less body stigma, body concerns, and psychological disturbance than women with delayed reconstruction.
- A prospective cohort study [7] and a meta-analysis of observational data [8] reported no significant difference in risk of local recurrence with immediate reconstruction compared with mastectomy alone.
- A 2013 systematic review of observational studies by Schaverien et al. reported a lower reoperation rate with delayed autologous tissue reconstruction compared with immediate autologous tissue reconstruction in the setting of RT (1.4% versus 15.1%; p=0.001) but no significant difference in overall complications or fat necrosis. A comparison of immediate reconstruction with versus without RT demonstrated no significant difference in overall complications or reoperations but significantly...
increased fat necrosis with the use of RT (23.8% versus 8.5%; p=0.006) [9].

- Two systematic reviews of observational studies assessed the effects of RT on immediate implant-based reconstruction. Lam et al. reported a higher rate of reconstruction failure with RT (18.6% versus 3.1%; p<0.00001) [10] and Barry et al. reported that women with RT had fourfold greater odds of suffering morbidity compared with women not requiring RT [11].

**Interpretation of Evidence**

The primary outcomes used to inform these recommendations include quality of life, adverse effects, patient satisfaction, and esthetic outcome. It is likely that the relative value of these outcomes will vary among women.

Benefits of immediate reconstruction compared with delayed reconstruction include increased immediate quality of life, improved esthetic outcome, and the convenience of undergoing mastectomy and breast reconstruction in a single procedure. These benefits must be weighed against the potential harms of delayed adjuvant chemotherapy and possible increased complications. Based on expert opinion and the evidence from observational studies reviewed, the Expert Panel believes that the potential benefits outweigh the potential harms for the subgroups of women listed above in Recommendation 3.

For women receiving postoperative RT, the Expert Panel believes that the potential harms of immediate breast reconstruction (complications, poor esthetic outcome of radiating a reconstructed breast mound, delay of adjuvant therapy, and the potential need for future revisional surgeries) outweigh the potential benefits of increased immediate quality of life, and convenience.

**Recommendation 4: Skin-sparing, nipple-sparing, and areola-sparing mastectomy**

- Skin-sparing mastectomy (SSM), nipple-sparing mastectomy (NSM) and areola-sparing mastectomy (ASM) are incisions utilized simultaneously with immediate breast reconstruction.
- SSM or NSM with immediate breast reconstruction can be offered to women at high risk for breast cancer (>25% lifetime risk) undergoing prophylactic mastectomy and women with known DCIS.
- SSM or NSM with immediate breast reconstruction is a reasonable option for women with early breast cancer who are believed to be likely lymph node negative.
- SSM, NSM, and ASM are **not** recommended for women intending to receive postoperative radiation with:
  - early breast cancer who are lymph node positive, inflammatory breast cancer or locally advanced breast cancer who will require postoperative RT
  - any clinical skin or nipple-areolar complex (NAC) involvement by invasive tumour.
- NSM and ASM are **not** recommended for women with Paget disease of the breast or women with a retroareolar tumour.
- NSM and ASM with immediate reconstruction is reserved for patients with minimal ptosis and do not require skin reducing incisions.
- Women with multicentric DCIS or early invasive cancer within 2 cm of the NAC who are contemplating NSM may consider a sampling taken from the base of the nipple for pathological assessment. Women found to have tumour involvement in the NAC either intraoperatively or postoperatively should have the nipple resected.
Qualifying Statements

- SSM, NSM, and ASM are oncologically safe when the tumour is resected with clear margins.
- Women considering NSM should be made aware that they will experience nipple anaesthesia and that there is a risk of nipple necrosis.
- Likelihood of lymph node positivity should be determined by consultation with a breast surgeon with oncology expertise or by a multidisciplinary tumour board discussion. When required, for women with invasive breast cancer and clinically negative nodes, a standalone sentinel lymph node biopsy may evaluate lymph node status prior to definitive mastectomy for women.

Key Evidence

- A systematic review and meta-analysis by Lanitis et al. of nine retrospective observational studies reported no significant difference between SSM with immediate reconstruction and non-SSM without reconstruction in local recurrence or postoperative severe complications [12].
- A systematic review by Mallon et al. of 29 observational studies reported an occult nipple involvement rate of 11.5%. Factors associated with increased incidence of nipple involvement were: tumour-to-nipple distance <2 cm, tumour grade, lymph node metastases, estrogen receptor/progesterone receptor-negative, tumour size >5 cm, retroareolar or central location, and multicentric location [13].
- Endara et al. reported a pooled locoregional recurrence rate following NSM of 1.8% across 28 observational studies, although follow-up ranged from 0.2 to 210 months. The pooled nipple necrosis rate across 39 studies was 7.7% [14].

Interpretation of Evidence

The certainty of the evidence for SSM and NSM is low to moderate. The primary outcomes considered in the development of these recommendations are recurrence, adverse effects, and patient satisfaction. There is likely significant variability in the relative value that women would place on each of these outcomes and this variability is expected to lead to different decisions regarding SSM and NSM.

In women who are at low risk for breast cancer recurrence (e.g., prophylactic mastectomy, DCIS, early stage lymph node-negative breast cancer), the potential benefits of SSM or NSM are expected to outweigh the potential harms.

Women who are likely to be lymph node negative (prophylactic, DCIS, or early breast cancer) benefit from immediate breast reconstruction at the time of mastectomy by potentially reducing the need for additional surgery and optimizing cosmesis with a skin-sparing procedure. The potential risk in early breast cancer patients is an unexpected clinical need for adjuvant chest wall RT that may compromise the cosmesis and/or viability of the reconstruction.

Recommendation 5: Delayed breast reconstruction

- Delayed reconstruction should be offered as an option for any woman undergoing mastectomy who desires reconstruction, has completed any recommended adjuvant chemotherapy and/or RT, and does not have contraindications to breast reconstruction.
Qualifying Statements
- For women who have received RT, it is the opinion of the Expert Panel that reconstruction should not occur sooner than one year after mastectomy.
- For women with advanced disease (T4, or N2 or N3), it is the opinion of the Expert Panel that it may be optimal to wait two or three years before undergoing reconstruction when the risk of recurrence is lowered.

Key Evidence
- A 2013 systematic review of observational studies by Schaverien et al. reported a lower reoperation rate with delayed reconstruction compared with immediate reconstruction in the setting of RT (1.4% versus 15.1%; p=0.001) but no significant difference in overall complications or fat necrosis [9].
- Although additional evidence to support this recommendation was not specifically reviewed for this guideline, the recommendations are in agreement with those from other groups (AHS, NCCN, NZGG).

Interpretation of Evidence
The primary outcomes used to inform these recommendations include quality of life, adverse effects (such as delay to adjuvant therapy), patient satisfaction, and esthetic outcome. It is likely that the relative value of these outcomes will vary among women. The overall certainty of the evidence on the safety and efficacy of delayed breast reconstruction is moderate. This recommendation is generalizable to all women who desire breast reconstruction and do not have the contraindications listed in Recommendation 2.

Compared with the alternative of mastectomy alone without reconstruction, the potential benefits of increased quality of life, patient satisfaction, and esthetic outcome are expected to outweigh the potential harms of complications. The benefits for delayed reconstruction compared with immediate reconstruction include reduced risk of delaying adjuvant therapy and reduced risk of complications. These potential benefits must be weighed against the undesirable effects of delaying reconstruction including not restoring quality of life at the time of mastectomy, reduced final esthetic outcome in most cases, and the inconvenience of undergoing an additional major surgical procedure, when compared with immediate reconstruction.

Recommendation 6: Autologous tissue versus implant-based reconstruction
- Women treated by mastectomy should be made aware that autologous tissue reconstruction and implant-based reconstruction are options for immediate or delayed reconstruction.
- Reconstruction methods should be selected based on patient and surgeon factors, because overall patient satisfaction and willingness to recommend reconstruction to others appear to be similar between autologous tissue and tissue-expander implant (TE/I)-based reconstructions. However, if women are candidates for either reconstruction, then they should be informed that TE/I reconstruction may be accompanied by a higher risk of reconstructive failure or soft tissue infection and that there is a trend toward decreased esthetic satisfaction with TE/I reconstruction over time.
- Latissimus dorsi (LD) flap with or without implants is another option to TE/I or autologous abdominal tissue (AAT) reconstruction.
**Radiation setting:**
- For women who have received prior RT to their breast as part of BCT, mastectomy with immediate autologous tissue reconstruction is the recommended option. Current evidence suggests that reconstruction using TE/I alone may be associated with an increased risk of complications.

**Qualifying Statement**
- Women desiring reconstruction in a previously radiated breast should be informed of the increased risk of complications compared with no radiation.

**Key Evidence**
- A systematic review by Tsoi et al. compared complications between TE/I and AAT reconstruction [15]. This review included 14 studies of low to moderate quality with very small sample sizes. Findings from this review demonstrated a greater risk of reconstructive failure associated with TE/I than AAT reconstruction. Soft tissue infections were significantly higher in TE/I; however, infections requiring re-operation were not significantly different between TE/I and AAT reconstruction. Skin or flap necrosis was significantly higher in the AAT reconstruction group. No significant difference was observed in other complications such as wound dehiscence, deep vein thrombosis/pulmonary embolism, major complications, and reoperation.
- A second systematic review publication by Tsoi et al. compared patient-reported outcomes between TE/I reconstruction and AAT reconstruction [16]. This review included 15 studies, the majority of which were low quality. Levels of pain did not differ between types of reconstruction. General satisfaction with method of reconstruction evolved over time but essentially converged, with no significant difference between the two approaches. Esthetic satisfaction remained constant in patients undergoing AAT reconstruction but declined over time following TE/I reconstruction. Overall patient satisfaction and willingness to recommend the surgery to others were similar between reconstruction types.
- The largest retrospective national database study comparing LD flaps (1079) with free flaps (609) and pedicled transverse rectus abdominis myocutaneous (TRAM) flaps (1608) found that overall 30-day complications, flap failure and non-flap complications were all significantly lower in the LD group compared with the other two techniques [17].

**Radiation setting:**
- Systematic reviews that compared the reconstructive options in patients who required postmastectomy radiation reported that complications were significantly higher in the implant-based reconstruction group compared with the autologous tissue reconstruction group [15]. In addition, a prospective single-centre study that examined 92 patients who underwent immediate reconstruction using autologous tissue (23 patients) compared with TE/I (69 patients) found that major complications, compromised functional status, and poor esthetic outcomes were significantly associated with the use of TE/I [18].

**Interpretation of Evidence**
Key outcomes used to inform the recommendations on autologous tissue versus implant-based reconstruction are adverse effects, patient satisfaction, and cosmesis of the final reconstructed result. Certainty of evidence for these outcomes is low, and the systematic reviews are made up of individual studies that are low in quality, small in patient number,
and there is a tendency for repeated reporting of studies in the reviews. There is likely significant variability in the relative value that women would place on each of the key outcomes and this variability is expected to lead to different decisions regarding autologous tissue or implant-based reconstruction.

Although some studies reported that TE/I reconstruction may be accompanied by a higher risk of reconstructive failure or soft tissue infection and that there is a trend toward decreased esthetic satisfaction over time, the Expert Panel believes that this evidence is insufficient at this time to support one option being superior over the other in the absence of radiation.

### Recommendation 7: Types of autologous tissue reconstruction

- In patients who will undergo unilateral autologous tissue reconstruction, pedicled TRAM, free TRAM, or deep inferior epigastric perforator (DIEP) flaps are all recommended options that are supported by positive patient-reported outcomes.
- In patients who will undergo bilateral autologous tissue reconstruction, DIEP flap is preferred over free or pedicled TRAM flap due to less functional disruption to the abdominal wall following surgery.
- Alternative autologous tissue donor types (e.g., gluteal flaps, thigh flaps) are suitable for selected patients in whom abdominal tissue is not available; however, the evidence on these types of reconstructions is very limited.
- All patients should be told of the risk of fat necrosis that can present as a nodule or mass after autologous tissue reconstruction, a benign condition that can mimic breast cancer recurrence. The risk of fat necrosis is likely to be greater following DIEP flaps compared with TRAM flaps.

### Key Evidence

- One meta-analysis by Man et al. found approximately one-half the risk of abdominal bulge or hernia development following DIEP flaps compared with TRAM flaps (relative risk [RR], 0.49; 95% confidence interval [CI], 0.28 to 0.86) [19]. Another meta-analysis showed a trend toward increased risk of abdominal bulge after TRAM flaps compared with DIEP flaps (RR, 0.80; 95% CI, 0.48 to 1.35; p=0.40) [20].
- Objective measures of abdominal wall function using isometric dynamometry show that bilateral pedicled TRAM flaps suffer the most deficit (up to 40% deficit in trunk flexion and 9% deficit in trunk extension) and a significant decrease in ability to perform sit-up compared with DIEPs. Functional deficits assessed by physiotherapy measures also revealed the greatest deficit in both rectus and oblique muscles after bilateral pedicled TRAM flaps, followed by free TRAM, whereas DIEP flaps returned to their preoperative rectus and oblique muscle functions [21].
- The risk of fat necrosis has been found to be significantly greatest following DIEP flaps (14.4%, p<0.001), followed by pedicled TRAM flaps (12.3%, p=0.04), and free TRAM flaps (6.9%, P<0.001) in a systematic review of 33 articles that analyzed more than 7233 flaps in 6394 patients [22].

### Interpretation of Evidence

- Key outcomes used to inform the recommendations on the different types of autologous tissue reconstruction are adverse effects, quality of life, and patient satisfaction. The certainty of the evidence for these outcomes is moderate. In terms of adverse effects, the trade-off between the development of compromised abdominal wall function and fat necrosis in the reconstructed breast needs to be presented to the
patient in a balanced fashion, and the final choice between DIEP, free or pedicled TRAM flaps will be up to the individual patient. There is moderate evidence that the DIEP flap may be a superior option to pedicled TRAM flaps in the growing subgroup of patients wishing to undergo bilateral autologous reconstruction to better preserve their abdominal muscle function following surgery.

**Recommendation 8 : Acellular dermal matrix**

- With the shortage of high-evidence studies on the use of Acellular dermal matrix (ADM), no recommendation can be made for or against the use of ADM as an adjunct to implant-based breast reconstruction.

**Qualifying Statements**

- It is the opinion of the Expert Panel that direct-to-implant reconstruction in a single stage using ADM may be used as an adjunct to implant-based breast reconstruction to improve esthetic outcomes in selected women who have smaller and non-pnototic breasts.
- Patient selection and surgical technique are critical to good outcomes.
- Other than improved esthetic outcomes, ADM has not been shown to have any other benefit for two-staged TE/I reconstruction.
- Esthetic outcomes, especially the inframammary fold, are potentially improved with the use of ADM in implant reconstruction.

**Key Evidence**

- A subgroup analysis in a systematic review by Clemens et al. suggested that there is a higher incidence of complications in women who received ADM in the setting of RT compared with women who did not receive RT [23].
- Two meta-analyses of implant-based reconstruction using ADM suggest that there are increased complications associated with the use of ADM [24,25].
- A RCT of 69 women comparing reconstruction with ADM versus submuscular placement of implants without ADM reported no significant difference in total complications, pain visual analogue scale, physical well-being, immediate 24-hour postoperative narcotic use, or intraoperative fill volume [26]. Outcomes not yet reported include esthetic outcomes, rate of capsular contracture, patient satisfaction, and quality of life.
- Two retrospective studies published since 2010 reported esthetic outcomes. One reported higher esthetic outcome overall and higher inframammary fold esthetic scores in the ADM group [27] and the other reported significantly higher esthetic scores in the ADM group for volume, placement, and inframammary fold but no significant difference for contour or scarring.

**Interpretation of Evidence**

Key outcomes used to inform this recommendation are cosmesis and adverse effects. The Expert Panel believes that the relative value placed on these outcomes is expected to vary significantly among women. The certainty of the evidence for these outcomes is low. There is currently insufficient evidence to determine whether the potential improvements in cosmesis, quality of life, and patient satisfaction and decrease in number of surgeries outweigh the higher risk of complications and cost. Generalizability of the evidence is highly variable based on patient and treatment factors.
### Recommendation 9: Autologous fat grafting

- With the shortage of high-evidence studies on the use of fat grafting, no recommendation can be made for or against the use of autologous fat grafting as an adjunct to improve esthetic outcomes in breast reconstruction.

#### Qualifying Statements

- Autologous fat grafting is a potential adjunct to improve esthetic outcomes in breast reconstruction following mastectomy; however, more high-quality evidence on the efficacy and safety of this procedure is necessary before its widespread implementation.

#### Key Evidence

- Two systematic reviews addressing the safety and oncological outcomes of autologous fat grafting suggested that fat grafting appeared to be safe but concluded that the evidence was inconsistent and further studies were required to determine that it is an effective and safe practice [28, 29].
- A low-quality, retrospective, matched cohort study of local recurrence in women with intraepithelial neoplasia by Petit et al. reported a higher rate of five-year local recurrence in women with fat grafting versus women without fat grafting in an exploratory subgroup analysis, although this difference was not statistically significant (18.4% versus 3.6%; p=0.11) [30].

#### Interpretation of Evidence

Key outcomes used to inform this recommendation are oncologic safety, adverse effects, and cosmesis. The Expert Panel believes that the relative value placed on these outcomes is expected to vary significantly among women. The certainty of the evidence for these outcomes is low. There is currently insufficient evidence to determine whether the potential improvements in cosmesis, quality of life, and patient satisfaction outweigh the potential risk of recurrence and complications. Generalizability of the evidence is highly variable based on patient, tumour, and treatment factors.

### Recommendation 10: Routine screening for breast cancer recurrence following postmastectomy breast reconstruction

- There is insufficient evidence to support the use of postmastectomy surveillance mammography in the reconstructed breast.
- Women should be followed with clinical examination of the chest wall and reconstructed breast as per the regular breast cancer follow-up regimen.
- Diagnostic mammography, ultrasound and magnetic resonance imaging may be helpful in the evaluation of symptomatic women with a reconstructed breast (e.g., lumps, skin changes).

#### Key Evidence

- A 2007 systematic review by Barnsley et al. identified eight small case series and/or case reports investigating the use of surveillance mammography following breast reconstruction [31]. Local recurrences were detected by surveillance mammography in only two studies.
- Three additional primary studies reported very low rates of detection of recurrence using surveillance mammography, with the majority of recurrences being detected by...
clinical examination. One retrospective study reported a recall rate of 4% due to suspicious or indeterminate findings [32].

**Interpretation of Evidence**

Certainty of the evidence for routine screening for breast cancer recurrence is very low. Critical outcomes informing the recommendations include recurrence, survival, and quality of life (e.g., anxiety and patient concern). The Expert Panel believes that the relative value placed on these outcomes is not expected to vary significantly among women.

The benefits of routine screening are anticipated to be small. It should be noted that there are few data on the effect of routine screening in subgroups by tumour characteristics or type of reconstruction.

**IMPLEMENTATION CONSIDERATIONS**

Issues related to the implementation of recommendations with respect to feasibility, patient considerations, equity, provider considerations, and system considerations were also considered by the Working Group and Breast Reconstruction Expert Panel. A formal Implementation Considerations statement was prepared by the Working Group and Breast Reconstruction Expert Panel and sent to the leadership of Cancer Care Ontario’s Surgical Oncology Program.

**RELATED GUIDELINES**


Breast cancer reconstruction surgery
(immediate and delayed) across Ontario:
Patient indications and appropriate surgical options

Section 3: Guideline Methods Overview

This section summarizes the methods used to create the guideline. For the systematic review, see Section 4.

THE PROGRAM IN EVIDENCE-BASED CARE
The Program in Evidence-Based Care (PEBC) is an initiative of the Ontario provincial cancer system, Cancer Care Ontario (CCO) [33]. The PEBC mandate is to improve the lives of Ontarians affected by cancer through the development, dissemination, and evaluation of evidence-based products designed to facilitate clinical, planning, and policy decisions about cancer control.

The PEBC supports the work of Guideline Development Groups (GDGs) in the development of various PEBC products. The GDGs are comprised of clinicians, other health care providers and decision makers, methodologists, and community representatives from across the province.

The PEBC is a provincial initiative of CCO supported by the Ontario Ministry of Health and Long-Term Care (OMHLTC). All work produced by the PEBC is editorially independent from the OMHLTC.

JUSTIFICATION FOR GUIDELINE
Guidelines on the appropriate use of postmastectomy breast reconstruction and the role of immediate reconstruction for breast cancer patients are needed for physicians and patients in Ontario to minimize the current disparities in care and provide equitable access to this surgery aimed at improving quality of life.

GUIDELINE DEVELOPERS
Development of the guideline was undertaken by the Breast Reconstruction Guideline Development Group and CCO’s PEBC at the request of the Surgical Oncology Program. The group is divided into the Breast Reconstruction Working Group and the Breast Reconstruction Expert Panel and comprises general surgeons, plastic surgeons, radiation oncologists, and a health research methodologist (see Appendix I for membership).

The project was led by a small working committee of the Breast Reconstruction Guideline Development Group (The Breast Reconstruction Working Group) whose members were responsible for creating the evidence base, drafting the first version of the recommendations, and leading the response to the external review. Other members of the Breast Reconstruction Guideline Development Group served as the Expert Panel and were responsible for the review and approval of the draft document produced by the Working Group. Conflict of interest declarations for all GDG members are summarized in Appendix I, and were managed in accordance with the PEBC Conflict of Interest Policy.

GUIDELINE DEVELOPMENT METHODS
The PEBC produces evidence-based and evidence-informed guidance documents using the methods of the Practice Guidelines Development Cycle [33,34]. This process includes a systematic review, interpretation of the evidence by the Working Group and draft
recommendations, internal review by content and methodology experts and external review by Ontario clinicians and other stakeholders.

The PEBC uses the AGREE II framework [35] as a methodological strategy for guideline development. AGREE II is a 23-item validated tool that is designed to assess the methodological rigour and transparency of guideline development.

The currency of each document is ensured through periodic review and evaluation of the scientific literature and, where appropriate, the addition of newer literature to the original evidence-base. This is described in the PEBC Document Assessment and Review Protocol. PEBC guideline recommendations are based on clinical evidence, and not on feasibility of implementation; however, a list of implementation considerations such as costs, human resources, and unique requirements for special or disadvantaged populations is provided along with the recommendations for information purposes. PEBC guideline development methods are described in more detail in the PEBC Handbook and the PEBC Methods Handbook.

Search for Existing Guidelines

As a first step in developing this guideline, a search for existing guidelines was undertaken to determine if an existing guideline could be adapted or endorsed. To this end, the following sources were searched for existing guidelines that addressed the research questions:

- Guideline developer websites: National Institute for Health and Care Excellence (NICE), Scottish Intercollegiate Guidelines Network (SIGN), and American Society of Clinical Oncology (ASCO).

In addition, the Breast Reconstruction Working Group was aware of a clinical practice guideline being developed by Alberta Health Services (AHS). The AHS guideline was completed and reviewed by the Working Group in September 2013. The following criteria were used to select potentially relevant guidelines: guidelines published in 2000 or later, English language, based on a systematic review of evidence, and addressed one or more of the clinical questions listed in Section 4, Evidence Review. Guidelines that were considered relevant to the objectives and the clinical questions were evaluated for quality using the AGREE II instrument [36].

For this guideline, a search for existing guidelines for adaptation or endorsement did not yield an appropriate source document. A summary of this process can be found in Appendix II. A search of the primary literature was required (see Section 4, Evidence Review).

Using this evidence, recommendations were drafted by the Working Group and approved by the Breast Reconstruction Expert Panel. The Working Group was responsible for the development of the first draft of the Guideline. Once this draft was completed the Breast Reconstruction Expert Panel was convened by CCO's Surgical Oncology Program with the purpose of reviewing and providing feedback on the first draft. The Working Group then amended the initial draft in response to the Expert Panels feedback which culminated into the final draft of the Guideline. The final draft of the Guideline was circulated for internal review to an independent committee of the PEBC and for external review to experts in the field (see Section 5, Internal and External Review). Refinements were made to the document in response to the feedback received and final recommendations approved by the guideline group. To achieve approval of the draft document and final document, a consensus by 75% of
the members of the Breast Reconstruction Expert Panel was required, with dissenting opinions noted, where appropriate.

Focus
The primary focus of this guideline is on the clinical evidence. Other features related to the implementation of recommendations such as costs, human resources, unique requirements for special or disadvantaged populations, development and measurement of quality indicators are addressed by other divisions at CCO. The perspectives of the Breast Reconstruction Expert Panel on these issues are described in Section 2.

GUIDELINE REVIEW AND APPROVAL

Internal Review
For the guideline document to be approved, 75% of the content experts who comprise the GDG Expert Panel must cast a vote indicating whether or not they approve the document, or abstain from voting for a specified reason, and of those that vote, 75% must approve the document. In addition, the PEBC Report Approval Panel (RAP), a three-person panel with methodology expertise, must unanimously approve the document. The Expert Panel and RAP members may specify that approval is conditional, and that changes to the document are required. If substantial changes are subsequently made to the recommendations during external review, then the revised draft must be resubmitted for approval by RAP and the GDG Expert Panel.

External Review
Feedback on the approved draft guideline is obtained from content experts and the target users through two processes. Through the Targeted Peer Review, several individuals with content expertise are identified by the GDG and asked to review and provide feedback on the guideline document. Through Professional Consultation, relevant care providers and other potential users of the guideline are contacted and asked to provide feedback on the guideline recommendations through a brief online survey. This consultation is intended to facilitate the dissemination of the final guidance report to Ontario practitioners.

ACKNOWLEDGEMENTS
The Breast Reconstruction Expert Panel and the Working Group would like to thank the following individuals for their assistance in developing this report:

- Melissa Brouwers, Nadia Coakley, Sheila McNair, Hans Messersmith, Norma Verela, Dr. Laurie Elit and Dr. Shail Varma, Dr. Andrea Eisen and Dr Kristen Gyetvai for providing feedback on draft versions.
- Elizabeth Chan for conducting a data audit.
- Sara Miller for copyediting.

A complete list of the members of the Breast Reconstruction Expert Panel and the Working Group, with their affiliations and conflict of interest information, is provided in Appendix I.
Breast cancer reconstruction surgery (immediate and delayed) across Ontario: Patient indications and appropriate surgical options

Section 4: Systematic Review

INTRODUCTION

In 2014, approximately 24,400 Canadian women were diagnosed with breast cancer, and breast cancer continues to be the most commonly diagnosed cancer in Canadian women over the age of 20 [37]. Since 39% of Canadians diagnosed with breast cancer undergo mastectomy, and the five-year survival rate for breast cancer is approximately 88%, the long-term deleterious side effects from the treatment of breast cancer are becoming both important and prevalent survivorship issues to consider. While some women with mastectomy have an excellent quality of life (QOL), for other women there are adverse psychosocial consequences including anxiety, depression, and negative effects on body image and sexual function [38-42].

Postmastectomy breast reconstruction (PMBR) has been shown to provide long-term QOL and psychosocial benefits to repair the physical and psychological damage from cancer surgery in many mastectomy patients [43-46]. However, PMBR delivery in Canada is currently inequitable and, in some areas, inaccessible; provincial rates of mastectomy with immediate PMBR (at same time as mastectomy) ranged from 7.6% in Ontario between 2004 to 2010 [47] to less than 2% in Nova Scotia for breast cancer patients [48], both markedly lower than the 29% reported by the Surveillance, Epidemiology, and End Results (SEER) database for the same time frame in the United States [49]. Additionally, mastectomy patients are often not provided with the full complement of PMBR options, and evidence to guide optimal PMBR practice is often poor [50-53].

The timing and method of PMBR are important considerations when choosing the optimal management strategy for breast cancer patients. There are currently two major surgical approaches to breast reconstruction: implant-based reconstruction and autologous tissue reconstruction. Timing can be immediate (at the same time as mastectomy) or delayed. Further to this, patient selection criteria and the impact of breast reconstruction to adjuvant therapy must be considered. In the past, the use of immediate breast reconstruction (IBR), as compared with delayed breast reconstruction (DBR), was an unpopular concept due to concerns that it may compromise surgical resection or decrease the detection of local recurrence [54,55]. Multiple procedures were required with prolonged hospital stays, and the final esthetic results were inconsistent [56]. Today, as the techniques of breast reconstruction have evolved, these concerns are no longer barriers to the use of IBR [5,45,57-59]. Advancements in autologous tissue techniques, refinements in implant technologies, the development of acellular dermal matrix (ADM), and IBR performed in concert with skin-sparing mastectomy (SSM) or nipple-sparing mastectomy (NSM) have resulted in favourable esthetic outcomes with minimal disruption to the patient’s lifestyle [60]. In Ontario, the rate of IBR in 2012 was 16% of all mastectomies, a twofold increase from 2002, but still differing significantly from data from the United States whose current rates are reported to be approximately 40% [47,61]. Therefore, guidelines on the appropriate use of PMBR for breast cancer patients are needed for physicians and patients in Ontario to minimize the current disparities in care and provide equitable access to this surgery aimed at improving QOL.
The mandate of the Institute for Health Care Improvement is to “usher in a new era of partnerships between clinicians and individuals where the values, needs, and preferences of the individual are honoured; the best evidence is applied; and the shared goal is optimal functional health and QOL” [62]. This process of shared decision making is the optimal model of care for patients considering breast reconstruction—surgery with many different treatment options each with its own advantages and disadvantages. It recognizes the expertise of both participants: the health care professionals as the expert in providing treatment options, benefits, harms, probabilities, and scientific uncertainties; and the patient as the expert in understanding her own personal circumstances and in judging the value or personal importance she attaches to each option.

In the ideal scenario, the decision to choose or decline breast reconstruction should be made by the patient after she has had the opportunity to learn about, discuss, and consider all the possible surgical treatment options for breast cancer. In many jurisdictions, access to breast reconstruction has become a quality indicator of the breast cancer treatment program [63]. In the United States, the National Accreditation Program for Breast Centers requires that a breast reconstruction program be a necessary component for any centers seeking or maintaining accreditation [64]. Recently, it has been legislated in both the United States as well as France, that options for breast reconstruction be discussed with the breast cancer patients by the physicians prior to committing to a surgical treatment [65]. In Canada, Alberta was the first province to publish new guidelines that have highlighted the importance of providing access to PMBR to eligible women as part of their breast cancer treatment [66].

In order to make recommendations as a part of a clinical practice guideline for breast cancer patients in Ontario, the multidisciplinary Working Group of the Breast Reconstruction Guideline Development Group developed this evidentiary base upon which those recommendations are based. Based on the objectives of the guideline, the Working Group derived the clinical questions outlined below.

CLINICAL QUESTIONS
1. Who is a candidate for PMBR? Which patient, cancer, and treatment factors can affect the outcomes of breast reconstruction?
2. a) What is the appropriate timing of breast reconstruction (immediate versus [vs.] delayed) for patients who do not require radiotherapy? 
b) What is the appropriate timing of breast reconstruction for patients who are expected to require radiotherapy?
3. a) What is the outcome of SSM compared with non-SSM? 
b) What is the outcome of NSM compared with non-NSM?
4. What are the risks and benefits associated with implant-based, autologous flap (i.e., deep inferior epigastric perforator [DIEP], transverse rectus abdominis myocutaneous [TRAM], superficial inferior epigastric artery [SIEA]) and combination (i.e., latissimus dorsi [LD] flap with implant) breast reconstruction?
5. What are the benefits and risks of using ADM in implant-based breast reconstruction?
6. What are the benefits and risks of autologous fat grafting as an adjunct to breast reconstruction?
7. Should women who have undergone PMBR receive routine screening for recurrence?
METHODS
This evidentiary base was developed using a planned two-stage method, summarized here and described in more detail below.

1. Search and evaluation of existing systematic reviews and practice guidelines: If one or more existing systematic reviews or evidence-based practice guidelines are identified that address the clinical questions and are of reasonable quality, then those would form the core of the evidentiary base.

2. Systematic review of the primary literature: This review would focus on those areas not covered by existing reviews if any are located and accepted.

The PEBC is supported by the Ontario Ministry of Health and Long-Term Care. All work produced by the PEBC and the Surgical Oncology Program is editorially independent from the Ministry.

Search for Systematic Reviews
The MEDLINE, EMBASE, and Cochrane Database of Systematic Reviews (CDSR) databases were searched from 2008 to June 2013 and using OVID to identify existing systematic reviews that addressed one or more of the clinical questions above. The search was later updated on May 13, 2014. Medical Subject Heading (MeSH) terms related to breast reconstruction were combined with relevant text words and a search filter to identify systematic review citations (See Appendix III for the complete search strategy). Systematic reviews published as a component of practice guidelines (not otherwise considered suitable for adaptation or endorsement) were also considered eligible for inclusion. The search was limited to the English language due to unavailability of translation services. If more than one systematic review was identified that addressed the same topic and reported the same outcomes, the most recent review was selected for further assessment. Identified systematic reviews that required further consideration were assessed using the AMSTAR tool, available at www.AMSTAR.ca [67]. The results of the AMSTAR assessment were used to determine whether an existing review could be incorporated as part of the evidentiary base.

Any identified reviews that did not meet the criteria above, whose AMSTAR assessments indicated important deficiencies in quality, or that were otherwise not incorporated as part of the evidence base were reported in the reference list, but not further described or discussed.

Search for Primary Literature
If no existing systematic review or evidence-based practice guideline was identified, or if identified reviews were incomplete or out of date, a systematic review of the primary literature was also planned. The criteria described below were written assuming no existing reviews would be incorporated.

Literature Search Strategy
A systematic search was conducted in OVID MEDLINE (2010 through September week 4 2013), OVID MEDLINE In-Process & Other Non-Indexed Citations (2010 through September week 4 2013) and OVID EMBASE (2010 through week 39 2013). The MeSH “exp breast neoplasms” was combined with additional terms and text words for breast cancer, mastectomy, breast reconstruction, surgical flaps, breast implants, acellular dermal matrix, and fat grafting. The results were limited to English language and articles published from 2010 to 2013. See Appendix III for the full search strategies.
**Study Selection Criteria and Process**

A review of the titles and abstracts that resulted from the search was performed by one reviewer (KS). For those items that warranted full-text review, one reviewer (KS) reviewed each item and consulted the rest of the Working Group whenever there was uncertainty.

Studies were included if they met the following criteria:

- Randomized controlled trials (RCTs), prospective cohort or retrospective case series of the following:
  - Effects of patient, cancer and treatment factors on outcomes of breast reconstruction; immediate vs. delayed reconstruction; reconstruction with vs. without radiation therapy (RT); SSM vs. non-SSM with reconstruction; NSM vs. non-NSM with reconstruction; SSM vs. NSM; mastectomy with vs. without reconstruction; mastectomy plus reconstruction vs. other type of reconstruction; reconstruction with ADM vs. no ADM; reconstruction with autologous fat grafting vs. no fat grafting; post-reconstruction routine screening for recurrence vs. no routine screening.
  - ≥30 patients
  - English language, due to unavailability of translation services
  - Published in 2010 or later

**Data Extraction and Assessment of Study Quality and Potential for Bias**

Data extraction was conducted by one author (KS) and was reviewed by a second independent individual using a data audit procedure (EC). Disagreements were resolved by consensus. The following items were extracted from each relevant article: author, publication year, study population, follow-up, procedure, number of participants, complications, and other outcomes.

Ratios, including hazard ratios (HRs), were expressed with a ratio <1.0 indicating that the experimental procedure had a better outcome than the control group.

Important quality features were assessed for each study. Quality features of interest included selection of subjects, comparability of groups, outcome assessment, and follow-up. The level of evidence to guide recommendations for PMBR is limited to Level II and III studies and a few smaller RCTs.

**Synthesizing the Evidence**

When clinically homogenous results from two or more trials were available, a meta-analysis was planned using the Review Manager software [68] provided by the Cochrane Collaboration. For time-to-event outcomes, HRs, rather than the number of events at a certain time point, would be the preferred statistic for meta-analysis, and would be used as reported. If the HR and/or its standard error were not reported, they would be derived from other information reported in the study, if possible, using the methods described by Parmar et al [69]. For all outcomes, the generic inverse variance model with random effects, or other appropriate random effects models in Review Manager would be used. Calculation of statistical heterogeneity was planned using the $\chi^2$ test for heterogeneity and the $I^2$ percentage. A probability level for the $\chi^2$ statistic less than or equal to 10% ($p \leq 0.10$) and/or an $I^2$ greater than 50% would be considered indicative of statistical heterogeneity.
RESULTS

Search for Existing Systematic Reviews

The original search for existing systematic reviews identified 91 citations, of which 38 were retrieved for full-text review. The updated search in May 2014 identified an additional 35 citations, of which 11 were reviewed in full text. Two additional reviews were identified using the PROSPERO registry of systematic review protocols [15,16]. Where multiple systematic reviews were identified that addressed the same outcomes and body of literature, only the most recent reviews are described in detail and assessed for quality. Thirty-five reviews [4,8-16,19-25,28,29,31,70-85] were selected for inclusion and were evaluated for quality using AMSTAR (www.AMSTAR.ca [67]) (Appendix IV). It should be noted that a review by Barnsley et al [31] was published outside of the literature review time constraints. It was identified by Working Group members. As this was the only systematic review that pertained to the use of magnetic resonance imaging in routine surveillance, it was added to the systematic reviews bringing the total number of systematic reviews to 36. There were no systematic reviews attached to Clinical Practice Guidelines identified for inclusion in this review.

Search for Primary Literature

Literature Search Results

Figure 4-1. Literature Search Results.

<table>
<thead>
<tr>
<th>Question</th>
<th>Number of studies included</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Candidates for breast reconstruction</td>
<td>2 systematic reviews</td>
<td>[4,70]</td>
</tr>
<tr>
<td></td>
<td>21 observational studies</td>
<td>[1-3,86-104]</td>
</tr>
<tr>
<td>2. Timing of reconstruction</td>
<td>6 systematic reviews</td>
<td>[9-11,71-73]</td>
</tr>
<tr>
<td></td>
<td>18 observational studies</td>
<td>[6,105-117]</td>
</tr>
<tr>
<td>3. Skin-sparing and nipple-sparing mastectomy</td>
<td>5 systematic reviews</td>
<td>[12-14,74,75]</td>
</tr>
</tbody>
</table>
### Study Design and Quality

Systematic reviews were assessed for quality using the AMSTAR criteria described at [www.AMSTAR.ca](http://www.AMSTAR.ca). Using these criteria, most reviews scored poorly (Appendix IV). Common limitations included lack of duplicate study selection and data extraction, use of only one database, failure to search grey literature, failure to provide a list of excluded studies, lack of quality assessment of included studies, lack of assessment of publication bias, and failure to provide information about conflict of interest for each of the included studies. Despite these limitations, it was believed that the existing systematic reviews provided valuable information to inform the clinical questions addressed in this review.

The majority of primary studies identified in the literature from 2010 to September 2013 were retrospective studies based on chart reviews or database audits, while some were prospective, nonrandomized cohorts, of which many did not include both an experimental and a control group. Common limitations of these studies included small sample size, selection bias, inconsistent measurement and collection of outcome data (information bias), and confounding. These lower level studies were retained because they represent the best available evidence to answer the clinical questions in the absence of high-quality RCTs. They were reviewed to determine whether new evidence confirmed or contradicted the results of the existing systematic reviews. There was no specific weighting of benefits and risks, or selection bias on what results were reported. The tables present all available evidence and outcomes and represent the constraints of the literature.

### Outcomes

**Clinical Question 1: Candidates for PMBR**

Two systematic reviews [4,70] and 22 prospective or retrospective studies with more than 200 patients published since 2010 were reviewed to inform the guideline recommendations on eligibility for PMBR. Walton et al. published a systematic review in 2011 to examine the available evidence on breast reconstruction in elderly women [4]. The authors reported that the evidence was limited in number and quality of studies; however, the available evidence seemed to demonstrate that complications from breast reconstruction in elderly women were comparable to those in younger women. Wolfswinkel et al. conducted a systematic review and meta-analysis of...
complications following abdominal-based free flap reconstruction in obese women and non-obese women. Results demonstrated a higher risk of infection (relative risk [RR], 1.97), mastectomy flap necrosis (RR, 2.61), partial flap loss (RR, 2.62), total flap loss (RR, 4.12), and donor site seroma (RR, 4.03) in obese women compared with non-obese women but no difference in overall donor site complications (RR, 1.09).

Primary studies specifically addressing the effect on patients, treatment, or disease factors on outcome of breast reconstruction that were published in 2010 or later were reviewed (Table 4-2). Of the 15 studies reviewed that addressed the effect of obesity on outcome, three were prospective studies [3,102,103], one was a cross-sectional survey [95], and the remainder were retrospective reviews of patient charts or databases. Statistical analyses and outcomes measured varied among studies. Most studies reported a significantly increased risk of complications with increasing body mass index (BMI). Types of postoperative complications commonly increased in obese women included flap loss, delayed wound healing, and postoperative complications overall. One study compared outcomes in women with morbid obesity vs. women with intermediate obesity [1] and reported significantly higher rates of major surgical complications, wound complications, and prosthesis or flap failure in women who were morbidly obese. The effect of smoking on complications of breast reconstruction was examined in five studies [3,86,87,91,104]. Three of the five studies did not detect a significant difference in complications between smokers and nonsmokers [86,87,91], one reported that smoking was the only factor significantly associated with complications overall in univariate analysis [104], and one study reported that flap complications, donor site complications and delayed wound healing were significantly higher in smokers than in nonsmokers who received abdominal autologous breast reconstruction [3]. Psychiatric illness was not assessed as a predictor of breast reconstruction outcome in any of the identified studies. The impact of older age was assessed in five studies [3,86,87,91,102]. Berry et al. reported significantly more overall complications and major complications in women over the age of 50 years with tissue expander/implant (TE/I) reconstruction but no difference in overall or major complications between age groups in women with autologous reconstruction [86]. One study reported no significant difference in overall complications, fat necrosis, thrombosis, or hematoma between age groups [87]. Khansa et al. reported that age over 50 years was a significant predictor of complications in multivariate analysis but was not a predictor of esthetic or general dissatisfaction [91]. Seidenstuecker et al. reported no significant differences in complications between age 65 years and older, and younger than 65 years [3] and Nelson et al. reported no significant difference in abdominal function following autologous abdominal free flap reconstruction between 60 years of age and older, and younger than 60 years [102]. The effect of diabetes on outcome of breast reconstruction was assessed in four studies [86,87,91,99]. One reported a significant association between diabetes and medical complications [99], two reported no significant difference in overall complications between diabetic and nondiabetic patients [87,91], and one reported a significantly higher overall complication rate in diabetic patients in univariate but not multivariate analysis [86]. Other factors were investigated included hypothyroidism, previous surgery, American Society of Anesthesiologists classification, neoadjuvant chemotherapy, tamoxifen, breast size, hypertension, chronic obstructive pulmonary disease, and tumour size.
Table 4-2. Candidates for breast reconstruction.

<table>
<thead>
<tr>
<th>Study</th>
<th>Type</th>
<th>Population</th>
<th>Participants</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| Berry 2010  | Retrospective, electronic clinical database | Autologous breast reconstruction, compared with prior single-centre review of TE/I reconstruction | 1037         | **Obesity**: TE/I reconstruction BMI >30 kg/m² vs. BMI <30 kg/m²: complications 49% vs. 27.5% (OR 1.93, 95% CI 1.48-2.52; p<0.001 logistic regression)  
Autologous reconstruction BMI >30 kg/m² vs. BMI <30 kg/m²: complications 48.2% vs. 25.7% (p<0.001 logistic regression). Multivariate analysis of major complications: OR 4.11 (95% CI 2.43-7.04; p<0.001)  
Smoking: No significant impact on complications  
**Older Age**: TE/I reconstruction age >50 years vs. age <50 years: complications 37% vs. 28.4% (OR 1.48, 95% CI 1.08-2.05; p=0.016 logistic regression).  
Major complications 30.8% vs. 20.6% (p=0.002).  
Autologous reconstruction age >50 vs. age <50: no significant impact on complications overall or major complications  
**Diabetes**: Total complications (diabetics vs. non-diabetics): 56.7% vs. 30.8% (p<0.004) in univariate analysis. Not significant risk factor in multivariate analysis. |
| Chang 2011  | Retrospective, single centre | Microsurgical breast reconstruction                                           | 650          | **Obesity**: The only significant predictor of overall complications in multivariate analysis  
Smoking: No significant impact on overall complications in a univariate analysis with X² test  
**Older Age**: No significant difference in overall complications, fat necrosis, or thrombosis/hematoma between age groups.  
**Diabetes**: No significant impact on overall complications in a univariate analysis with X² test  
**Other**: Hypothyroidism and previous surgery were not significantly related to overall complications. ASA classification correlated with increased risk of overall surgical complications. |
| Chen 2011   | Retrospective, multi-state database, insurance records                      | --                                                                          | 8000         | **Obesity**: Presence of any complication (reconstruction subgroup): 29.4% (obese) vs. 1.8% (control), p<0.001 |
| Hu 2011     | Retrospective, single centre                                              | Stage I–III breast cancer, mastectomy, chemotherapy, USA                   | 665          | **Obesity**: BMI >25 kg/m²: 56.9% vs 41.2%; p<.01 developed surgical complications  
**Older Age**: Aged >50 years: 53.6% vs. 38.4% p<0.01 developed surgical complications  
**Other**: Neoadjuvant chemotherapy: complications after mastectomy and immediate reconstruction: 35.7% with neoadjuvant chemotherapy vs. 37.4% with adjuvant chemotherapy (p=1.00) |
| Jandali 2011| Retrospective, single centre                                              | Autologous abdominal breast reconstruction, USA                            | 404 (25 BMI ≥40 kg/m²) | **Obesity**: BMI ≥40 kg/m² vs. <40 kg/m²: No significant difference in major intraoperative complications.  
Total flap loss 8% vs. 0.5% (p=0.02).  
Overall major postoperative complications: 12% vs. 3% (p=0.05).  
No major medical complications in morbidly obese group.  
Delayed abdominal wound healing 72% vs. 44% (p=0.006). |
| Khansa 2011 | Retrospective, single centre, online medical records and office charts     | Breast reconstruction, USA                                                  |              | |
Participants: 532 participants for 802 reconstructions
Outcomes:
- **Obesity**: Not a predictor of complications. Obesity decreased general satisfaction (OR 0.29; p<0.001)
- **Smoking**: Not a predictor of complications
- **Older Age**: Age >50 years a significant predictor of complications in multivariate analysis (OR 2.10; p<0.001).
  Age was not a predictor of esthetic or general dissatisfaction.
- **Diabetes**: Not a predictor of complications
- **Other**: Previous BCT vs. no prior history of BCT: Complications 36.5% vs. 27.1% (p=0.026) but multivariate analysis not significant (OR 1.09; p=0.690). Previous BCT not a significant factor for decreased esthetic or general satisfaction.

<table>
<thead>
<tr>
<th>Study</th>
<th>Type</th>
<th>Population</th>
<th>Participants</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seidenstuecker 2011</td>
<td>Prospective, single centre</td>
<td>Breast reconstruction, DIEP or free msTRAM, Germany</td>
<td>558</td>
<td><strong>Obesity</strong>: BMI ≥30 kg/m² had significantly more flap complications, total flap loss, marginal necrosis, donor site complications, and seroma formation</td>
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<tr>
<td></td>
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<td></td>
<td><strong>Smoking</strong>: Flap complications, donor site complications (p=0.007) and delayed wound healing (p=0.001) were significantly higher in smokers compared with nonsmokers</td>
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<td></td>
<td></td>
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<td></td>
<td><strong>Older Age</strong>: No significant difference in complications between age ≥65 years and age &lt;65 years</td>
</tr>
<tr>
<td>Donker 2012</td>
<td>Retrospective, single centre</td>
<td>Invasive malignancy, skin-sparing mastectomy with immediate reconstruction, subpectoral prosthetic implant, Netherlands</td>
<td>213</td>
<td><strong>Other</strong>: Neoadjuvant chemotherapy vs. no neoadjuvant chemotherapy: significantly less short-term postoperative complications (15% vs. 29%; p=0.042) and no difference in loss of implant (8% vs. 11%; p=0.566)</td>
</tr>
<tr>
<td>Garvey 2012</td>
<td>Retrospective, single centre</td>
<td>Abdominal-based free flap breast reconstruction, obese (BMI ≥30 kg/m²)</td>
<td>700</td>
<td><strong>Obesity</strong>: Overall complications: 39.5%. Flap vs. implant: 42.3% vs. 35.9% (p=0.04). Significantly more reconstruction loss, infection and hematoma/seroma with implants vs. flaps. More delayed wound healing with flaps. BMI ≥37 kg/m² vs. BMI &lt;37 kg/m²: complications 47.1% vs. 37.4% (p=0.01).</td>
</tr>
<tr>
<td>Kelley 2012</td>
<td>Retrospective, single centre</td>
<td>Delayed microvascular breast reconstruction, USA</td>
<td>670</td>
<td><strong>Other</strong>: Tamoxifen vs. no tamoxifen: complications 21.5% vs. 15% (p=0.04). Significantly increased immediate total flap loss and lower rate of flap salvage but no difference in pulmonary embolus.</td>
</tr>
<tr>
<td>Kulkarni 2012</td>
<td>Cross-sectional survey</td>
<td>DCIS or invasive breast cancer, age ≤79 kg/m², obese, USA</td>
<td>374</td>
<td>Surgical outcome satisfaction similar among normal weight, overweight, and obese patients</td>
</tr>
<tr>
<td>Ochoa 2012</td>
<td>Retrospective, single centre</td>
<td>Consecutive DIEP flap patients, USA</td>
<td>418</td>
<td><strong>Obesity</strong>: Delayed wound healing: significantly higher rate in severely obese patients compared with lower BMI. Overall and other flap complications not significantly different between BMI groups.</td>
</tr>
<tr>
<td>Duggal 2013</td>
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<tr>
<td>Study</td>
<td>Type</td>
<td>Population</td>
<td>Participants</td>
<td>Outcomes</td>
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<tr>
<td>Fischer 2013 [1,2]</td>
<td>Retrospective, single centre</td>
<td>Unilateral breast reconstruction, documented mastectomy specimen weight, USA</td>
<td>355</td>
<td>Breast size: Overall complications 44%. Patients with complications had significantly higher mean mastectomy specimen weights than those without complications (p&lt;0.01).</td>
</tr>
<tr>
<td>Fischer 2013 [99]</td>
<td>Retrospective, free flap database, single centre</td>
<td>Abdominal free-flap breast reconstruction, USA</td>
<td>812</td>
<td>Obesity: Higher incidence of complications with increased BMI. Morbid obesity was associated with significantly higher rates of total flap loss, delayed wound healing, hernia, and abdominal morbidity.</td>
</tr>
<tr>
<td>Hanwright 2013 [100]</td>
<td>Retrospective, national database (NSQIP)</td>
<td>Breast reconstruction (autologous or implant), USA</td>
<td>12,986</td>
<td>Obesity: Overall morbidity significantly higher in obese patients. BMI correlated with increased surgical complications for tissue expander, pTRAM and free flaps. Medical complications higher in obese pts with tissue expander and pTRAM but not LD or free flap reconstructions.</td>
</tr>
<tr>
<td>Kneubil 2013 [101]</td>
<td>Retrospective, single centre, consecutive patients</td>
<td>Total mastectomy, SSM or NSM for primary unilateral invasive breast cancer, immediate reconstruction, no neoadjuvant treatment, Italy</td>
<td>1742</td>
<td>Obesity: BMI significantly associated with risk of locoregional recurrence in univariate and multivariate analysis. Other: Tumour size significantly associated with risk of locoregional recurrence in univariate and multivariate analysis. Triple negative and luminal B/HER2-positive subtypes were associated with higher risk of locoregional recurrence in multivariate analysis.</td>
</tr>
<tr>
<td>Nelson 2013 [102]</td>
<td>Prospective blinded cohort</td>
<td>Autologous abdominal free flap reconstruction, immediate reconstruction, USA</td>
<td>145</td>
<td></td>
</tr>
</tbody>
</table>
Older Age: Age ≥60 years vs. age <60 years: no significant difference in abdominal function

Study: Schaverien 2013 [103]
Type: Prospective cohort
Population: Immediate free flap breast reconstruction, SSM, UK
Participants: 87
Outcomes:
  Other: Neoadjuvant chemotherapy vs. none: no significant difference in complications overall or reoperations

Study: Yezhelyev 2013 [104]
Type: Retrospective, single centre
Population: LD flap reconstruction
Participants: 277
Outcomes:
  Obesity: Incidence of overall complications, flap complications and donor site complications not significantly different between obese, overweight and normal weight patients.
  Smoking: Smoking was only factor on univariate analysis associated with higher incidence of complications (p=0.031)

Abbreviations: ASA: American Society of Anesthesiologists; BCT: breast-conserving therapy; BMI: body mass index; CI: confidence interval; COPD: Chronic obstructive pulmonary disease; DCIS: ductal carcinoma in situ; DIEP: deep inferior epigastric perforator flap; LD: latissimus dorsi; mSTAM: muscle-sparing TRAM; NSM: nipple-sparing mastectomy; NSQIP: National Surgical Quality Improvement Program; OR: odds ratio; pTRAM: pedicled TRAM; TE/I: tissue expander/ implant; TRAM: transverse rectus abdominis myocutaneous; SSM: skin-sparing mastectomy; vs. versus

Clinical Question 2: Timing of breast reconstruction
Immediate vs. delayed reconstruction
Systematic reviews

Five systematic reviews were identified that compared immediate vs. delayed reconstruction or reconstruction before vs. after RT in women undergoing mastectomy for breast cancer: three addressed autologous reconstruction [9,11,71] and two reviewed studies of implant-based reconstruction [72,73]. One of the reviews was limited to RCTs only and included women with or without RT [73] while the others included observational studies in which all women received RT [9,11,71,72].

The Cochrane review by D’Souza et al. was limited to RCTs, of which only one was found [73]. The RCT was published in 1983 by Dean et al. and included only 64 participants [5]. In the IBR group, silicone subpectoral prosthesis was provided for 33 participants. In the DBR group, 31 patients were advised about an implant but only six chose to undergo reconstruction 12 months postmastectomy. At three months, the rate of psychiatric morbidity was lower in patients receiving IBR compared with women in the control group (7% vs. 36%; p=0.05). By 12 months, no difference was detected (4% vs. 10%; p=NS). In addition, by three months, 67% of patients in the IBR group had returned to work vs. 46% in the control group. At three months, 37% of patients reported feeling ugly and mutilated in the IBR group vs. 67% in the DBR group and this did not change by 12 months (p=0.05 for both time points). The RCT was deemed to be at high risk of bias; limitations include its small sample size, absence of information about random sequence generation and allocation concealment, lack of blinding of outcome assessors, incompleteness of outcome data, and possible sampling bias. In addition, Momoh et al. performed a systematic review in 2014 comparing implant reconstruction with RT given pre-reconstruction (often with delayed reconstruction) or following reconstruction (often with immediate reconstruction) [72]. Twenty-six observational studies were identified with more than 1500 patients. For the comparison of pre-reconstructive radiation vs. post-reconstructive radiation, similar results between groups were reported for major complication rates (49% vs. 39%), capsular contracture (25% vs. 32%), and reconstructive failure (19% vs. 20%).
Three systematic reviews examined observational studies comparing immediate vs. delayed autologous breast reconstruction in the context of RT [9,11,71]. A 2011 review by Barry et al. [11] included three studies comparing immediate and delayed TRAM flap breast reconstruction with RT, all of which were also included in the Schaverien review [9], and is not discussed further. Schaverien et al. [9] published a systematic review in 2013 including 16 studies: 12 studies included both an immediate and delayed reconstruction group and four studies contributed data only for delayed reconstruction. All patients received RT before or after reconstruction. The meta-analysis of data from observational studies demonstrated a lower rate of reoperation in women with delayed reconstruction compared with immediate reconstruction (mean 1.4% vs. 15.1%; odds ratio [OR], 0.15; 95% confidence interval [CI], 0.05 to 0.48; p=0.001) but no significant difference in overall complications (mean 32.5% vs. 32.6%; OR, 1.13; 95% CI, 0.77 to 1.65; p=0.53) or fat necrosis (mean 14.9% vs. 22.2%; OR, 0.63; 95% CI, 0.39 to 1.38; p=0.25). Kelley et al. [71] published a systematic review in 2014 of 20 studies examining autologous reconstruction before or after RT, the majority of which were not included in the Schaverien review [9]. Due to heterogeneity among studies, a meta-analysis was not conducted; however, rates and 95% CIs were calculated for each type of complication. The following postoperative complication rates were similar between delayed reconstruction after RT and immediate reconstruction before RT: wound healing (10% vs. 14%), infections (4% vs. 6%), hematoma (2% vs. 1%), seroma (4% vs. 4%), and total flap loss (1% vs. 4%). The systematic reviews included for this outcome are all subject to the limitations with using observational studies as the evidentiary base. The majority of studies involved small patient populations from single centres with retrospective analysis and variable follow-up periods.

**Primary studies**

Seven studies were identified that compared immediate vs. delayed breast reconstruction. Two were prospective studies [6,105] and five were retrospective reviews of patient charts or databases (see Table 4-3, below) [106-110]. One of the studies compared delayed reconstruction with delayed immediate reconstruction [106]. Use of adjuvant RT varied across studies: in two studies, all women received adjuvant RT [105,106]; in two studies, some women received adjuvant RT [107,109]; in two studies no women received adjuvant RT [108,110]; and in one study, the use of adjuvant RT was not reported [6].

Complications of immediate vs. delayed reconstruction were addressed in three studies [105,108,109]. In a prospective pilot study, Giacalone et al. reported no significant difference in early or late complications except a higher rate of marginal back skin flap necrosis in the immediate reconstruction group (19.3% vs. 5.1%; p=0.04). Baltaci Goktas et al. reported no significant difference in surgical complications or arm lymphedema between groups but significantly higher RT complications with immediate reconstruction in the subgroup of women who received RT (75% vs. 6%; p=0.01); however, it should be noted that only four women in the immediate reconstruction group received RT compared with 17 women in the delayed reconstruction group [109]. In the setting of implant-based reconstruction without RT, Hvilsom et al. reported significantly higher rates of hematoma and seroma after immediate two-stage TE/l reconstruction compared with delayed two-stage reconstruction [108]. No significant difference was observed in rates of infection, capsular contracture, asymmetry or displacement of the implant, or reoperation. Patel et al. compared delayed autologous reconstruction with delayed-immediate
autologous reconstruction in the setting of adjuvant RT and reported no significant difference in total complications (first-stage reconstruction), vascular complications (second-stage), or non-vascular complications (second-stage); however, reoperations were significantly higher in the delayed immediate group (78.8% vs. 60.8%; p=0.008) [106].

One study reported on the delay to adjuvant chemotherapy with immediate reconstruction [110]. Immediate reconstruction was associated with a modest but statistically significant delay in initiating chemotherapy. The authors concluded that this delay was unlikely to have any clinical significance for most women.

A comparison of esthetic outcomes, QOL, or satisfaction between immediate and delayed reconstruction was reported in three studies [6,105,109]. Giacolone et al. reported that there was no significant difference in esthetic outcome (medical or patient evaluation) for women who were disease free and had no reconstructive failure [105]. In the study by Baltaci Goktas et al., the rates of serious sexual problems, loss of feminine feeling, deterioration of body image, and decrease of self-esteem were significantly higher in the delayed reconstruction group compared with the immediate reconstruction group [109]. In a Canadian prospective study of 190 women by Metcalfe et al. [6], women undergoing delayed reconstruction had higher levels of body stigma (p=0.01) and body concerns (p=0.002) than women who underwent immediate reconstruction. At one-year follow-up there was no difference between treatment groups, although psychological distress was evident among all women regardless of timing of reconstruction. Psychological functioning including quality of life, sexual functioning, cancer-related distress, and body image was not different at one year post-surgery in the immediate and delayed reconstruction groups.

Four primary studies (all retrospective and single centre studies) were identified that specifically compared RT before vs. after breast reconstruction [111-114]. Three studies reported no significant difference in the overall complication rate between groups [111-113]. Adesiyun et al. reported that there was no significant difference in early complications between groups but the rate of late complications was significantly higher in women who received RT after reconstruction compared with women who received RT before reconstruction [111]. In women who received implant reconstruction, capsular contracture was significantly higher in women who received RT after reconstruction. Lentz et al. compared TE/I exchange before vs. after RT and observed no significant difference in reconstructive failure but significantly more capsular contracture in women who had TE/I exchange before RT [113]. Pestana et al. observed a higher rate of failed reconstruction in women who had RT after reconstruction compared with women who had RT before reconstruction [114]. Overall general satisfaction and esthetic satisfaction were reported in two studies and neither detected a significant difference between the reconstruction before RT and reconstruction after RT groups [111,112].

Immediate reconstruction with vs. without postmastectomy RT
Systematic reviews

Schaverien et al. published a systematic review in 2013 comparing immediate autologous breast reconstruction with RT vs. without RT [9]. Twenty-five studies were evaluated: 10 were observational studies comparing immediate reconstruction with and without RT and 15 studies contributed data only to the postoperative RT group. Although no difference was observed in overall complications (33.9% vs. 28.6%; OR, 1.10; 95% CI, 0.78 to 1.54; p=0.59; five studies) or reoperations (18.3% vs. 16.1%; OR,
0.65; 95% CI, 0.25 to 1.68; p=0.38; three studies), fat necrosis was increased with the use of RT (23.8% vs. 8.5%; OR, 2.82; 95% CI, 1.35 to 5.92; p=0.006; six studies). In addition, esthetic outcome was decreased in four of seven studies where patients received RT and volume loss in the flap was observed in two of three studies with rates as high as 77%.

Two systematic reviews with meta-analyses addressed the effects of postmastectomy RT specifically on immediate implant-based reconstruction [10,11]. Lam et al. [10] reviewed 12 observational studies (one prospective and 11 retrospective) of immediate two-stage reconstruction and reported a higher reconstruction failure rate in women who received RT (18.6% vs. 3.1%; p<0.00001; seven studies). This increased failure rate was particularly evident when RT was given after stage 1 placement of the tissue expander (29.7% vs. 5%; p<0.00001; six studies). In the 2011 systematic review by Barry et al. [11], pooled data from four observational studies demonstrated that women undergoing immediate implant-based reconstruction in the presence of postmastectomy RT had fourfold greater odds of suffering morbidity compared with women not requiring RT (OR, 4.2; 95% CI, 2.4 to 7.2).

Primary studies

Four retrospective studies were identified that compared complications for immediate reconstruction with vs. without adjuvant RT (See Table 4-3, below) [112,115-117]. Christante et al. reported a significantly higher overall complication rate and TE/I loss rate in women who received immediate reconstruction plus RT compared with women who did not receive RT [115]. Similarly, Lee et al. reported a higher overall complication rate with RT [112]. A study of free flap reconstructions by Fosnot et al. reported significantly higher rates of overall vascular complications and intraoperative vascular complications with RT but no difference in delayed vascular complications, fat necrosis, wound infection, skin flap necrosis, hematoma, seroma, delayed wound healing, or flap loss [116]. Lin et al. reported more major complications, wound dehiscence and failure to expand in women who received RT in the setting of two-stage implant-based reconstruction [117].
## Table 4-3. Timing of reconstruction and radiotherapy

<table>
<thead>
<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants</th>
<th>Complications</th>
<th>Other outcomes</th>
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</thead>
<tbody>
<tr>
<td><strong>Immediate vs. delayed reconstruction</strong></td>
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<tr>
<td>Alderman 2010 [110] Retrospective, multi-centre</td>
<td>Stage I-III unilateral breast cancer for which NCCN guidelines recommended adjuvant chemotherapy; no neoadjuvant RT or chemotherapy, no RT before initiation of adjuvant therapy; USA</td>
<td>NR</td>
<td>Mastectomy with immediate reconstruction</td>
<td>696 with either immediate or delayed reconstruction</td>
<td>NR</td>
<td>Time to chemotherapy from definitive surgery (delayed/immediate)(^a): Age 0-39 years: HR, 2.27 (95% CI, 1.49 to 3.46) Age 40-49 years: HR, 1.38 (95% CI, 0.98 to 1.96) Age 50-59 years: HR, 1.44 (95% CI, 0.88 to 2.34) Age &gt;60 years: HR, 1.50 (95% CI, 0.64 to 3.54)</td>
</tr>
<tr>
<td>Giacalone 2010 [105] Prospective pilot study</td>
<td>Non-metastatic invasive breast cancer, mastectomy, neoadjuvant chemotherapy and RT plus immediate reconstruction or adjuvant chemotherapy and RT plus delayed reconstruction</td>
<td>Mean 4.7 yrs (immediate reconstruction) and 4.5 yrs (delayed reconstruction)</td>
<td>Neoadjuvant chemotherapy and RT, IBR Adjuvant chemotherapy and RT, delayed reconstruction</td>
<td>26 78</td>
<td>Early complications: 61% vs. 56% (p=0.645). No difference in breast skin envelope necrosis, marginal LD flap necrosis, implant infection, hematoma, or dorsal seroma. Marginal back skin flap necrosis 19.3% vs. 5.1% (p=0.04) Late complications: 31% vs. 22% (p=0.362). No difference in capsular contracture, back pain, reconstruction failure, implant revision capsule, total implant revision, or symmetrization procedure</td>
<td>Esthetic outcome (for disease-free patients and patients with no reconstructive failure): No significant difference between groups in medical evaluation (77.7% excellent or good vs. 87%) or patient evaluation (89% vs. 94%)</td>
</tr>
<tr>
<td>Author, publication year, study design</td>
<td>Study population</td>
<td>Follow-up</td>
<td>Procedure</td>
<td># of participants</td>
<td>Complications</td>
<td>Other outcomes</td>
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<tr>
<td>Losken 2010 [107] Retrospective chart review, single centre</td>
<td>Postmastectomy breast reconstruction using bilateral LD flaps, 17/83 patients had pre- or postoperative RT; USA</td>
<td>Average 2.3 years</td>
<td>Immediate reconstruction, Delayed reconstruction, Mixed</td>
<td>52, 22, 8</td>
<td>Insufficient data for analysis of reconstruction timing</td>
<td>Need for additional procedures: no significant association with timing of reconstruction; Overall patient satisfaction (n=37): No significant difference for RT vs. no RT or timing of reconstruction</td>
</tr>
<tr>
<td>Baltaci Goktas 2011 [109] Retrospective, single centre</td>
<td>Breast cancer, immediate or delayed reconstruction, earlier pathological stage in immediate reconstruction group, 41% had RT; Turkey</td>
<td>10.5 months (immediate) and 12 months (delayed)</td>
<td>Immediate reconstruction, Delayed reconstruction</td>
<td>28 (4 had adjuvant RT), 23 (17 had adjuvant RT)</td>
<td>Arm lymphedema: 14% vs. 39% (p=0.05), Surgical complications: 7% vs. 17% (p=0.19), Radiotherapy complications (in patients who received RT): 75% vs. 6% (p=0.01)</td>
<td>Sexual problems: serious 18% vs. 57%, mild 36% vs. 26% (p=0.01), Loss of feminine feeling: 21% vs. 57% (p=0.02), Deterioration of body image: 39% vs. 83% (p=0.04), Decrease of self-esteem: 25% vs. 70% (p=0.03)</td>
</tr>
<tr>
<td>Author, publication year, study design</td>
<td>Study population</td>
<td>Follow-up</td>
<td>Procedure</td>
<td># of participants</td>
<td>Complications</td>
<td>Other outcomes</td>
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<tr>
<td>Hvilsom 2011 [108] Retrospective, national database</td>
<td>Immediate implant breast reconstruction (one stage or two-stage) or delayed two-stage reconstruction, breast cancer, no RT; Denmark</td>
<td>10.1 yrs (immediate reconstruction)</td>
<td>Immediate one-stage reconstruction</td>
<td>40</td>
<td>Overall complications at 1 year (two-stage reconstructions): 51.7% vs. 44.5%</td>
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<td>Immediate two-stage reconstruction</td>
<td>149</td>
<td>Overall complications at 8 yrs (two-stage): 76.2% vs. 67.2%</td>
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<tr>
<td></td>
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<td></td>
<td>Delayed two-stage reconstruction</td>
<td>353</td>
<td>Higher risk of hematoma and seroma after immediate compared with delayed two-stage reconstruction (p=0.044 and p=0.017)</td>
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<td></td>
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<td>Mastectomy</td>
<td>24</td>
<td>No significant difference in infection, capsular contracture, asymmetry, implant displacement, or reoperation between immediate and delayed two-stage reconstruction.</td>
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<td></td>
<td>Mastectomy with immediate reconstruction</td>
<td>57</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Delayed reconstruction</td>
<td>109</td>
<td>Psychosocial functioning: At 1 year follow-up, no significant differences in psychosocial functioning scores between groups</td>
<td></td>
</tr>
<tr>
<td>Metcalfe 2012 [6] Prospective longitudinal survey, two centres</td>
<td>Primary invasive breast cancer, RT not reported; Canada</td>
<td>1 year follow-up</td>
<td>Mastectomy with immediate reconstruction</td>
<td>24</td>
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<td></td>
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<td></td>
<td>Delayed reconstruction</td>
<td>57</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Mastectomy alone</td>
<td>109</td>
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</table>
### Author, publication year, study design | Study population | Follow-up | Procedure | # of participants | Complications | Other outcomes |
<table>
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<tr>
<td><strong>Patel 2013 [106]</strong> Retrospective, single centre</td>
<td>Autologous breast reconstruction, adjuvant RT, delayed or delayed immediate reconstruction; USA</td>
<td>Average 3.2 years (delayed) and 2.8 years (delayed immediate)</td>
<td>Delayed reconstruction</td>
<td>118 breasts 74 breasts</td>
<td>Total complications (first stage reconstruction): 8.5% vs. 10.8% (p=0.81)</td>
<td>Revision surgery: 60.8% vs. 78.8% (p=0.008), including skin contouring, soft tissue contouring, fat grafting</td>
</tr>
<tr>
<td><strong>Christante 2010 [115]</strong> Retrospective, single centre, consecutive pts</td>
<td>Primary nonmetastatic unilateral breast cancer, mastectomy; USA</td>
<td>Median 31 months</td>
<td>Immediate reconstruction plus PMRT Immediate reconstruction alone</td>
<td>302</td>
<td>Complication rate (IBR ± PMRT): 42% vs. 16%; OR 3.3 (95% CI, 1.5 to 7.1; p&lt;0.001) Complication rate (PMRT with IBR vs. delayed reconstruction): 42% vs. 22% (p≤0.001) TE/I loss rate: 31% vs. 6% (p=0.005)</td>
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</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants</th>
<th>Complications</th>
<th>Other outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee 2010 [112] Retrospective, single centre</td>
<td>Simple or modified radical mastectomy, unilateral or bilateral, no previous RT for failed BCT, autologous or implant; USA</td>
<td>Median 28.3 months, 63.6 months, and 56.8 months for the 3 groups, respectively</td>
<td>PMRT then reconstruction</td>
<td>57 59 665</td>
<td>Overall complication rate (any PMRT vs. none): 39.7% vs. 23.2% (p&lt;0.001) Overall complication rate (reconstruction then PMRT vs. reconstruction only): 47.5% vs. 23% (p&lt;0.001) Early complications: 17.5% vs. 15.6% vs. 7.7%</td>
<td>Overall general satisfaction (n=536): 67.5% vs. 68.4% vs. 67.2% Esthetic satisfaction (n=536): 50.0% vs. 63.2% vs. 66.9%</td>
</tr>
<tr>
<td>Fosnot 2011 [116] Retrospective chart review</td>
<td>Free flap breast reconstructions, unilateral or bilateral, 22% of flaps in previously irradiated field; USA</td>
<td>NR</td>
<td>No RT RT</td>
<td>799 flaps 226 flaps</td>
<td>Flaps with any vascular complication: 9.6% vs. 17.3% (p=0.001) Flaps with intraoperative vascular complication (arterial or venous thrombosis, technical difficulties): 7.6% vs. 14.2% (p=0.003) Flaps with delayed vascular complication (arterial or venous thrombosis, other delayed issues): 2.4% vs. 4.0% (p=0.19) No significant difference in fat necrosis, wound infection, skin flap necrosis, hematoma, seroma, delayed wound healing, or flap loss</td>
<td>--</td>
</tr>
<tr>
<td>Author, publication year, study design</td>
<td>Study population</td>
<td>Follow-up</td>
<td>Procedure</td>
<td># of participants</td>
<td>Complications</td>
<td>Other outcomes</td>
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<tr>
<td>Lin 2012 [117] Retrospective, single centre</td>
<td>Two-stage prosthetic breast reconstruction following modified radical mastectomy, unilateral or bilateral, 18% of breasts had previous RT exposure; USA</td>
<td>Minimum 6 months, mean 26.3 to 28.4 months</td>
<td>Neoadjuvant RT</td>
<td>32</td>
<td>Major complication rates: 43.8% vs. 41.2% vs. 13.8%.</td>
<td>--</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Adjuvant RT</td>
<td>17</td>
<td>Wound dehiscence: 21.9% vs. 23.5% vs. 1.8%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No RT</td>
<td>218</td>
<td>Failure to expand: 18.8% vs. 11.8% vs. 0.5%</td>
<td></td>
</tr>
<tr>
<td>Momoh 2012 [171] Retrospective, operating room records, consecutive patients, single centre</td>
<td>Delayed autologous reconstruction after mastectomy and adjuvant therapy; USA</td>
<td>Mean 33.3 months (RT) and 39.4 months (no RT)</td>
<td>RT</td>
<td>100</td>
<td>Total complications: 40% vs. 20.2% (p=0.0023)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No RT</td>
<td>99</td>
<td>Wound dehiscence: 11% vs. 3% (p=0.0489)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No significant difference in flap loss, vascular thrombosis, fat necrosis, infection, or seroma</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Overall complications similar in women reconstructed early or late after PMRT</td>
<td></td>
</tr>
<tr>
<td>Lee 2010 [112] Retrospective, single centre</td>
<td>Simple or modified radical mastectomy, unilateral or bilateral, no previous RT for failed BCT, autologous or implant; USA</td>
<td>Median 28.3 months, 63.6 months, and 56.8 months for the 3 groups, respectively</td>
<td>PMRT then reconstruction</td>
<td>57</td>
<td>Overall complication rate (PMRT then reconstruction vs. reconstruction then PMRT): 31.6% vs. 47.5% (p=0.081)</td>
<td>Overall general satisfaction (n=536): 67.5% vs. 68.4% vs. 67.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reconstructio n then PMRT</td>
<td>59</td>
<td>Early complications: 17.5% vs. 15.6% vs. 7.7%</td>
<td>Esthetic satisfaction (n=536): 50.0% vs. 63.2% vs. 66.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Breast reconstructi on only</td>
<td>665</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Author, publication year, study design

<table>
<thead>
<tr>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants</th>
<th>Complications</th>
<th>Other outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adesiyun 2011 [111] Retrospective chart review, single centre</td>
<td>Postmastectomy breast reconstruction, PMRT, 87% received chemotherapy, autologous or implant; USA</td>
<td>Median 46.5 months</td>
<td>PMRT then reconstruction then PMRT</td>
<td>57</td>
<td>Overall complication rate: 32% vs. 44% (p=0.176)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>57</td>
<td>Early complications: 18% vs. 11% (p=0.210)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Late complications: 14% vs. 33% (p=0.009)</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td>Capsular contracture in patients with implant reconstruction: 2% vs. 19% (p=0.002)</td>
</tr>
<tr>
<td>Lentz 2013 [113] Retrospective, single centre</td>
<td>TE/I reconstruction for breast cancer, postmastectomy RT</td>
<td>Mean 46.0 months (exchange before RT) and 27.3 months (exchange after RT)</td>
<td>TE/I exchange before RT</td>
<td>22</td>
<td>Reconstructive failure: 13.6% vs. 20.6% (p=0.72)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TE/I exchange after RT</td>
<td>34</td>
<td>Overall complications: 54.5% vs. 47.1% (p=0.785)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Capsular contracture: 40.9% vs. 11.8% (p&lt;0.05)</td>
</tr>
<tr>
<td>Pestana 2013 [114] Retrospective, consecutive patients, single centre</td>
<td>Breast cancer, mastectomy and breast reconstruction, autologous or implant, immediate or delayed, RT before or after reconstruction; USA</td>
<td>Mean 6 years</td>
<td>RT before reconstruction</td>
<td>94 breasts</td>
<td>Failed reconstruction: 16% vs. 37% (p=0.003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RT after reconstruction</td>
<td>63 breasts</td>
<td></td>
</tr>
</tbody>
</table>

**Other comparisons**
<table>
<thead>
<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants</th>
<th>Complications</th>
<th>Other outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baumann 2011 Retrospective, single centre</td>
<td>Locally advanced breast cancer, delayed breast reconstruction, free TRAM or DIEP or SIEA, no tissue expander; USA</td>
<td>Median 302 days (delay &lt;12 months) and 211 days (delay &gt;12 months)</td>
<td>Delayed breast reconstruction &lt;12 months after mastectomy</td>
<td>82</td>
<td>Total flap loss: 6% vs. 0% (p=0.014)</td>
<td>Reoperation &lt;30 days: 14.6% vs. 4.7% (p=0.022)</td>
</tr>
<tr>
<td>Peled 2012 Retrospective, surgical outcomes database, consecutive cohorts, single centre</td>
<td>Postmastectomy RT and two-stage expander implant reconstruction, skin-sparing or total skin-sparing, 98% had neoadjuvant or adjuvant chemotherapy; USA</td>
<td>Mean 31 months</td>
<td>Expander-implant exchange &lt;6 months after RT</td>
<td>49</td>
<td>Expander-implant failure: 22.4% vs. 7.7% (p=0.036)</td>
<td></td>
</tr>
<tr>
<td>Hughes 2012 Retrospective, single centre</td>
<td>Implant-based reconstruction, skin-sparing or conventional mastectomy</td>
<td>N/A</td>
<td>Implant-based reconstruction</td>
<td>132 total</td>
<td>Overall complications and capsular contracture not significantly associated with delayed reconstruction or RT</td>
<td>Reoperation: significantly associated with delayed reconstruction and RT</td>
</tr>
</tbody>
</table>

**Abbreviations:** BCT: breast conserving therapy; CI: confidence interval; DIEP: deep inferior epigastric perforator flap; HR: hazard ratio; IBR: immediate breast reconstruction; LD: latissimus dorsi; N/S: not available; NCCN: National Comprehensive Cancer Network; NR: not reported; OR: odds ratio; PMRT: postmastectomy radiotherapy; RT: radiotherapy; SIEA: superficial inferior epigastric artery; TE/I: tissue expander/implant; TRAM: transverse rectus abdominis myocutaneous; vs.: versus.

**Notes:**

a HR>1 indicates earlier initiation of chemotherapy in the delayed reconstruction group
b Many inconsistencies between table and text data
c See paper for additional subgroup analyses
Clinical Question 3: Skin-sparing and nipple-sparing mastectomy

Systematic reviews: SSM

One systematic review with meta-analysis was identified that specifically evaluated the harms and benefits of SSM with immediate reconstruction compared with non-SSM without reconstruction in breast cancer [12]. Nine retrospective nonrandomized studies were included, comprising 3739 patients in total, of whom 1104 underwent SSM. No difference between SSM and non-SSM without reconstruction was detected for local recurrence (6.2% vs. 4.0%; OR, 1.22; 95% CI, 0.85 to 1.74) or postoperative severe complications (18.7% vs. 22%; OR, 0.81; 95% CI, 0.57 to 1.16). The SSM group had a significantly lower rate of distant relapse compared with the non-SSM group (10.0% vs. 12.0%; OR, 0.67; 95% CI, 0.48 to 0.94; p=0.02), although the authors stated that they had no explanation for this observation other than the possibility that there were differences in tumour grade and adjuvant therapy between groups. Insufficient data were available to assess time to local or distant recurrence. The authors concluded that long-term follow-up is required to confirm the findings of the meta-analysis.

Systematic reviews: NSM

Four systematic reviews published since 2010 addressed the harms and benefits of NSM [13,14,74,75]. While there was some overlap in studies among reviews, inclusion criteria and reporting of results differed substantially among reviews. Studies included in the reviews were prospective or retrospective series based on patient record review, many of which were not comparative in nature.

Occult nipple involvement was assessed in three of the four systematic reviews [13,74,75]. Mallon et al. [13] reported a mean incidence of 11.5% across 29 observational studies. The following factors were identified that were associated with an increased incidence of occult nipple malignancy: tumour-to-nipple distance less than 2 cm, tumour grade, lymph node metastasis, estrogen and progesterone receptor-negative, tumour size greater than 5 cm, retroareolar or central location and multicentric tumours. Rusby et al. [74] reported an occult nipple involvement incidence rate ranging from 0% to 58% across 18 observational studies; excluding studies with fewer than 100 patients resulted in a range from 5.6% to 31%. Murthy et al. [75] reported similar results across 10 studies. Possible reasons suggested for the wide range across studies included differences in patient selection, definition of nipple involvement, and the pathological technique used to assess involvement.

Local recurrence was addressed in all four systematic reviews of NSM. Endara et al. [14] reported a pooled locoregional recurrence rate of 1.8% with follow-up ranging from 0.2 to 210 months across patients in 28 studies. Nipple recurrence was not reported. Mallon et al. [13] reported a pooled nipple recurrence rate of 0.9% and a skin flap recurrence rate distal to the nipple-areolar complex (NAC) of 4.2% across 20 studies with a median follow-up time of 49.3 months. Murthy et al. [75] identified 10 studies reporting locoregional recurrence in both the prophylactic and therapeutic setting with a mean follow-up between 10.5 and 156 months. Local recurrence, including chest wall and axilla, ranged from 0% to 8.5%. No recurrence in the NAC was reported in nine of the 10 studies, while one study reported a NAC recurrence rate of 1.6%.

Rusby et al. [74] examined the safety of NSM in women undergoing prophylactic mastectomy. Three of four clinical series reported no primary breast cancers originating in the nipple while the fourth series reported that one of 575 women undergoing prophylactic NSM had subsequent breast cancer in the nipple.
The pooled rate of nipple necrosis following NSM was reported to be 7.7% across 39 studies in the systematic review by Endara et al. [14]. Necrosis rates varied significantly from study to study (e.g. range from 0% to 48% across studies in the Rusby et al. systematic review [74]) and appeared to be influenced by patient factors, surgical technique, and receipt of radiation. Mallon et al. [13] reported pooled rates of nipple necrosis by level of severity. The pooled rate of full-thickness necrosis was 2.9% while partial-thickness necrosis occurred in 6.3% of patients. Mallon et al. reported additional complications of NSM including hematoma requiring surgical intervention (0.3%) and infection (1.7%).

The 2010 review by Rusby et al. [74] reported data on patient satisfaction, cosmesis, and nipple sensation; however, studies assessing these outcomes were limited in size and design to provide definitive answers.

Primary studies: NSM vs. SSM

Primary studies comparing SSM vs. NSM are described here. Three studies were identified: Kim 2010 [118], Boneti 2011 [119] and Burdge 2013 [120] (see Table 4-4). Kim et al. [118] conducted a retrospective study in Korea comparing NSM or SSM with immediate TRAM flap reconstruction and modified radical mastectomy. Disease-free survival and overall survival were not significantly different between the SSM and NSM groups at five years. Local recurrence was 2.0% in the NSM group, 0.8% in the SSM group and 0.9% in the modified radical mastectomy group. Two nipple areola recurrences were observed in the NSM group (1.3%). A subgroup of 115 NSM patients was followed prospectively and NAC necrosis occurred in 9.6% of these patients (complete necrosis in 11 patients and partial necrosis in 15 patients). Boneti et al. [119] compared nipple-skin sparing mastectomy (removal of the glandular NAC with preservation of the NAC skin) with SSM in a retrospective study of 293 patients. The rate of locoregional recurrence, overall complications, skin flap ischemia, and postoperative infections were not significantly different between the groups. Cosmesis data, available for only 19.1% of patients, indicated a significantly higher score for nipple-skin sparing mastectomy compared with SSM. A small retrospective study by Burdge et al. [120] compared nipple-skin sparing mastectomy with SSM in 60 patients with locally advanced breast cancer. The radiation-induced complication rate was 30.8% in the nipple-skin sparing mastectomy group compared with 38.1% in the SSM group. Locoregional recurrence rates were 10.3% vs. 14.3% respectively and no recurrences involved the preserved NAC or the nipple-skin sparing mastectomy scar. No statistical comparison between groups was conducted for either of these outcomes. Other outcomes were not reported specifically for the nipple-skin sparing and SSM groups.
### Table 4-4. Skin-sparing and nipple-sparing mastectomy primary studies.

<table>
<thead>
<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants</th>
<th>Complications</th>
<th>Other outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kim, 2010 [118] Retrospective, single centre. 115 NSM pts followed prospectively for complications</td>
<td>Operable stage 0 to Iia breast cancer, mastectomy, immediate TRAM reconstruction, Korea</td>
<td>Median 60 months (NSM) and 67 months (SSM)</td>
<td>SSM NSM Modified radical mastectomy</td>
<td>368 152 1900</td>
<td>Reported only for 115 NSM pts followed prospectively. NAC necrosis: 9.6% (11 pts complete necrosis, 15 pts partial necrosis)</td>
<td>5 yr RFS: 87.2% SSM vs. 89% NSM (p=0.695) 5 yr OS: 95.8% SSM vs. 97.1% NSM (p=0.669) Local recurrence: 0.8% SSM vs. 2.0% NSM vs. 0.9% modified radical mastectomy</td>
</tr>
<tr>
<td>Boneti, 2011 [119] Retrospective</td>
<td>SSM and TSSM cases, no advanced disease with skin involvement, no inflammatory breast cancer, no collagen vascular disease, and no known smoking in past 6 months, USA</td>
<td>38.2 months SSM (range 4 to 144 months) and 25.3 months TSSM (range 3 to 102 (p&lt;0.001)</td>
<td>SSM NSSM</td>
<td>293 pts total 227 procedures 281 procedures</td>
<td>Overall complications: 6.2% vs. 7.1% (p=0.67) Skin flap ischemia: 3.1% vs. 4.6% (p=0.37) Postoperative infection: 2.6% vs. 1.7% (p=0.79)</td>
<td>Cosmesis (data available for 19.1% of pts): SSM score significantly lower than TSSM Locoregional recurrence: 5.0% vs. 4.6% (p=0.89)</td>
</tr>
<tr>
<td>Burdge, 2013 [120] Retrospective, single centre</td>
<td>Locally advanced disease, no inflammatory cancer, SSM or NSSM, USA</td>
<td>38.2 months (SSM) and 25.3 months (NSSM)</td>
<td>SSM NSSM</td>
<td>21 39</td>
<td>Radiation-induced complications: 38.1% SSM vs. 30.8% NSSM</td>
<td>Locoregional recurrence: 14.3% vs. 10.3%</td>
</tr>
</tbody>
</table>

**Abbreviations:** NAC: nipple-areolar complex; NSM: nipple-sparing mastectomy; NSSM: nipple-skin sparing mastectomy; OS: overall survival; pts: patients; RFS: recurrence-free survival; SSM: skin-sparing mastectomy; TRAM: transverse rectus abdominis myocutaneous; TSSM: total skin-sparing mastectomy; yr: years.
**Clinical Question 4: Types of reconstruction**

*a) Mastectomy with breast reconstruction vs. mastectomy alone or breast-conserving surgery*

Systematic reviews

Five systematic reviews were identified that compared mastectomy plus breast reconstruction vs. mastectomy alone or breast-conserving surgery (BCS) [8,12,76-78] to evaluate the overall benefits and harms of breast reconstruction. Study inclusion criteria and reported outcomes varied significantly among reviews. Two of the five reviews assessed oncologic outcomes: one compared recurrence rates in patients who underwent immediate reconstruction with patients who had mastectomy alone [8] and one compared recurrence and severe postoperative complications in patients undergoing SSM and immediate reconstruction with patients undergoing mastectomy alone [12]. Three reviews evaluated patient-reported outcomes: one included patient outcomes overall [78], one focused on breast sensation [77], and one reported body image outcomes compared with patients undergoing mastectomy alone or BCS [76]. All primary studies included in the systematic reviews were observational in design, including prospective or retrospective reviews of patient charts or databases and cross-sectional surveys.

The 2012 meta-analysis by Gieni et al. [8] did not detect a significant difference in local recurrence (OR, 0.98; 95% CI, 0.62 to 1.54; p=0.92) or systemic recurrence (OR, 0.89; 95% CI, 0.63 to 1.26; p=0.51) between mastectomy with IBR and mastectomy alone in eight studies. The 2010 review by Lanitis et al. [12] comparing SSM and immediate reconstruction with non-SSM alone did not detect a significant difference in local recurrence (OR, 1.22; 95% CI, 0.85 to 1.74; seven studies) or severe postoperative complications (OR, 0.81; 95% CI, 0.57 to 1.16; three studies). A significant difference was reported for distant recurrence favouring reconstruction (OR, 0.67; 95% CI, 0.48 to 0.94; five studies); however, the authors could provide no explanation why SSM with immediate reconstruction should decrease the distant recurrence rate.

The 2009 Lee et al. systematic review [78] of studies comparing patient-reported outcomes between mastectomy plus reconstruction and mastectomy alone concluded that, overall, the majority of studies did not find a statistically significant benefit for reconstruction in QOL, body image, or sexuality. However, most of the 28 studies were limited in design by selection bias, low sensitivity of outcome measures, and low statistical power. The 2010 systematic review by Shridharani et al. [77] examining breast sensation following breast reconstruction reported that study results were conflicting. Recovery of adequate sensation appeared to take 18 to 24 months after reconstruction. Recovery was faster for innervated flaps than for noninnervated flaps and was better for DIEP flaps than TRAM flaps, LD flaps, and implant-based reconstruction [77]. A meta-analysis published in 2013 by Fang et al. [76] indicated a significantly worse body image in women undergoing mastectomy and breast reconstruction compared with women undergoing BCS; however, there was significant heterogeneity among the results of the 12 studies, indicating that there were clinical differences between studies. The meta-analysis of seven studies comparing body image between mastectomy plus breast reconstruction and mastectomy alone demonstrated better body image scores in women who underwent reconstruction. No statistically significant heterogeneity was detected in this analysis.

**Primary studies**

Five primary studies were identified and compared outcomes following breast reconstruction vs. BCS: two prospective cohorts, two retrospective studies, and one cross-sectional survey [121-125] (see Table 5). Local or locoregional recurrence was reported in two of the five studies: one reported similar rates for both groups (3.3% in the mastectomy with LD flap group vs. 3.2% in the BCS group) and the other reported that there were no
locoregional recurrences at a mean follow-up of 36 months. Quality of life was reported to be similar between groups in the two retrospective studies [121,124]. The study by Sackey et al. suggested better physical functioning and less limitation due to bodily pain in the mastectomy with reconstruction group compared with the BCS groups but a higher mental health score for the BCS alone group [122]. No difference was detected in rates of anxiety or depression between groups. Of the two studies that compared body image between mastectomy with reconstruction and BCS, one reported more body image problems in the mastectomy/reconstruction group [122] and one reported no significant difference between groups (analysis adjusted for severity of surgical side effects) [123]. One of the five studies reported reconstruction-related complications [124]. The overall morbidity rate for immediate reconstruction was 16.1%, with fat necrosis in 14.1%, wound infection in 11.8%, and capsular contracture in 11.0%. No partial or total flap losses were reported.

Twenty primary studies were identified that compared mastectomy plus breast reconstruction with mastectomy alone: two prospective studies and 18 retrospective studies, four of which utilized data from large registries or national databases [6,126-144]. Eleven of the 20 studies reported data for complications. The overall rate of postoperative complications was not significantly different between groups in one study [138] but was significantly higher in women with immediate reconstruction than women with mastectomy alone in another study (27.0% vs. 15.6%; p=0.0001) [139]. Major complications were significantly higher in the reconstruction group in this study (15.5% vs. 3.7%; p<0.0001) and a small study by Prabhu et al. reported a significantly higher rate of complications requiring unplanned surgical intervention (37.5% vs. 5%; p=0.001) [137]. Another retrospective matched cohort reported no significant difference in complications within 30 days (7.3% vs. 6.3%) [130]. In all three studies reporting lymphedema rates, women undergoing mastectomy with reconstruction had significantly lower rates of lymphedema than women undergoing mastectomy alone [127,134,142]. Surgical site infection was significantly higher in women undergoing reconstruction in an analysis of a large national database (3.5% vs. 2.5%; RR, 1.4; p<0.001) [136] while tissue adhesion was significantly higher at 12 months in women with mastectomy alone in a small prospective cohort study (5.0% vs. 25.0% (p=0.032) [140].

Of the six primary studies that compared overall survival between mastectomy plus reconstruction with mastectomy alone [126,130,135,137,138,143], four reported no significant difference between groups while two reported a significant survival benefit for reconstruction [126,130]. Breast cancer-specific survival was significantly higher in women who underwent reconstruction in two studies [130,133] but no significant difference was found between reconstruction and mastectomy alone in another study [137]. Disease-free survival was not significantly different in one study (HR, 0.8; p=0.34) [143] but a benefit for reconstruction was demonstrated at five years in another (95.2% vs. 92.7%; p=0.01) [132]. Most of the eight studies evaluating local or locoregional recurrence were not able to detect a significant difference between mastectomy with reconstruction and mastectomy alone [128,130,131,137,138,143], although Yi et al. reported a lower recurrence rate in women undergoing reconstruction (5.3% vs. 7.6%; p=0.04) [132] and Lee et al. reported a lower regional recurrence rate with reconstruction (1.1% vs. 2.4%; p=0.0098) but no difference in local recurrence rate (1.8% vs. 1.2%; p=0.17) [135]. All three studies examining the effect of reconstruction on time to adjuvant chemotherapy reported additional delay for women undergoing reconstruction (mean additional delay ranged from 1.7 weeks to 2.7 weeks) [129,139,144]. In the study by Kontos et al. [129], 67% of women undergoing reconstruction received adjuvant chemotherapy greater than six weeks after surgery compared with 28.8% of women undergoing mastectomy alone.

Patient-reported outcomes including QOL, body image, and satisfaction were reported in several small retrospective studies. Overall QOL was not significantly different between
mastectomy with reconstruction and mastectomy alone in one study [128]. Psychosocial and sexual functioning and pain scores were better in women who underwent reconstruction in one study [141] while another study reported no significant difference in psychosocial functioning after adjustment for age and stage [6]. Body image was significantly higher in women with reconstruction in one study [128] and satisfaction with breasts was higher with reconstruction in two studies [138,141]. A prospective cohort of 104 patients reported significantly better shoulder flexion and abduction at 12 months in the reconstruction group compared with the group undergoing mastectomy alone [140].
### Table 4-5. Breast reconstruction vs. mastectomy alone.

<table>
<thead>
<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants</th>
<th>Complications</th>
<th>Other outcomes</th>
</tr>
</thead>
</table>
| Min 2010 [121] Retrospective, single-centre, cross-sectional survey, matched control cohort | Primary breast cancer, Korea | Mean 39.2 months (LD) vs. 42.1 months (BCS) | Mastectomy with LD flap and BCS | 120 | NR | Local recurrence: 3.3% vs. 3.2%  
QoL: Similar in BCS and mastectomy/LD groups with or without RT |
| Sackey 2010 [122] Cross-sectional | DCIS, Sweden | NR | Mastectomy and immediate reconstruction and BCS alone | 42 | NR | HRQoL: Better physical functioning and less limitation due to bodily pain in mastectomy/reconstruction group compared with BCS groups. Higher mental health score for BCS alone group than other groups.  
Anxiety and depression: No significant differences between groups  
Body image: More body image problems in mastectomy/reconstruction group |
<p>| Collins 2011 [123] Prospective cohort | Pathologically confirmed DCIS and stage I and IIA invasive breast cancer, age &gt;39 years, no neoadjuvant chemotherapy, no prior history of breast cancer, USA | 2 yr follow-up | Mastectomy with reconstruction and Mastectomy alone and BCS | 127 | NR | Body image at 6 months: Pts with reconstruction had poorer body image than pts with mastectomy alone (p=0.011). No significant difference between BCS and mastectomy with reconstruction (adjusted for severity of surgical side effects) |</p>
<table>
<thead>
<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants</th>
<th>Complications</th>
<th>Other outcomes</th>
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</thead>
<tbody>
<tr>
<td>Heneghan 2011 [124] Retrospective, single-centre, age- and stage-matched control cohort</td>
<td>Breast cancer, Ireland</td>
<td>Mean 36 months (range 12-70 months)</td>
<td>Mastectomy with immediate reconstruction BCS</td>
<td>179 160</td>
<td>Reconstruction-related morbidity: 16.1%. No partial or total flap loss. Fat necrosis: 14.1% Wound infection: 11.8% Capsular contracture: 11.0%</td>
<td>QoL: No significant difference between groups for functional outcome, symptoms or global health score Locoregional recurrence: none at mean follow-up time of 36 months</td>
</tr>
<tr>
<td>Shi 2011 [125] Prospective, 2 centres</td>
<td>Incidental breast cancer, no distant metastasis, no benign tumour, no cognitive impairment, Taiwan</td>
<td>2 yr follow-up</td>
<td>Mastectomy with reconstruction Modified radical mastectomy alone BCS</td>
<td>32 83 57</td>
<td>NR</td>
<td>QoL: Unclear</td>
</tr>
<tr>
<td>Agarwal 2010 [126] Retrospective, SEER database</td>
<td>Invasive breast cancer, mastectomy (no partial mastectomy), USA</td>
<td>NR</td>
<td>Immediate or early-delayed reconstruction No reconstruction</td>
<td>8645 43,057 NR</td>
<td>NR</td>
<td>Overall survival: Mean 56.2 vs. 51.9 months; HR, 0.62; 95% CI, 0.57 to 0.68 (p&lt;0.001)</td>
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<tr>
<td>Avraham 2010 [127] Retrospective, single centre</td>
<td>Breast cancer surgery with SLNB or SLNB/ALND, clinically node negative, USA</td>
<td>Median 5 yrs (range 2.7 to 8 yrs)</td>
<td>Tissue expander reconstruction No reconstruction</td>
<td>186 130</td>
<td>Measured lymphedema: 5% vs. 18% (p=0.0004) Severe measured lymphedema: &lt;1% vs. 4% (p=0.09)</td>
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<tr>
<td>De Gournay 2010 [128] Retrospective, case-controlled study, single centre</td>
<td>Mastectomy for nonmetastatic breast cancer, alive in July 2008, France</td>
<td>Minimum 6 months after surgery</td>
<td>Immediate or delayed LD flap with or without implant No reconstruction</td>
<td>160 86 NR</td>
<td></td>
<td>Local recurrence: 2.5% vs. 1.2% (p=0.66) QoL: No significant difference in scores between groups Body image: Significantly higher body image questionnaire score for reconstruction group (p=0.0247)</td>
</tr>
<tr>
<td>Author, publication year, study design</td>
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<tr>
<td>Kontos 2010 [129] Retrospective, single centre</td>
<td>Mastectomy for breast cancer, adjuvant therapy, UK</td>
<td>NR</td>
<td>Immediate free flap reconstruction (TRAM, DIEP, S-GAP) No reconstruction</td>
<td>27</td>
<td>139</td>
<td>Time between surgery and commencement of adjuvant therapy &gt;6 wks: 67% vs. 28.8% (p=0.0001) Mean time between surgery and commencement of adjuvant treatment: 55 days vs. 40 days (p=0.0025)</td>
</tr>
<tr>
<td>Eriksen 2011 [130] Matched retrospective cohort (age, tumour size, nodal status, year of operation), single centre</td>
<td>Invasive breast cancer, mastectomy, no previous ipsilateral breast cancer, Sweden Pts with inflammatory breast cancer, tumours adhering to the pectoral muscle, high BMI and heavy smokers not recommended immediate reconstruction</td>
<td>Median follow-up 11.5 yrs (range 2 to 20)</td>
<td>Immediate implant-based reconstruction Mastectomy alone</td>
<td>300</td>
<td>300</td>
<td>Complications &lt;30 days: 7.3% vs. 6.3% (p=0.622) Local recurrence: 8.2% vs. 9.0% (p=0.879) Regional recurrence: 8.2% vs. 9.7% (p=0.555) Distant metastases: 20.3% vs. 27.1% (p=0.049) Overall survival: HR, 0.67 (95% CI, 0.48 to 1.0; p=0.038) Breast cancer-specific survival: HR, 0.62 (95% CI, 0.42 to 0.91; p=0.026)</td>
</tr>
<tr>
<td>Reddy 2011 [131] Retrospective, single centre</td>
<td>Breast cancer; mastectomy; no bilateral breast cancer, metastatic disease, prophylactic mastectomy, delayed reconstruction; USA</td>
<td>Mean 4.5 yrs</td>
<td>Immediate reconstruction Mastectomy alone</td>
<td>494</td>
<td>427</td>
<td>Locoregional recurrence: 2.2% vs. 4.0% (p=0.1220) 1.9% autologous vs. 2.0% autologous/implant vs. 3.4% implant alone (p=N5) Overall recurrence: 5.9% vs. 11.5% (p=0.0023)</td>
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<td>Yi 2011 [132] Retrospective</td>
<td>Stage 0 to III primary unilateral breast carcinoma, total mastectomy with or without complete axillary dissection, minimum 2 years follow-up; USA</td>
<td>Median 53 months (range 24-104 months)</td>
<td>SSM (98.1% IBR) Conventional mastectomy (16.9% IBR)</td>
<td>799 1011</td>
<td>NR</td>
<td>Median time to first recurrence: 32.1 months vs. 28.7 months (p=0.06) Recurrence rate: 5.3% vs. 7.6% (p=0.04) 5-yr disease-free survival: 95.2% vs. 92.7% (p=0.01)</td>
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<tr>
<td>Agarwal 2012 [133] Retrospective, SEER database</td>
<td>Breast cancer, mastectomy (no partial mastectomy), USA</td>
<td>NR</td>
<td>Reconstruction Mastectomy alone</td>
<td>8446 43,803</td>
<td>NR</td>
<td>Breast cancer-specific survival: HR 0.73 (0.66-0.81;p&lt;0.0001)</td>
</tr>
<tr>
<td>Card 2012 [134] Retrospective, matched cohort (age, post-op RT, SLND) single centre</td>
<td>Therapeutic mastectomy</td>
<td>Minimum 3 yrs follow-up Average follow-up 59 months</td>
<td>Mastectomy and reconstruction Mastectomy alone</td>
<td>541 549</td>
<td>Breast cancer-related lymphedema: 3.7% vs. 9.9%; HR, 0.34 (95% CI, 0.20 to 0.57; p&lt;0.001) Multivariate model of time to development of lymphedema: HR, 0.44 (95% CI, 0.26 to 6.87; p=0.002)</td>
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<tr>
<td>Lee 2012 [135] Retrospective, single centre</td>
<td>No stage 4, biannual clinical examination/mammography/chest X-ray, Korea</td>
<td>Median follow-up 57 months (56.4 in TRAM group and 60 in mastectomy alone group)</td>
<td>Immediate pedicled TRAM reconstruction Modified radical mastectomy alone</td>
<td>1000 3183</td>
<td>NR</td>
<td>Local recurrence: 1.8% vs. 1.2% (p=0.1712) Regional recurrence: 1.1% vs. 2.4% (p=0.0098) Distant metastasis: 2.8% vs. 9.5% (p=0.001) Survival: Log-rank p=0.276 (in higher stage pts log-rank p=0.503)</td>
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<td>Author, publication year, study design</td>
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<td>Metcalfe 2012 [6] Prospective longitudinal survey, 2 centres</td>
<td>First primary invasive breast cancer, age &gt;18 years, able to read and understand English, eligible for breast reconstruction at time of mastectomy, Canada</td>
<td>83.2% completed 1 yr follow-up</td>
<td>Mastectomy plus immediate reconstruction Previous mastectomy plus delayed reconstruction Mastectomy alone</td>
<td>24</td>
<td>NR</td>
<td>Psychosocial functioning: No significant differences among groups after adjustment for age and stage</td>
</tr>
<tr>
<td>Nguyen 2012 [136] Retrospective, national database</td>
<td>Mastectomy as primary or secondary procedure, no nipple-areolar complex reconstruction, USA</td>
<td>NR</td>
<td>Immediate breast reconstruction Mastectomy alone</td>
<td>9315</td>
<td>39,078</td>
<td>Surgical site infection: 3.5% vs. 2.5%; RR, 1.4 (95% CI, 1.3 to 1.7, p&lt;0.001) Flap failure: 1.3% in reconstruction group</td>
</tr>
<tr>
<td>Prabhu 2012 [137] Retrospective, consecutive pts</td>
<td>Noninflammatory stage III breast cancer, neoadjuvant chemotherapy, postmastectomy RT; USA</td>
<td>Median 30.6 months</td>
<td>SSM with immediate reconstruction Non-SSM (28.3% delayed reconstruction)</td>
<td>40</td>
<td>60</td>
<td>Complication rate requiring unplanned surgical intervention: 37.5% vs. 5% (p&lt;0.001) 2-yr locoregional control: 94.7% vs. 97.4% (p=NS) 2-yr breast cancer-specific survival: 91.5% vs. 86.3% (p=NS) 2-yr overall survival: 87.4% vs. 84.8% (p=NS)</td>
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<tr>
<td>Author, publication year, study design</td>
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<tr>
<td>Shi 2012 [138] Retrospective, randomly selected control group from same time interval</td>
<td>Breast cancer, no distant metastasis, no other life-threatening or chronic diseases</td>
<td>Median 68 months (range 10-104 months)</td>
<td>Subcutaneous NSM and IBR Modified radical mastectomy</td>
<td>35 100</td>
<td>Postoperative complications: no significant difference between groups No severe complications</td>
<td>Local recurrence: no significant difference between groups Distant metastasis: no significant difference between groups Overall survival: no significant difference between groups Satisfaction with esthetic outcome: significantly higher in pts receiving reconstruction</td>
</tr>
<tr>
<td>Zhong 2012 [139] Retrospective, 2 centres</td>
<td>Mastectomy, no neoadjuvant chemotherapy, Canada</td>
<td>NR</td>
<td>Mastectomy and immediate breast reconstruction Mastectomy alone</td>
<td>148 243</td>
<td>Major complications: 15.5% vs. 3.7% (p&lt;0.0001) Overall postoperative complications: 27.0% vs. 15.6% (p&lt;0.009)</td>
<td>Time from last definitive breast surgery to start of chemotherapy: 8.5 wks vs. 6.8 wks (p&lt;0.01)</td>
</tr>
<tr>
<td>De Oliveira 2013 [140] Prospective cohort</td>
<td>Modified radical mastectomy, Brazil</td>
<td>12 months follow-up</td>
<td>Immediate LD flap reconstruction Mastectomy alone</td>
<td>47 57</td>
<td>Tissue adhesion: 5.0% vs. 25.0% (p=0.032) at 12 months</td>
<td>Shoulder motion: No difference in shoulder flexion at 1 month or 3 months. At 6 and 12 months, reconstruction group had significantly better shoulder flexion. Shoulder abduction significantly better in reconstruction group at 12 months</td>
</tr>
<tr>
<td>Eltahir 2013 [141] Retrospective, cross-sectional survey</td>
<td>Unilateral or bilateral mastectomy for breast cancer or prophylaxis. Excluded age &lt;18 years, severely ill patients, flap or prosthesis loss; Netherlands.</td>
<td>NR</td>
<td>Successful reconstruction Mastectomy alone</td>
<td>92 45</td>
<td>Incidence of mastectomy-associated complications similar between groups. Additional reconstruction-associated complications in the reconstruction group (i.e., partial or total flap necrosis, implant loss).</td>
<td>QoL: Significantly higher satisfaction with breasts, psychosocial and sexual well-being, satisfaction with surgeon and physical functioning and lower pain scores in reconstruction group</td>
</tr>
<tr>
<td>Author, publication year, study design</td>
<td>Study population</td>
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<tr>
<td>Lee 2013 [142] Retrospective chart review, single centre</td>
<td>Modified radical mastectomy. Excluded stage III and IV disease, prior breast cancer, and pre-existing lymphedema.</td>
<td>Mean follow-up 53 months</td>
<td>Immediate autologous reconstruction  Modified radical mastectomy alone</td>
<td>117 595</td>
<td>Lymphedema: 9.4% vs. 18.5% (p=0.017) No significant difference in severity of lymphedema between groups (p=0.556)</td>
<td>--</td>
</tr>
<tr>
<td>Sakurai 2013 [143] Retrospective, single centre</td>
<td>Breast cancer (invasive or non-invasive); Japan</td>
<td>Median 87 months</td>
<td>NSM Total mastectomy</td>
<td>788 144</td>
<td>Nipple necrosis: none reported</td>
<td>Local recurrence: 8.2% vs. 7.6% (p=0.81) NAC recurrence rate: 3.7% Disease-free survival: HR, 0.8 (95% CI, 0.7 to 2.2; p=0.34) Overall survival: HR, 0.8 (95% CI, 0.4 to 1.4; p=0.33)</td>
</tr>
<tr>
<td>Vandergrift 2013 [144] Retrospective, national database</td>
<td>Stage I to III unilateral breast cancer</td>
<td>Minimum 180 days follow-up</td>
<td>Immediate reconstruction  Mastectomy alone</td>
<td>784 1166</td>
<td>NR</td>
<td>Time to adjuvant chemotherapy: Reconstruction associated with additional 2.7 weeks before chemotherapy (p&lt;0.001)</td>
</tr>
</tbody>
</table>

**Abbreviations:** ALND: axillary lymph node dissection; BCS: breast-conserving surgery; BMI: body mass index; CI: confidence interval; DCIS: ductal carcinoma in situ; DIEP: deep inferior epigastric perforator; HR: hazard ratio; HRQoL: health-related quality of life; IBR: immediate breast reconstruction; LD: latissimus dorsi; NAC: nipple-areolar complex; NR: not reported; NSM: nipple-sparing mastectomy; pts: patients; QoL: quality of life; RT: radiation therapy; S-GAP: superior gluteal artery perforator; SLNB: sentinel lymph node biopsy; SSM: skin-sparing mastectomy; TRAM: transverse rectus abdominis myocutaneous; vs.: versus; yr: year.

**Notes:**

a12 pts excluded due to flap or implant loss
b) Comparisons between types of breast reconstruction

Systematic reviews

Seven systematic reviews articles were identified that compared different types of breast reconstruction: two compared TE/I reconstructions with autologous abdominal reconstruction [15,16] and five compared flap complications and/or donor site morbidity for various types of autologous abdominal reconstruction [19-22,79].

Two publications by Tsoi et al represented one systematic review comparing TE/I vs. autologous abdominal tissue (AAT) reconstruction for women with primary breast cancer: one presented patient-reported outcomes [16] and one presented surgical complication outcomes [15]. Fourteen observational studies including 3244 reconstructed breasts were included that addressed surgical complications, all of which compared TE/I with one or more variations of TRAM flaps. Only six of the 14 studies involved more than 100 breasts and follow-up ranged from six to 60 months. Compared with patients receiving TE/I, patients undergoing AAT reconstruction were less likely to have reconstructive failure (1% vs. 5%; RR, 0.14; 95% CI, 0.06 to 0.32) and surgical site infections (6% vs. 9%; RR, 0.37; 95% CI, 0.25 to 0.55) but more likely to experience skin or flap necrosis (12% vs. 5%; RR, 2.79; 95% CI, 1.87 to 4.17). No statistically significant difference was demonstrated for infections leading to reoperation (1% vs. 0%; RR, 0.97; 95% CI, 0.22 to 4.16), hematoma or seroma (4% vs. 7%; RR, 0.56; 95% CI, 0.31 to 1.00), skin or flap necrosis requiring reoperation (10% vs. 3%; RR, 2.76; 95% CI, 0.80 to 9.46), wound dehiscence, deep venous thrombosis, pulmonary embolism, major complications, or reoperations, although results suggested a trend toward a lower seroma and hematoma rate in women undergoing AAT reconstruction. Tsoi et al. [15] also reported on complications that were specific to each method of reconstruction. In seven studies, the capsular contracture rate following TE/I reconstruction ranged from 0.0% to 33.3%. Complications specific to women undergoing AAT reconstruction included hernia, abdominal bulge, and impaired trunk function. In a subgroup of patients who received postoperative RT, major complications were less frequently reported in women who received AAT reconstruction compared with TE/I (18% vs. 24%; RR, 0.46; 95% CI, 0.29 to 0.73).

In the Tsoi et al. review [16], 15 articles representing nine studies (1393 patients) were identified that compared patient-reported outcomes between TE/I and AAT reconstruction. All abdominal tissue reconstructions were free or pedicled TRAM flaps and the studies included both immediate and delayed reconstructions. Four smaller studies of less than 100 patients reported similar rates of general and esthetic satisfaction for the two reconstructive approaches while the five larger studies detected a tendency toward better satisfaction in women undergoing autologous tissue reconstruction. One study suggested that patients with AAT reconstruction had stable esthetic satisfaction over time while patients with TE/I experienced declining esthetic satisfaction. The limited data available for psychosocial and functional outcomes suggest that reconstructive approach does not have a great impact on these outcomes.

Five systematic reviews compared flap complications and/or donor site morbidity for different types of AAT reconstruction. The most recent review by Khansa et al. focused specifically on fat necrosis and included observational 70 studies [22]. The overall pooled fat necrosis rate was found to be 11.3% across 41 studies (10,764 flaps). Thirty-three articles reported fat necrosis by flap type: DIEP (14.4% fat necrosis), pedicled TRAM (12.3%), SIEA (8.1%), and free TRAM (6.9%). Predictors of necrosis included obesity, RT, active smoking and abdominal scars. An older review by Sailon et al. published in 2009 reported a significant difference between DIEP and free TRAM flaps in overall necrosis rates across eight studies (25.5% vs. 11.3%; p<0.001) and total necrosis rates (4.2% vs. 1.6%; p=0.044) but no difference in partial necrosis rates (3.5% vs. 11.2%; p=0.057) [79]. The 2012 meta-analysis by Egeberg et
al. assessed donor site morbidity in five comparative observational studies [20]. The risk of bulging and hernia was not significantly different between DIEP and muscle-sparing TRAM flap reconstruction. A 2009 review by Man et al. pooled the results of six studies comparing DIEP with free TRAM flaps; however, they reported significantly lower risk for hernia and bulge in women with DIEP flaps (RR, 0.49; 95% CI, 0.28 to 0.86) [19]. Flap-related complications were more frequent with DIEP flaps while donor-site morbidity was more common with free TRAM flaps. Objective measures of abdominal function were reported to be slightly better for DIEP flaps than TRAM flaps in a 2009 systematic review by Atisha et al. [21]; however, this did not appear to translate into deficits in performance of activities of daily living.

Primary studies

Twenty-two primary studies were identified that were published between 2010 and 2013 that compared different types of breast reconstruction. Seven compared two or more types of autologous tissue reconstruction [17,145,147,151,155,158,159], four compared different approaches to implant-based reconstruction [146,156,157,161] and 11 included patients with autologous tissue- and implant-based reconstruction [144,148-150,152-154,160,162-164] (see Table 6).

Of the four studies investigating different approaches to implant-based reconstruction, one compared saline vs. silicone implants [146], two compared one-stage immediate implant reconstruction with the use of tissue expanders [157,161] and one compared tissue expanders vs. expandable textured implants vs. polyurethane implants [156]. Macadam et al. reported no significant difference between saline and silicone implants with respect to satisfaction with outcome, overall quality of life, physical well-being, or sexual well-being in 143 patients. Satisfaction with reconstructed breasts, psychological well-being, and physical well-being were higher in the silicone implant group, however. Based on a retrospective review of insurance claims data, Singh et al. reported no significant difference in complication rates between one-stage immediate implant reconstruction and reconstruction using tissue expanders [157]. A larger retrospective analysis of a national database by Davila et al. demonstrated significantly higher rates of 30-day morbidity and prosthesis failure in women undergoing one-stage direct implant compared with tissue expanders but no difference in reconstruction-related complications overall, wound disruption, surgical site infection, reoperation, or major medical complications [161]. The study by Pompei et al. comparing tissue expanders, expandable textured implants, and polyurethane implants reported complication rates but did not conduct tests of statistical significance [156]. The overall complication rate was highest for tissue expanders (14.7%) and lowest for polyurethane implants (5.0%).

Six retrospective single-centre studies included both a TRAM and a DIEP group: three investigated pedicled TRAM flaps [145,148,155] and three investigated free TRAM flaps [147,151,159]. In one study, there was no significant difference between bilateral pedicled TRAM and DIEP in abdominal hernia or bulge or seroma/hematoma in the donor or recipient site; however, donor site partial skin loss and wound dehiscence and recipient site fat necrosis were more frequent in the DIEP group [145]. Another study reported no difference between pedicled TRAM and DIEP for flap loss, major fat necrosis, hematoma/seroma, infection, open wound, mastectomy skin loss, or esthetic satisfaction but better general patient satisfaction in the DIEP group. Yueh et al. reported no significant difference in general or esthetic satisfaction between pedicled TRAM and DIEP in a logistic regression analysis [148]. Nelson et al. reported no significant difference between muscle-sparing free TRAM and DIEP flaps for intraoperative complications or postoperative minor or late complications but a higher rate of postoperative major complications in the DIEP group (arterial or venous thrombosis and flap necrosis) [147]. Garvey et al. detected no significant
difference in fat necrosis, partial flap necrosis, or overall complications between muscle-sparing TRAM and DIEP flaps [151]. Chang et al. similarly reported no difference in early complications between free TRAM, muscle-sparing free TRAM, and DIEP flaps [159].

Nine studies included patients who received LD flap reconstructions: five included a group with LD flap alone [17,148,149,152,164] and six included LD flaps combined with an implant [150,152-154,160,164]. Yueh et al. reported that general and esthetic satisfaction was lower for women receiving LD flap compared with abdominal flaps [148]. Christensen et al. compared LD flaps with pedicled TRAM flaps and implants and concluded that LD flaps were associated with significantly higher patient satisfaction than implants [149]. None of the 26 women who had LD flap reconstructions had major complications. Gart et al. reported that women with LD flaps had lower rates of overall complications, surgical site infections, and flap failure than free flaps and pedicled TRAM flaps [17]. Monrigal et al. included women with LD flap reconstruction and LD flap reconstruction with implant [152]. LD reconstructions had less necrosis than TRAM flap reconstructions and required fewer surgical revisions. Winters et al. compared autologous LD flap with LD flap plus implant and reported no statistically significant difference in early complications up to three months after surgery, long-term complications, or health-related QOL [164]. Role functioning and pain were significantly better in the group that received LD flaps with implant compared with LD flaps alone. Levine et al. compared delayed LD flaps plus implant with delayed autologous abdominal flap reconstruction in previously irradiated patients [154]. No statistically significant differences were found between groups in complications overall, reconstruction failures, or incidence of lymphedema. Costa et al. compared immediate LD flaps plus implant with implants alone and autologous reconstruction. There was no statistically significant difference in incidence of surgical site infections after adjustment for confounding factors [160]. Another study by Crosby et al. of women undergoing reconstruction for unilateral breast cancer with a synchronous contralateral prophylactic mastectomy and reconstruction did not statistically compare outcomes between types of reconstruction, but the authors concluded that the risk of postoperative complications was similar for index mastectomy with reconstruction and prophylactic mastectomy with reconstruction [150].
Table 4-6. Breast reconstruction types.

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<tr>
<th>Author, publication year; study design</th>
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<tr>
<td>Chun 2010 [145]</td>
<td>Immediate (n=86) or delayed (n=19) TRAM or DIEP; USA</td>
<td>Average 6.2 yrs (TRAM) and 2.3 yrs (DIEP)</td>
<td>Bilateral pTRAM Bilateral DIEP</td>
<td>105/58</td>
<td>Abdominal hernia: 2.9% vs. 0% (p=0.20)</td>
<td>New back pain: 18.5% vs. 22.2% (p=0.77)</td>
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<td>Abdominal bulge: 2.9% vs. 6.9% (p=0.22)</td>
<td>Patient satisfaction: 79.7% very satisfied vs. 92.6% very satisfied (p=0.13)</td>
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<td>Donor site partial skin loss/wound dehiscence: 3.8% vs. 10.3% (p=0.04)</td>
<td>Physical function: no significant difference between groups</td>
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<td>Abdominal donor site or recipient site seroma or hematoma: no significant difference in incidence</td>
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<td>Recipient site fat necrosis: 11.4% vs. 19.8% (p=0.04). 1 complete flap loss in DIEP group.</td>
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<tr>
<td>Macadam 2010 [146]</td>
<td>Implant-based reconstruction for breast cancer or prophylaxis; USA &amp; Canada</td>
<td>Mean 53.6 months (saline) and 31.4 months (silicone)</td>
<td>Saline implant (62% immediate) Silicone implant (83% immediate)</td>
<td>68/75</td>
<td>NR</td>
<td>Satisfaction with breast: significantly higher in silicone group</td>
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<td>Satisfaction with outcome: no significant difference between groups</td>
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<td>Psychological well being: significantly better in silicone group</td>
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<td>Physical and sexual well being: no significant difference between groups</td>
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<td>QoL: No significant difference between groups overall. Higher physical functioning score in silicone group.</td>
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<td>Author, publication year; study design</td>
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<td>Nelson 2010 [147] Retrospective cohort study, single centre, single surgeon</td>
<td>DIEP and muscle-sparing free TRAM; USA</td>
<td>12.1 months (only msfTRAM, only DIEP) and 14.0 months (msfTRAM and DIEP)</td>
<td>Only msfTRAM Only DIEP One msfTRAM and one DIEP</td>
<td>91 53 31</td>
<td>Intraoperative complications: 7.1% (msfTRAM) vs. 6.9% (DIEP) (p=0.93) Postoperative major complications (arterial or venous thrombosis, flap necrosis): 0% (msfTRAM) vs. 3.9% (DIEP) (p=0.027) Postoperative minor or late complications: No significant difference</td>
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<tr>
<td>Yueh 2010 [148] Retrospective, single centre, cross-sectional survey</td>
<td>Postmastectomy breast reconstruction; USA</td>
<td>NR</td>
<td>Tissue expander/implant LD pTRAM DIEP</td>
<td>87 116 (90 with implants) 119 117</td>
<td>NR</td>
<td>General patient satisfaction: 56.3% vs. 56.9% vs. 70.6% vs. 80.3% Esthetic satisfaction: 48.3% vs. 59.5% vs. 76.5% vs 70.9%</td>
</tr>
<tr>
<td>Christensen 2011 [149] Retrospective chart review, single centre</td>
<td>Breast reconstruction for cancer, no known recurrence; Denmark</td>
<td>NR</td>
<td>Implant LD flap pTRAM</td>
<td>206 34 123</td>
<td>Minor complications (chart review): 27% vs. 21% vs. 35% (p=0.30) Major complications (chart review): 13% vs. 0% vs. 13%</td>
<td>Overall satisfaction: 64% vs. 81% vs. 84% (p=0.002) Improved quality of life: 83% vs. 88% vs. 90% (p=0.149) Pleased with breast size compared with opposite breast: 50% vs. 54% vs. 80% (p&lt;0.0001) Pleased with breast shape: 36% vs. 65% vs. 77% (p&lt;0.0001) Pleased with how the breast feels: 41% vs. 77% vs. 94% (p&lt;0.0001)</td>
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| Crosby 2011 [150] Retrospective, single centre, consecutive patients | Unilateral breast cancer with mastectomy and synchronous contralateral prophylactic mastectomy, bilateral immediate breast reconstruction, no prior or postmastectomy RT; USA | Mean 13.2 months | Implant  
Abdominal flap  
LD/implant | 334  
142  
21 | At least one complication: 30.5% vs. 30.3% vs. 42.9%  
Index breast complications: 22.5% vs. 21.1% vs. 33.3%  
Prophylactic breast reconstructions: 19.2% vs. 19.0% vs. 19.0% | -- |
| Garvey 2011 [151] Retrospective, single centre | Free-flap abdominal autologous reconstruction, flap perfused by either medial-only or lateral-only type II DIEA branch perforators; USA | Average 33.2 months (range 7.6 to 107.0 months) | DIEP  
msfTRAM | 157  
71 | Fat necrosis: 10.2% vs. 11.3% (p=0.81)  
Partial flap necrosis: 3.2% vs. 2.8% (p=1.0)  
Fat necrosis/partial flap necrosis: 13.4% vs. 14.1% (p=0.89)  
Any complication: 19.7% vs. 19.7% (p=1.0) | -- |
| Monrigal 2011 [152] Retrospective, single centre | Primary operative invasive breast cancer, neoadjuvant chemotherapy and RT; no local recurrence, inflammatory or T4 cancer; France | Mean 96 months | LD/implant  
free TRAM  
LD  
Implant | 107  
56  
25  
22 | Total early complications (necrosis, seroma, infection, hematoma): 17.8% vs. 33.9% vs. 20.0% vs. 13.6%  
Early surgical revisions: 7.5% vs. 19.6% vs. 4% vs. 13.6%  
Total delayed complications (implant complications, abdominal wall hernia, necrosis, lymphedema, functional discomfort, chronic pain, seroma): 24.3% vs. 26.8% vs. 20.0% vs. 40.1%  
Delayed surgical revisions: 3.7% vs. 7.1% vs. 0% vs. 27.3% | -- |
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<th>Author, publication year; study design</th>
<th>Study population</th>
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<th>Complications</th>
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<tbody>
<tr>
<td>Crosby 2012 [153] Retrospective, single centre, consecutive patients</td>
<td>Breast cancer with immediate reconstruction; USA</td>
<td>Mean 56 months</td>
<td>Tissue expander/implant LD/implant pTRAM Free flap</td>
<td>737 breasts 117 breasts 36 breasts 609 breasts</td>
<td>Lymphedema: 3.3% vs. 3.4% vs. 5.5% vs. 3.3%</td>
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<tr>
<td>Levine 2012 [154] Retrospective, single centre</td>
<td>Postmastectomy RT, delayed abdominal-based autologous reconstruction or LD flap plus implant; USA</td>
<td>Mean 22.7 months</td>
<td>Abdominal flaps LD/implant</td>
<td>75 56</td>
<td>Reoperation (vascular compromise): 4.0% vs. 0% Flap failure: 2.7% vs. 0% Partial flap loss: 4.0% vs. 2.7% Implant loss: N/A vs. 5.4% Seroma: 13.3% vs. 21.4% Hematoma: 5.3% vs. 1.8% Cellulitis: 2.7% vs. 0% Abdominal bulge: 1.3% vs. N/A</td>
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<td>Author, publication year; study design</td>
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<td>Momoh 2012 [155] Retrospective, single centre, cross-sectional survey</td>
<td>pTRAM or DIEP for breast cancer or prophylaxis, immediate or delayed, excluded if different reconstruction on each breast or stage 4; USA</td>
<td>Mean 51.2 months (DIEP) and 74.4 months (pTRAM)</td>
<td>DIEP pTRAM</td>
<td>167 179</td>
<td>Total flap loss: 1.8% vs. 0% (per flap) (p=0.1249) Partial flap loss: 1.4% vs. 1.5% (per flap) (p=1.0000) Major fat necrosis: 15.2% vs. 11.7% (p=0.2940) Hematoma/seroma: 3.6% vs. 3.6% (p=1.0000) Infection: 0.5% vs. 2.5% (p=0.1068) Open wound: 2.8% vs. 3.0% (p=1.0000) Mastectomy skin loss: 10.1% vs. 5.6% (p=0.0875)</td>
<td>General patient satisfaction (based on 234 survey responses): 81.7% vs. 70.2% (p=0.0395) Esthetic satisfaction: 72.5% vs. 77.2% (p=0.4086)</td>
</tr>
<tr>
<td>Pompei 2012 [156] Retrospective</td>
<td>Unilateral immediate breast reconstruction with implants; Italy</td>
<td>Median 51 months (range 12 to 90 months)</td>
<td>Tissue expanders Expandable textured implants Polyurethane implants</td>
<td>136 47 119</td>
<td>Infection: 0.7% vs. 2.1% vs. 0% Exposure/extrusion: 5.1% vs. 2.1% vs. 0.8% Total complications: 14.7% vs. 12.8% vs. 5.0%</td>
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<td>Author, publication year; study design</td>
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<tr>
<td>Singh 2012 [157] Retrospective, insurance claims data review</td>
<td>Implant breast reconstruction procedure during same visit as mastectomy, no death during 18-month postmastectomy study period, 17.8% RT; USA</td>
<td>18 months post-reconstruction</td>
<td>1-stage reconstruction Tissue expanders reconstruction</td>
<td>95 1221</td>
<td>No significant differences between groups. Complications of implant/graft/mesh: 28.4% vs. 27.4% (RR=1.03) Complications of tissue/artificial skin graft: 2.1% vs. 0.7% (RR=2.85) Hematoma: 6.3% vs. 2.9% (RR=2.14) Infection: 9.5% vs. 12.4% (RR=0.76) Necrosis: 1.1% vs. 3.3% (RR=0.32) Seroma: 6.3% vs. 4.5% (RR=1.4) Skin/connective tissue: 20.0% vs. 26.4% (RR=0.76)</td>
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<tr>
<td>Tong 2012 [158] Retrospective, single centre, consecutive groups</td>
<td>Abdominal breast reconstruction; USA</td>
<td>NR</td>
<td>pTRAM Perforator flaps</td>
<td>69 69</td>
<td>Fat necrosis: 53.6% vs. 15.9% (p=0.0001) Fat necrosis requiring operation: 23.7% vs. 5.9% (p=0.0004) Partial flap necrosis: 20.6% vs. 7.2% (p=0.045) Abdominal bulge: 21.1% vs. 9.7% (p=0.32) Abdominal hernia: 8.8% vs. 1.6% (p=0.21) Hematoma: 1.5% vs. 10% (p=0.06) Full flap necrosis: 0% vs. 1.5% (p=1)</td>
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<td>Author, publication year; study design</td>
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<td>Chang 2013 [159] Retrospective, single centre</td>
<td>Unilateral or bilateral microvascular breast reconstruction; 27% prior RT, 28% postoperative RT; 65% immediate reconstruction; USA</td>
<td>Minimum 5 yrs</td>
<td>DIEP msfTRAM free TRAM S-GAP Other (tensor fasciae latae, pedicled TRAM flap, deep circumflex iliac artery flap, T12 perforator flap)</td>
<td>150 flaps</td>
<td>Early complications: no significant difference between flap types except higher breast wound breakdown in S-GAP group (10.5%; p&lt;0.03)</td>
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<tr>
<td>Costa 2013 [160] Retrospective, national database</td>
<td>Mastectomy with immediate reconstruction, no NAC reconstruction, no death within 30 days of surgery; USA</td>
<td>NR</td>
<td>Prosthetic Autologous Hybrid</td>
<td>7333 1475 320</td>
<td>Surgical site infection within 30 days of surgery: 3.33% vs. 4.88% vs. 2.19% (p=0.005). Autologous vs. prosthetic unadjusted OR, 1.49 (95% CI, 1.13 to 1.95; p&lt;0.004), adjusted OR, 1.14 (95% CI, 0.83 to 1.58; p=0.42). Hybrid vs. prosthetic unadjusted OR, 0.65 (95% CI, 0.30 to 1.39; p=0.264), adjusted OR, 0.59 (95% CI, 0.27 to 1.27; p=0.18)</td>
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<td>Author, publication year; study design</td>
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<td>Davila 2013 [161] Retrospective, national database</td>
<td>Immediate tissue expander or implant reconstruction after mastectomy, no concomitant flap reconstruction, no simultaneous expander and implant; USA</td>
<td>NR</td>
<td>One-stage direct to implant Tissue expander</td>
<td>1528 9033</td>
<td>30-day morbidity: 6.8% vs. 5.4% (p=0.02) Reconstruction-related complications: 5.5% vs. 4.4% (p=0.05) Prosthesis failure: 1.4% vs. 0.8% (p=0.04) Wound disruption: 0.8% vs. 0.4% (p=0.08) No significant difference in surgical site infections, reoperation rates (7.5% vs. 6.9%), or major medical complications</td>
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<tr>
<td>Fischer 2013 [162] Retrospective, single centre</td>
<td>Expander/implant or free flap reconstructions, senior surgeon’s patients, no postoperative RT, &lt;65 yrs, BMI 25-35 kg/m²; USA</td>
<td>Minimum 4 yrs</td>
<td>Expander/implants Free flaps</td>
<td>60 142</td>
<td>Hematoma: 6.7% vs. 2.8% (p=0.24) Seroma: 15.0% vs. 5.6% (p=0.03) Cellulitis: 10% vs. 2.8% (p=0.07) Delayed wound healing: 36.6% vs. 15% (p=0.003) Failure: 7.3% vs. 1.3% (p=0.008) Major complications: 13.3% vs. 7.0% (p=0.15) Minor complications: 43.3% vs. 46.5% (p=0.68) Free flap complications: flap loss (1.3%), fat necrosis (9.9%), hernia/bulge (2.8%) Expander/implant complications: capsular contracture requiring revision (18.3%), implant exposure (6.7%), implant infection (8%)</td>
<td>Rate of revision: 38.3% vs. 49.3% (p=0.17) Contralateral balancing procedure: 33.3% vs. 18.3% (p=0.021)</td>
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<tr>
<td>Author, publication year; study design</td>
<td>Study population</td>
<td>Follow-up</td>
<td>Procedure</td>
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<td>Gart 2013* [17] Retrospective, national database</td>
<td>Autologous tissue-based reconstruction, no mixed reconstruction types; USA</td>
<td>30-day follow-up</td>
<td>Free flap LD flap pTRAM</td>
<td>609 1079 1608</td>
<td>Overall 30-day complications: 19.4% vs. 7.1% vs. 13.4% (p&lt;0.001). Flap complications 12.0% vs. 5.0% vs. 10.0% (p&lt;0.001). Nonflap complications 11.3% vs. 3.2% vs. 5.7% (p&lt;0.001). Wound infection: 5.9% vs. 3.3% vs. 6.7% (p=0.001)</td>
<td>Reoperation: 15.6% vs. 5.7% vs. 9.9% (p&lt;0.001)</td>
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<td>Mioton 2013* [163] Retrospective, national database</td>
<td>Autologous tissue-based or prosthetic reconstruction, no mixed reconstruction types, 25.9% delayed reconstruction; USA</td>
<td>30-day follow-up</td>
<td>Prosthetic Autologous</td>
<td>9786 3296</td>
<td>Overall 30-day complications: 5.38% vs. 12.47% (p&lt;0.001) Surgical complications: 4.39% vs. 8.71% (p&lt;0.001) Medical complications: 1.55% vs. 5.92% (p&lt;0.001) Wound infection: 3.45% vs. 5.46% (p&lt;0.001) Prosthesis/flap failure: 0.85% vs. 3.13% (p&lt;0.001) Wound disruption: 0.44% vs. 1.24% (p&lt;0.001)</td>
<td>Reoperation: 6.76% vs. 9.59% (p&lt;0.001)</td>
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<td>Author, publication year; study design</td>
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<td>Pestana 2013 [114] Retrospective</td>
<td>Mastectomy and breast reconstruction for breast cancer, pre- or post-operative RT; USA</td>
<td>Mean 6 yrs</td>
<td>Implant, Autologous + implant, Autologous</td>
<td>88a, 38c, 28c</td>
<td>Reconstruction failure (estimated): 33% (implant) vs. 11% (autologous)</td>
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<td>Winters 2013 [164] Prospective cohort, multi-centre</td>
<td>Stage 0-II breast cancer, immediate reconstruction; UK</td>
<td>NR</td>
<td>LD/implant, LD alone</td>
<td>82, 100</td>
<td>Early complications (up to 3 months): 66% vs. 51% (p=0.062) Any severe early complication: 46% vs. 29% Infection: 15% vs. 8% Fat necrosis: 13% vs. 16% Skin necrosis: 43% vs. 22% Long-term complications (4 to 12 months): 48% vs. 45% (p=0.845) Any severe long-term complication: 49% vs. 31% Capsular contracture: 15% vs. 0%</td>
<td>Reoperation: 61% vs. 65% (p=0.685)</td>
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**Abbreviations:** BMI: body mass index; CI: confidence interval; DIEA: deep inferior epigastric artery; DIEP: deep inferior epigastric perforator flap; LD: latissimus dorsi; msfTRAM: muscle-sparing free TRAM; N/A: not applicable; NAC: nipple-areolar complex; NR: not reported; OR: odds ratio; pTRAM: pedicled TRAM; QoL: quality of life; RR: relative risk; RT: radiotherapy; S-GAP: superior gluteal artery perforator flap; TRAM: transverse rectus abdominis myocutaneous; vs.: versus; yrs: years

**Notes:**
- a Same pts as Mioton 2013
- b Autologous pts same as Gart 2013
- c Estimated from reported data
- d Unclear from article
Clinical Question 5: Acellular dermal matrix

Systematic reviews

Eight systematic reviews of observational studies have assessed the benefits and harms associated with the use of ADM with TE/I-based breast reconstruction [23-25,80-84]. One of the reviews (Clemens et al.) focused exclusively on the use of ADM in the setting of RT [23]. Ten clinical studies plus the authors’ own experience yielded 276 patients who received radiation and ADM. Although only a minority of patients included in these studies received radiation, subgroup analyses suggest that there is a higher incidence of complications in patients who receive ADM in the setting of radiation compared with patients who do not receive radiation.

A systematic review and meta-analysis by Hoppe et al. published in 2011 assessed complications in seven studies comparing expander/implant reconstruction with vs. without ADM [24]. The meta-analysis indicated a higher infection rate in patients who received ADM (OR, 2.33; 95% CI, 1.55 to 3.49; p<0.0001), higher rate of seroma (OR, 3.00; 95% CI, 1.96 to 4.61; p<0.00001) and a higher rate of explantation (OR, 2.41; 95% CI, 1.59 to 3.64; p<0.00001). A second systematic review and meta-analysis published in 2012 by Kim et al. included six of the seven comparative studies included in the Hoppe review and reported similar results [25]. The rate of total complications was higher in the ADM group than the submuscular group (RR, 2.05; 95% CI, 1.55 to 2.70), as was the rate of seroma (RR, 2.73; 95% CI, 1.67 to 4.46), infection (RR, 2.47; 95% CI, 1.71 to 3.57) and reconstructive failure (RR, 2.80; 95% CI, 1.76 to 4.45). The risk of hematoma (RR, 2.06; 95% CI, 0.86 to 4.95) and flap necrosis (RR, 1.56; 95% CI, 0.85 to 2.85) was not significantly increased in patients with ADM compared with patients with submuscular reconstruction. Pooled complication rates from 19 studies of human ADM were the following: total complications 15.4%, seroma 4.8%, hematoma 1.0%, infection 5.3%, flap necrosis 6.9%, and reconstructive failure 3.8%. Four additional systematic reviews addressed complications associated with ADM in implant-based reconstruction but are not discussed further [80,81,83,84].

A systematic review by Nguyen et al. published in 2011 evaluated the evidence to support the perceived advantages of ADM [82]. The authors reported that the following perceived advantages were based only on anecdotal reports and opinions: reduction in postoperative pain, decreased operative time, precise control of the lateral and inframammary fold, maximal use of mastectomy skin flaps, and improved lower pole expansion. Data were inconsistent for perceived advantages including eliminating the need for expanders, increased initial fill volumes, fewer expansions, faster time to reconstruction completion, decreased rate of revision, and improved esthetic outcome. There was consistent evidence to support decreased incidence of capsular contracture but the studies had limited long-term follow-up.

Primary studies

Thirty additional primary studies addressing ADM in breast reconstruction were identified. Seventeen were retrospective studies of less than 100 patients, noncomparative retrospective studies, or studies that compared ADM vs. a different type of ADM and are not discussed further. The remaining 13 studies are reported in Table 4-7. One was an RCT [26], two were small prospective cohorts [175,176] and 10 were retrospective studies with more than 100 patients that compared implant-based breast reconstruction with vs. without ADM [27,177-185].

The multicentre, blinded RCT by McCarthy et al. represents the best attempt to date to examine the benefits and harms of ADM while controlling for confounding factors [26]. Sixty-nine patients were randomized intraoperatively to receive ADM or a standard submuscular approach. Accrual to the trial was stopped early after an unplanned interim analysis indicated a low probability of a positive result; however, all patients continued to be...
followed for the full 12 months. Outcomes reported to date include patient-reported pain, rate of tissue expansion, and adverse events. Total complications were not significantly different between groups (17% vs. 15%; p=1.00). No significant difference in pain visual analogue score was detected between groups in the immediate postoperative period, in the expansion phase or before the exchange procedure. Similarly, the difference between groups for physical well-being, immediate 24-hour postoperative narcotic use, and intraoperative fill volume was not significant. Outcomes including cosmesis, rate of capsular contracture, patient satisfaction, and quality of life have not yet been reported.

Of the 10 retrospective studies, two reported esthetic outcomes [27,181]. One reported higher esthetic outcome overall and higher inframammary fold esthetics in the ADM group [27] and the other reported significantly higher esthetic scores in the ADM group for volume, placement, and inframammary fold but no significant difference between groups for contour or scarring [181]. Results for complications were not consistent between studies, due in part to differences in study populations, methods for measuring complications, and length of follow-up. Of the six studies that reported overall complication rates, one reported that there were significantly more complications in the ADM group [178], one reported more complications in patients without ADM [27], and four reported no significant difference between the ADM and no ADM groups [177,179,180,184]. Infections were not significantly different between groups in four studies [27,177,179,184], were higher in the ADM group in two studies [178,185], and lower in the ADM groups in one study [183]. There was a significantly higher rate of seroma in the ADM group in one study [182] and no significant differences between groups in four studies [27,183-185]. Explantation or prosthesis failure was higher in the ADM group in one study [185], lower in another study [183], and no significant difference between groups was detected in three studies [179,182,184]. The two prospective nonrandomized studies reported low complication rates for patients receiving ADM [175,176]. The prospective series by Wu et al. demonstrated significant ADM stretching at three months compared with baseline (p=0.002) and no significant difference in patient satisfaction or physical and social well-being between ADM and a non-ADM cohort [176].
Table 4-7. Acellular dermal matrix primary studies.

<table>
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<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants</th>
<th>Complications</th>
<th>Other outcomes</th>
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<tbody>
<tr>
<td>McCarthy 2012 [26] Randomized controlled trial, blinded, multicentre</td>
<td>Immediate, postmastectomy two-stage tissue expander/implant reconstruction</td>
<td>Mean/median NR Follow-up continuing</td>
<td>ADM (AlloDerm) No ADM</td>
<td>36 33</td>
<td>Total complications: 17% vs. 15% (p=1.00) Hematoma: 1 vs. 1 Seroma: 1 vs. 3 Infection: 3 vs. 1 Premature removal of device: 1 vs. 0</td>
<td>Pain: No difference in VAS for immediate postoperative pain (p=0.19), average pain in expansion phase (p=0.65), or pain before exchange procedure (p=0.93) Physical well-being (BREAST-Q): No difference in immediate postoperative period (p=0.52), during expansion phase (p=0.77), or before exchange procedure (p=0.82) Immediate 24-hour postoperative narcotic use: No difference (p=0.38) Intraoperative fill volume: No difference (p=0.86) Mean # of percutaneous injections: 6.4 (ADM) vs. 7.3 (no ADM) (p=0.04)</td>
</tr>
<tr>
<td>Vardanian, 2011 [27] Retrospective, single centre, consecutive cohorts</td>
<td>Implant-based immediate reconstruction, autologous flap with implant excluded, 90% of reconstructions for breast cancer (10% prophylactic, silicone mastitis, congenital asymmetry), USA</td>
<td>Mean 29 months after implant exchange</td>
<td>ADM (AlloDerm) No ADM</td>
<td>208 129</td>
<td>All complications: 29.3% vs. 40.3% (OR, 0.61; 95% CI, 0.38 to 0.97) Less capsular contracture, problems with inframammary fold, bottoming out, rippling and mechanical shift in ADM group (p&lt;0.05). Seroma/hematoma, infection, overall wound problems, wound dehiscence and skin thinning not significantly different between ADM and no ADM.</td>
<td>Esthetic outcome: Overall higher in ADM group (p&lt;0.05). Inframammary fold esthetics higher in ADM group (p&lt;0.05).</td>
</tr>
<tr>
<td>Author, publication year, study design</td>
<td>Study population</td>
<td>Follow-up Procedure</td>
<td># of participants</td>
<td>Complications</td>
<td>Other outcomes</td>
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<tr>
<td>Brooke, 2012 [177] Retrospective, single centre</td>
<td>Primary cancer-related tissue expander and implant reconstruction, USA</td>
<td>Mean NR. Pts with inadequate data or lost to follow-up were excluded.</td>
<td>ADM (AlloDerm, DermaMatrix or FlexHD) No ADM</td>
<td>131</td>
<td>Overall clinically significant complications: 17% vs. 11% (p=0.48)</td>
<td>Infections: 10% vs. 2% (p=0.09 after adjusting for RT exposure and smoking)</td>
</tr>
<tr>
<td>Collis, 2012 [178] Retrospective, single centre</td>
<td>Immediate postmastectomy reconstruction with tissue expanders and permanent implant, USA</td>
<td>NR</td>
<td>ADM (AlloDerm or FlexHD) No ADM</td>
<td>63</td>
<td>Total complications (per breast): 18.9% vs. 7.4% (p&lt;0.05)</td>
<td>Tissue expander/graft infection requiring removal: 5.7% vs. 4.4% (p&lt;0.05) Epidermolysis: 13.2% vs. 1.5% (p&lt;0.01)</td>
</tr>
<tr>
<td>Endress, 2012 [180] Retrospective, single centre</td>
<td>Immediate 2-stage reconstruction, USA?</td>
<td>NR</td>
<td>ADM (fetal bovine Surgimend) No ADM</td>
<td>28</td>
<td>Overall complications (per breast): 20.8% vs. 13.0% (p=0.241). Data for specific complications also reported</td>
<td></td>
</tr>
<tr>
<td>Nguyen, 2012 [181] Retrospective, single centre</td>
<td>Expander implant reconstructions, photographically documented postexchange follow-up of at least 90 days, USA</td>
<td>Minimum 90 days after exchange. Mean NR.</td>
<td>ADM No ADM</td>
<td>62</td>
<td>Reoperation due to complications: 32.3% vs. 30.2% (p=0.8426)</td>
<td>Significantly higher esthetic scores in ADM group for volume, placement, and inframammary fold. No significant difference between groups for contour or scarring.</td>
</tr>
<tr>
<td>Parks, 2012 [182] Retrospective, consecutive cohorts</td>
<td>Breast reconstruction, private practice setting, USA</td>
<td>NR</td>
<td>ADM (AlloDerm) No ADM</td>
<td>232</td>
<td>Seroma formation (per pt): 34.0% vs. 20.2% (p&lt;0.001)</td>
<td>Skin necrosis (per pt): 13.8% vs. 14.9% (p=0.35) Loss of tissue expander (per pt): 14.7% vs. 9.7% (p=0.88)</td>
</tr>
<tr>
<td>Author, publication year, study design</td>
<td>Study population</td>
<td>Follow-up</td>
<td>Procedure</td>
<td># of participants</td>
<td>Complications</td>
<td>Other outcomes</td>
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<tr>
<td>Peled, 2012 [183] Prospective review, consecutive cohorts</td>
<td>Total skin-sparing mastectomy, immediate expander/implant, USA</td>
<td>Mean 25.5 months</td>
<td>ADM</td>
<td>65</td>
<td>Infection (per breast): 20% vs. 15.8% vs. 27.8% (p=0.04)</td>
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<td></td>
<td></td>
<td></td>
<td>Selective ADM (based on mastectomy skin flap thickness)</td>
<td>160</td>
<td>Unplanned return to OR: 11% vs. 10% vs. 23.3% (p=0.004)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>No ADM</td>
<td>63</td>
<td>Skin flap necrosis: 6% vs. 6.2% vs. 11.1% (p=0.26)</td>
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<td>Expander/implant loss: 7% vs. 5% vs 17.8% (p=0.001)</td>
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<td>Seroma: 4% vs. 5.8% vs. 4.4% (p=0.75)</td>
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<td>Hematoma: 3% vs. 2.7% vs. 3.3% (p=0.95)</td>
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<td></td>
<td>Nipple necrosis: 1% vs. 1.2% vs. 0% (p=0.82)</td>
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</tr>
<tr>
<td>Seth, 2012 [184] Retrospective, single centre</td>
<td>Mastectomy with immediate tissue expander reconstruction, permanent 2nd stage implant, USA</td>
<td>Mean follow-up 23.2 months (ADM) and 24.4 months (no ADM)</td>
<td>ADM (AlloDerm or FlexHD)</td>
<td>137</td>
<td>Total complications (per breast): 18.1% vs. 14.3% (p=0.19)</td>
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<td></td>
<td></td>
<td></td>
<td>No ADM</td>
<td>280</td>
<td>No significant difference between groups for hematoma, extrusion, infection, seroma, pain/tightness, major flap necrosis, nonoperative or operative complications, or explantation or conversion to flap</td>
<td></td>
</tr>
<tr>
<td>Author, publication year, study design</td>
<td>Study population</td>
<td>Follow-up</td>
<td>Procedure</td>
<td># of participants</td>
<td>Complications</td>
<td>Other outcomes</td>
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<tr>
<td>Weichman, 2012 [185] Retrospective, single centre</td>
<td>Immediate 2-stage implant-based reconstruction after mastectomy using pectoralis muscle for coverage, USA</td>
<td>NR</td>
<td>ADM (AlloDerm) No ADM</td>
<td>442 189</td>
<td>Mastectomy flap necrosis (per breast): 8.3% vs. 3.2% (p=0.005). Major necrosis: 6.7% vs. 2.7% (p=0.015). Mastectomy flap necrosis with infection: 1.8% vs. 2.1% (p=0.756) Infection: 13.6% vs. 7.5% (p=0.017). Major infection: 8.6% vs. 2.7% (p=0.001). Seroma: 1.8% vs 3.2% (p=0.326) Hematoma: 0.5% vs. 1.1% (p=0.586) Explantation: 7.7% vs. 2.7% (p=0.004)</td>
<td>--</td>
</tr>
<tr>
<td>Davila, 2013 [179] Retrospective, national surgical database</td>
<td>Immediate tissue expander reconstruction following mastectomy, USA</td>
<td>ADM No ADM</td>
<td>1717 7442</td>
<td>Total complications: 5.6% vs. 5.3% (p=0.57) No significant difference in operative infection, wound disruption, prosthesis failure, major medical complications, or reoperation within 30 days</td>
<td>--</td>
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</tr>
<tr>
<td>Venturi 2013 [175] Multicentre prospective cohort, consecutive patients</td>
<td>Immediate expander-based reconstruction, unilateral or bilateral</td>
<td>Mean 12 months (range 9 to 18 months)</td>
<td>ADM (AlloMax, sterile)</td>
<td>39 (65 breast reconstructions)</td>
<td>Early postoperative complications: 3 breasts in 2 patients (1 bilateral mastectomy flap necrosis, 1 unilateral cellulitis)</td>
<td>Average intraoperative fill volume: 50.9% of expander volume</td>
</tr>
<tr>
<td>Author, publication year, study design</td>
<td>Study population</td>
<td>Follow-up</td>
<td>Procedure</td>
<td># of participants</td>
<td>Complications</td>
<td>Other outcomes</td>
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<tr>
<td>Wu 2013 [176] Prospective consecutive case series with comparative cohort from same time period</td>
<td>Postmastectomy prosthetic breast reconstruction</td>
<td>Mean 96 days (ADM group)</td>
<td>ADM (AlloDerm)</td>
<td>31</td>
<td>Postsurgical complications: 10% vs. 13%. 1 late seroma, 1 delayed erythema, 1 urinary tract infection in ADM group. In no-ADM group: 2 cellulitis, 2 expander replacement, 1 delayed wound healing, 1 skin necrosis</td>
<td>ADM stretching at 3 months: mean perimeter increase 11% (p=0.002 vs. baseline) and surface area increase 21% (p=0.002 vs. baseline). Surface area changes range 4% to 35% across patients. Patient satisfaction with breasts, implants, and surgery outcome (BREAST-Q survey): not significantly different between groups. Physical and psychosocial well-being (BREAST-Q survey): not significantly different between groups</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No ADM</td>
<td>45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** ADM: acellular dermal matrix; CI: confidence interval; NR: not reported; OR: odds ratio; OR: operating room; pts: patients; RT: Radiotherapy; VAS: visual analogue scale; vs.: versus.
Clinical Question 6: Autologous fat grafting

Systematic reviews

Three systematic reviews were identified that addressed the safety and oncological outcomes of autologous fat grafting: Krastev 2013 [28], Claro Jr. 2012 [85] and Saint-Cyr 2012 [29]. The most recent review by Krastev et al. examined the rate of locoregional and distant recurrence for fat grafting in breast reconstruction after mastectomy or breast-conserving treatment for breast cancer [28]. Of the 20 clinical studies identified in the review, only four studies (one retrospective cohort and four case series) were suitable for analysis after excluding studies with overlapping patient populations. Two studies reported a locoregional recurrence rate of 1.35% and 0.72% in women who underwent mastectomy and fat grafting with a mean follow-up of 1.60 and 5.23 years, respectively. The other two case series were smaller and reported no locoregional recurrence during follow-up. Another retrospective cohort study by Petit et al., whose population overlapped significantly with one of the studies above, compared locoregional recurrence in 321 breast cancer patients who underwent fat grafting with 642 matched patients without fat grafting and reported no significant difference in the recurrence rate between groups (1.15% vs. 1.36%). The review authors concluded that the available evidence was inconclusive but promising, with larger prospective studies with longer follow-up being required to determine the oncological safety of fat grafting.

Another systematic review by Saint-Cyr et al. of fat grafting in the reconstructive and esthetic setting reported on clinical outcomes, cosmesis, patient satisfaction, and complications [29]. Nineteen studies were included in the review, of which 14 included patients receiving fat grafting as an adjunct to breast reconstruction. Satisfaction of patients and the surgical team with the results of fat grafting varied among studies; however, the majority of studies reported satisfactory or better results. Four studies reported the occurrence of postoperative infections, all of which could be managed with antibiotics. Other complications included a siliconoma, two pneumothoraces, and a sternal fibrous breast tissue. The authors concluded that while autologous fat grafting appeared to be a safe option, further studies were required to confirm that it is an effective and safe practice.

A third systematic review by Claro Jr. et al. included 60 articles, of which 41 addressed fat grafting for partial or total breast reconstruction [85]. Complication rates were reported to be low, although results were not reported separately for studies of patients who underwent breast reconstruction.

Primary studies

Ten additional primary studies of fat grafting in the context of breast reconstruction following mastectomy were identified. Six of the 10 studies were noncomparative retrospective studies and are not discussed further. The remaining four studies were prospective cohorts of patients undergoing fat grafting [166] or single-centre retrospective comparisons of fat grafting vs. no fat grafting [30,167,168] and are reported in Table 4-8.

Seth et al. compared 69 patients who underwent tissue expander reconstruction with fat grafting vs. 817 patients who underwent tissue expander reconstruction alone [167]. In 99 fat grafting procedures in 90 breasts, only one postoperative complication associated with fat grafting was reported (local fat necrosis). Local recurrence (1.5% vs. 0%; p=0.63) and survival (95.5% vs. 100%; p=0.10) were not significantly different between the no fat grafting and fat grafting groups.

A retrospective matched cohort study by Petit et al. [30] investigated local recurrence in patients with intraepithelial neoplasia. In an exploratory subgroup analysis of patients who underwent mastectomy with vs. without fat grafting, five-year local recurrence was 18.4% in patients with fat grafting vs. 3.6% in patients without fat grafting (log-rank p=0.11). Another retrospective study comparing free flap reconstruction with fat grafting to free flap
reconstruction alone reported a postoperative complication of fat grafting in one of 100 breasts: a major infection at the recipient site requiring hospitalization and intravenous antibiotics [168]. Choi et al. [166] used three-dimensional imaging to assess volumetric fat graft survival in a prospective cohort of patients receiving autologous fat grafting to the breast. Some women underwent lumpectomy or partial mastectomy and not mastectomy. Results indicated that patients receiving higher volumes of fat grafting had slower volume loss and greater total volume retention. The group with the largest injected volume had 52.3% volume retention at 140 days while the smallest group had 27.1% retention.
### Table 4-8. Autologous fat grafting primary studies.

<table>
<thead>
<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Procedure</th>
<th># of participants (patients without mastectomy excluded)</th>
<th>Complications</th>
<th>Other outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petit, 2012 [186] Retrospective, single centre, matched cohort</td>
<td>No synchronous distant metastases at diagnosis, bilateral or recurrent tumour, previous breast cancer, or neoadjuvant therapy; Italy</td>
<td>Median from primary surgery: 56 months</td>
<td>Mastectomy, reconstruction and fat grafting</td>
<td>196</td>
<td>NR</td>
<td>Local or locoregional recurrence: HR, 1.92 (95% CI, 0.68 to 5.43), Gray test p=0.211</td>
</tr>
<tr>
<td>Seth, 2012 [167] Retrospective, single centre</td>
<td>Mastectomy, immediate tissue expander reconstruction; USA</td>
<td>Mean from tissue expander insertion: 44 months FG, 42 months control. Mean 25 months from fat grafting in FG group.</td>
<td>Mastectomy, tissue expander reconstruction and fat grafting (Coleman) Mastectomy, tissue expander reconstruction</td>
<td>69 817</td>
<td>1 postoperative complication associated with fat grafting (local fat necrosis at site of injection, managed conservatively)</td>
<td>Local recurrence: 0% vs. 1.5% (p=0.63) Survival: 100% vs. 95.5% (p=0.10)</td>
</tr>
<tr>
<td>Petit, 2013 [30] Retrospective, single centre, matched cohort</td>
<td>Intraepithelial neoplasia; no synchronous distant metastases at diagnosis, bilateral or recurrent tumour, or previous breast cancer; Italy</td>
<td>Median from oncologic surgery: 63 months FG, 66 months control</td>
<td>Mastectomy, reconstruction and fat grafting</td>
<td>47 94</td>
<td>NR</td>
<td>5-year local or locoregional recurrence: 18.4% FG vs. 3.6% control, log-rank p=0.11</td>
</tr>
<tr>
<td>Weichman, 2013 [168] Retrospective, single centre</td>
<td>Autologous reconstruction, microvascular free flaps; minimum 1 year follow-up; USA</td>
<td>Mean 18 months, range 12 to 41 months</td>
<td>Mastectomy, free flap reconstruction and fat grafting (modified Coleman) Mastectomy, free flap reconstruction</td>
<td>100 (breasts) 274 (breasts)</td>
<td>1 major infection at the recipient site requiring hospital admission and intravenous antibiotics</td>
<td>-</td>
</tr>
</tbody>
</table>

**Abbreviations:** CI: confidence interval; FG: fat grafting group; HR: hazard ratio; NR: not reported; vs.: versus.
Clinical Question 7: Routine screening for recurrence

A systematic review of surveillance mammography following breast reconstruction published by Barnsley et al. captured studies published between 1980 and 2004 [31]. Eight retrospective reviews, case series, or case reports were included, four of which included fewer than 10 patients. Only one of the eight articles described the mammography regimen, which consisted of semiannual mammography. Significant heterogeneity did not allow for meta-analysis and survival was not addressed. Local recurrences were detected by surveillance mammography or other methods in only two studies. In the largest series of 113 women with TRAM reconstruction, two of three local recurrences were detected by surveillance mammography. The positive predictive value, sensitivity, and specificity were calculated to be 33%, 67%, and 98%, respectively. In another descriptive study of four patients with local recurrence, one case was detected by surveillance mammography. The review authors concluded that there was a lack of evidence to guide clinicians in the use of routine surveillance mammography following treatment of breast cancer with breast reconstruction and further research was required.

Three additional primary studies were identified that addressed detection of recurrence following breast reconstruction; two were identified in the systematic literature search and one from reviewing reference lists (see Table 9). A retrospective database review by Sim et al. compared women who underwent routine surveillance mammography with women who underwent radiological investigation for symptoms in the reconstructed breast and surveillance mammography of the contralateral breast only [32]. In the 116 patients who underwent routine surveillance mammograms, one asymptomatic recurrence was identified by surveillance mammography three years after breast reconstruction. One additional patient was diagnosed with a second nonpalpable primary cancer in the contralateral breast. Four patients with symptoms in the reconstructed breast were found to have recurrent cancer. This study demonstrated a 0.86% detection rate of nonpalpable recurrent breast cancer and a 4% recall rate, with the most common diagnosis being fat necrosis. Patterson et al. reported a retrospective study of 390 women with TRAM reconstructions who did not undergo routine surveillance imaging [169]. The locoregional recurrence rate was 4.6%; all were detected first by physical examination rather than by imaging. This rate is comparable with rates observed in women who undergo mastectomy without reconstruction. The average time for locoregional recurrence to present after mastectomy and reconstruction was 35.8 months and 22.9 months, respectively, for stage III patients. The 2008 study by Lee et al. retrospectively identified 264 TRAM patients that had completed 554 mammograms in a six-year period [170]. Eight recall events occurred, all of which were found to be benign after pathological examination. The recall rate was 1.4% and the detection rate of nonpalpable breast cancer recurrence was 0%.
Table 4-9. Routine screening for recurrence primary studies.

<table>
<thead>
<tr>
<th>Author, publication year, study design</th>
<th>Study population</th>
<th>Follow-up</th>
<th>Surveillance method</th>
<th># of participants</th>
<th>Recurrence</th>
<th>Other outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sim 2012 [32] Retrospective, national database</td>
<td>Reconstructive breast surgery for breast cancer, radiological imaging</td>
<td>Effective follow-up period range 1 to 13 years (median and mode 6)</td>
<td>Mammography of reconstructed breast as routine surveillance Radiological investigation for symptoms in reconstructed breast. Surveillance mammography of contralateral breasts only.</td>
<td>116</td>
<td>Surveillance mammography group: 1 asymptomatic recurrent invasive breast carcinoma 3 years after reconstruction (detection rate of nonpalpable cancer 0.86%). Symptomatic reconstructed breast (54 patients): 4 recurrent cancers</td>
<td>Surveillance results: 75% normal, 21% benign findings, 4% indeterminate or suspicious findings</td>
</tr>
<tr>
<td>Patterson 2012 [169] Retrospective, 2 centres</td>
<td>Immediate TRAM reconstruction for breast cancer or DCIS, USA</td>
<td>Median follow-up 69.2 months (range 24.1 to 134.4 months)</td>
<td>No routine surveillance imaging</td>
<td>390</td>
<td>18 patients had palpable locoregional recurrence (4.6%), 8 superficial recurrences, 1 deep to the TRAM reconstruction, 5 regional in axilla, 4 in supraclavicular lymph node. No LRR was diagnosed first by imaging. 5-year LRR-free rate: 92.4% (95% CI, 87.1 to 95.5). Average time for LRR to present after mastectomy &amp; reconstruction: 35.8 months. Stage III patients: 22.9 months.</td>
<td></td>
</tr>
<tr>
<td>Lee 2008 [170] Retrospective, single centre</td>
<td>Mastectomy for primary breast cancer, TRAM reconstruction (immediate or delayed), USA</td>
<td>Median follow-up after mastectomy 4.9 years (range 0.2-22.0 years)</td>
<td>Surveillance mammography</td>
<td>264</td>
<td>No local recurrences. Three patients had distant recurrence. Rate of detection of nonpalpable recurrent cancer: 0% (95% CI, 0% to 1.4%). 1.4% (8 patients) had false-positive screening mammography results.</td>
<td></td>
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</table>

**Abbreviations:** CI: confidence interval; DCIS: ductal carcinoma in situ; LRR: local-regional recurrence; TRAM: transverse rectus abdominis myocutaneous.
DISCUSSION
Candidates for postmastectomy breast reconstruction

a) Patient factors

Older age
Since the incidence of breast cancer increases with advanced age, it is important to re-evaluate the appropriateness of IBR in the older patient population. There has been one systematic review on this topic that summarized six studies. It concluded that breast reconstruction is safe and feasible, and provides significant improvements in the health-related QOL of older patients [4]. Contrary to the previously held belief that older patients may not tolerate longer and more complex autologous tissue reconstruction methods, other authors have found that the use of autologous tissue provided more symmetrical results, fewer complications, and less pain compared with implant-based methods in three studies [3,187,188].

Obesity
Results from the largest study of this topic that examined 15,937 patients in the National Surgical Quality Improvement Program (NSQIP) from 2005 to 2010 who underwent breast reconstruction in the United States showed that morbidly obese (BMI >40 kg/m²) patients had significantly increased early postoperative complications in terms of major surgical complications, medical complications, wound healing problems, and an additional return to the operating room compared with both nonobese patients and mildly obese patients (BMI between 30 kg/m² and 39.9 kg/m²) [1]. In addition, the same group also found that progressively higher BMI was associated with significantly higher incidence of all complications captured by the NSQIP database, including major surgical complications, medical complications, wounds, return to the operating room, infections, and reconstructive failures [2].

Active smokers
Smoking is seen as a relative contraindication to breast reconstruction as outlined by the National Comprehensive Cancer Network (NCCN) guidelines (Version 3.2014). In a prospective single-centre study [3] that examined 558 patients who underwent microsurgical breast reconstruction techniques using abdominal flaps, the authors found that patients who were active smokers (17%) had significantly higher rates of both flap and donor complications compared with nonsmokers. The NSQIP database also corroborated these findings, and found that minor surgical complications were significantly increased in active smokers who underwent microsurgical flap reconstruction (OR, 1.87; p=0.03) [99].

Evidence on the effect of active smoking on the outcome of implant-based reconstruction is limited to single-centre retrospective studies with small numbers of patients. This is likely due to the provider bias to avoid implant reconstruction in active smokers [86,93,189,190].

b) Cancer factors
Current national and provincial guidelines published by the NCCN in the United States, National Institute for Health and Care Excellent (NICE) in the United Kingdom, Alberta Health Services, and Saskatchewan Cancer Agency broadly endorse the use of breast reconstruction as part of the clinical pathway for women with in situ and invasive breast cancer.

The Alberta Health Services Clinical Practice Guidelines endorses the use of IBR for ductal carcinoma in situ (DCIS), T1 and T2 tumours, and multicentric tumours, while it does not endorse the use of IBR for T3 and T4 tumours, inflammatory breast cancer, or where axillary
lymph nodes are involved with breast cancer [66]. The use of DBR, however, is acceptable in all patients after surgical resection and adjuvant treatments are completed.

A recent systematic review [191] on SSM and IBR listed the following as the generally accepted indications for consideration of SSM and IBR:

1. Multicentric disease
2. In situ disease or diffuse microcalcification
3. Large tumour size to breast volume ratio, which may preclude the use of breast conservation surgery
4. Absence of lymphovascular invasive disease
5. Failed initial conservation surgery necessitating mastectomy
6. Recurrence of breast cancer in a previously conserved breast
7. Radiotherapy is not possible such as in a previously irradiated breast or chest (Hodgkin disease), patient with collagen vascular disease, or with Tp53 mutation.

c) Treatment factors

Chemotherapy

Neoadjuvant chemotherapy: SSM with IBR is safe in the setting of neoadjuvant chemotherapy and does not appear to lead to increased surgical complications as evidenced by several retrospective studies. Hu et al. found comparable overall rates of postoperative complications in a group of 180 patients who received neoadjuvant chemotherapy (30%) compared with 485 patients who did not (31%) following SSM and IBR (p=0.85) [89]. In another large single-centre retrospective study of 1037 patients who received IBR, the use of neoadjuvant chemotherapy was not significantly associated with increased postoperative complications (OR, 0.93, p=0.86) [86].

Adjuvant chemotherapy: The concern that the use of IBR in patients with active breast cancer may lead to increased surgical complications and compromise the timely delivery of adjuvant chemotherapy is not supported by the evidence. While a large multicentre cohort study showed a statistically significant delay in median time to chemotherapy following IBR (six weeks) compared with mastectomy alone (five weeks), this was deemed not clinically important [110].

Radiotherapy

Prior radiotherapy: Pre-reconstruction radiotherapy is usually in patients who have undergone previous breast-conserving therapy (BCT) and have developed recurrent disease. A systematic review compared pre and post radiotherapy in implant-based reconstructive patients [72]. Investigators identified 26 relevant studies involving over 1500 patients. They were unable to directly compare radiation pre- and post-breast implant reconstruction, because most of the studies were case series and not comparative in nature, there was significant heterogeneity among the studies with respect to patient characteristics, and outcomes of interest were not reported in a consistent fashion. Nevertheless, they did report considerable complications for pre- and postreconstructive radiation: major complications 49% (95% CI, 25% to 72%) and 39% (95% CI, 24% to 55%), respectively; severe contractures 37% (95% CI, 20% to 55%) and 25% (95% CI, 10% to 45%), respectively; and reconstructive failure 19% (95% CI, 10% to 29%) and 20% (95% CI, 15% to 25%), respectively. Other studies suggest that these rates are considerably higher than for patients who undergo implant reconstruction in the absence of any radiotherapy [72]. In the largest retrospective series that examined 1037 patients, the authors found that prior radiotherapy significantly increased major complication rates from 21.2% to 45.4% in the TE/I group, while this relationship did not exist for the autologous tissue group [86]. In addition, 10.3% of the failed TE/I group went on to receive autologous tissue reconstruction. In another larger retrospective series that examined
532 patients who underwent both implant and autologous tissue reconstruction, prior BCT (in 113 patients) was not significantly associated with higher complications rates (OR, 1.09; p=0.69), or lower satisfaction on a validated instrument. However, prior radiation was correlated with a significantly higher rate of mastectomy flap necrosis (12.4% vs. 6.8%, p=0.024) [91].

Timing of breast reconstruction

a) Patients not expected to require postoperative radiotherapy

We recommend IBR with SSM as a first-line surgical treatment option to be discussed with all patients diagnosed with breast cancer who will likely not receive postmastectomy radiation. For patients interested in PMBR, IBR appears to be superior to DBR in psychological and QOL outcomes, and equivalent to standard mastectomy (alone) in terms of oncologic outcomes. Based on a randomized trial of immediate vs. delayed reconstruction and a cross-sectional survey study that included 190 breast cancer patients who underwent mastectomy alone, IBR, and DBR, women who had IBR had lower levels of body stigma, body concerns, and psychological disturbance compared with the DBR group [6,73]; however, these results should be interpreted cautiously due to the high risk of bias in these two studies. The RCT was limited in its small sample of women undergoing IBR and lack of psychosocial functioning scores prior to mastectomy in the DBR group.

The oncologic safety of IBR has also been supported by several large-scale studies that employed different study methodologies. A prospective cohort of 677 patients with T1-T3 tumours who underwent either mastectomy alone or mastectomy with IBR without postmastectomy radiation were found at a median of 70 months follow-up to have 5.2% local recurrence rate in the IBR groups compared with 9.4% in the mastectomy alone group [7]. There were no differences in regional and distant metastasis rates, disease-free survival, or overall survival rates in the two groups. A recent meta-analysis also confirmed that there was no difference in terms of the risk of local recurrence between patients who had IBR compared with mastectomy alone [8].

b) Patients who are expected to require postoperative radiotherapy

Most guidelines that address the timing of breast reconstruction in the setting of anticipated postmastectomy radiotherapy (PMRT) have recommended that breast reconstruction be delayed for a period of at least several months after the delivery of PMRT has been completed [192-194]. The NCCN guidelines have recognized the importance of making separate recommendations about autologous tissue and implant-based reconstructions in the setting of PMRT. The NCCN guidelines (v3.2014) state that when PMRT is anticipated, immediate reconstruction with implants are preferred to avoid tissue expansion of radiated skin flaps [195]. The Alberta Health Services clinical practice guidelines stated that there was insufficient evidence to make a recommendation for or against the use of IBR in the setting of anticipated PMRT [196]. While most of the existing guidelines on this topic were based on studies that were published prior to 2012, our current review yielded additional systematic reviews that were published between 2012 and 2014 that examined PMRT with implant-based IBR or autologous tissue reconstruction [9,10,72,94,197]. Importantly, our current recommendations were informed by the more current studies that employed the newer and more advanced radiation techniques as well as a greater number of studies than previously available. It should be noted that the studies included in the systematic reviews consisted mainly of observational, retrospective studies which are prone to selection bias. In the autologous IBR setting, the available literature indicates that while reoperation rates are not significantly different with or without PMRT, fat necrosis was significantly different and esthetic outcome was decreased in more than one-half of the studies [9]. In an implant-based
setting, there was a higher rate of reconstruction failure and risk of morbidity associated with PMRT [10,86].

The decision-making process between immediate vs. delayed breast reconstruction for the patient requiring adjuvant therapy is highly complex, and must take into consideration both the oncologic and reconstructive outcomes. We now know that from an oncologic perspective, the performance of IBR does not lead to a clinically meaningful delay in adjuvant chemotherapy [110,139]. The literature has also shown that reconstructed breasts do not impair the ability to radiate the chest wall effectively, even when the internal mammary lymph nodes are in the radiated field [159]. Thus, the major argument against the use of IBR is no longer only about the oncologic safety of this practice; rather it rests on a detailed examination of the possible detrimental effects of radiation on the reconstructive outcomes. Patients should be made aware of these potential complications so that they can make fully informed decisions.

Skin-sparing and nipple-sparing mastectomy

All studies evaluating the safety and efficacy of SSM in the systematic review were retrospective and therefore subject to selection bias. Median follow-up time was highly variable among studies; therefore, recurrence rates are challenging to interpret. Within the retrospective studies, there is significant heterogeneity among patients; therefore, interpretation and generalizability is limited. Although the evidence is low when comparing SSM with standard mastectomy, recurrence rates for SSM across clinical trials appear to be reasonably low in the prophylactic, DCIS, and early breast cancer patient cohorts [12].

Similarly, all studies included in the systematic review evaluating NSM were retrospective and, therefore, subject to selection bias. Median follow-up time among studies was highly variable; therefore, recurrence rates are challenging to interpret and subject to significant patient and tumour heterogeneity. Although the evidence is low when comparing NSM with standard mastectomy, recurrence rates for NSM across studies appear to be reasonably low in prophylactic, DCIS, and early breast cancer patients [13,14,74,75].

Prospective RCTs will be challenging when patient preference drives the decision to attempt nipple sparing vs. none, or to entertain immediate (skin-sparing) vs. delayed (non-skin sparing) breast reconstruction. Even if patient preference is deferred, patients may be technically ineligible for one or the other, which would further challenge a prospective RCT.

Types of reconstruction

**a) Autologous tissue vs. tissue expander/ implant reconstruction**

There is only a single systematic review examining the rates of complications TE/I reconstructions and AAT [15]. Only 14 studies were included and the level of evidence is very low, the studies have small sample sizes, and overlap exists among the patient populations. While reoperation rate and major complications are equivalent between the methods of reconstruction, this review suggests a greater potential for reconstructive failure and soft tissue infection in TE/I reconstructions. More evidence and better quality studies are required to determine the accuracy of this interpretation. Complications associated with implants, including risk of infection and very rare risk of ALCL should be discussed with patients [198].

A single systematic review examining patient related outcomes following different types of breast reconstruction exists [16]. This study encompasses 15 studies of very low quality and there is no consistency among measurement method, duration of follow up, or outcomes assessed. This led to the inability to pool data. The trends from this review are for improved social well-being, emotional and mental health associated with reconstruction, regardless of type, similar levels of pain between methods of reconstruction, and similar
overall satisfaction or willingness to recommend surgery to others. There is some suggestion that esthetic satisfaction with TE/I reconstruction declines over time, while AAT satisfaction remains level; however, this needs to be validated with better quality studies and larger sample sizes. Consistency among outcome measures would significantly improve ability to assess patient-related outcomes.

**Radiation**

Our current recommendation on the type of reconstruction following PMRT have examined autologous tissue separately from implant-based reconstructions, and have focused primarily on short- and long-term complications of PMRT. In all the systematic reviews that compared the reconstructive options in patients who required PMRT, it was found that complications are significantly higher in the implant group compared with the autologous tissue group [197]. In addition, a 2008 prospective single-centre study that examined 92 patients who underwent IBR using autologous tissue (23 patients) compared with tissue expander (69 patients) found that major complications, compromised functional status, and poor esthetic outcomes to be significantly associated with the use of tissue expanders [18].

**b) Types of autologous tissue reconstruction**

Evidence is based on two meta-analyses and three systematic reviews; however, the analyzed studies share some common weaknesses. The reviews are based on individual studies that are made up of very small cohorts, mostly retrospective in design, from single institutions, and lacking uniform definition to define our interested outcomes such as abdominal bulge, hernia, weakness, and fat necrosis. The current literature comparing outcomes among different techniques is also severely limited by the great variability in surgical techniques, the degree to which rectus muscle may be injured or violated by the surgery, and the type of abdominal wall repair that occurs with the reconstruction. Higher level of evidence in the area will require data collected from multicentre, longitudinal studies with clearly defined primary outcomes that are both subjective and objective following pedicled or free TRAM and DIEP flaps.

**Acellular dermal matrix**

The level of evidence for the use of ADM varies from retrospective single-centre anecdotal reports to meta-analyses of observational studies and RCTs. The largest RCT stopped accrual early and has not reported final outcomes. There was high variability in reporting of complications among studies; however, three meta-analyses suggested an increased rate of complications using ADM. Given the lack of benefit in postoperative pain, time to second operation, and number of tissue expander fills, and the higher rate of complications, ADM is currently not recommended for two-stage expander-implant reconstruction. Given the possibility of avoiding a second surgery, ADM may be considered in appropriate patients for direct-to-implant reconstruction in a single stage. Although cost of using ADM was not examined in this evaluation, it must be considered. A Canadian study evaluating cost suggests that it is not prohibitive [199].

**Autologous fat grafting**

Overall, the level of evidence for autologous fat grafting is very low. It appears that fat grafting after mastectomy is likely safe in patients with invasive carcinoma. Intraepithelial neoplasia may be a subset that should not receive fat grafting due to higher levels of locoregional recurrence. Complication rates associated with fat grafting are likely minimal; however, complications can occur that would not have occurred without this additional
procedure. No standardization exists for fat grafting techniques in terms of timing, number of sessions, volume of fat, or processing of fat.

**Routine screening for recurrence**

With the increased utilization of reconstructive surgery following mastectomy, questions regarding the application of surveillance mammography in this setting have been raised. Unfortunately, the current literature is lacking in strong evidence to provide conclusive direction. Current breast cancer guidelines for women without breast reconstruction recommend annual ipsilateral mammography for women treated with BCT and contralateral native breast mammography. There is currently no role for routine imaging following mastectomy alone. Postmastectomy surveillance comprises a physical examination of the chest wall as part of a scheduled follow-up program. The locoregional recurrence rate following breast reconstruction appears to be similar to the rate in women who undergo mastectomy without reconstruction (<10%); however, breast reconstruction may interfere with the ability to appropriately evaluate the chest wall for recurrence. The question remains whether mammography should be employed as a surveillance tool for women who have undergone reconstructive surgery.

The available evidence suggests that mammography can identify lesions in the follow-up of women who undergo mastectomy and breast reconstruction but results in high recall rates and the need for further invasive testing. The majority of lesions identified by screening mammography were later determined to be benign on pathological examination. Such results have the potential to cause undue anxiety that may outweigh the benefits of screening for women without symptoms of recurrence.

Important clinical considerations in the determination of optimal follow-up include the type of reconstruction (implant vs. autologous tissue) and the timing and modality of surveillance imaging. The majority of the studies reviewed for the development of these guidelines only included women with autologous breast reconstruction. This is based on the idea that imaging is not required for implant-based reconstruction because the pectoralis major muscle is raised off the chest wall and is adherent to the skin, making clinical evaluation of the chest wall for recurrence technically possible. Conversely, autologous reconstruction is placed over the chest wall, leading to the concern that a chest wall recurrence might be concealed.

There is some suggestion that chest wall recurrences behave differently than skin flap recurrences, with an increased number of women with chest wall recurrence having metastatic disease at the time of diagnosis or identified during early follow-up. It is unclear whether early detection of such recurrences would lead to an improvement of outcomes. A retrospective chart review by Chagpar et al. identified 155 women with chest wall recurrence, of whom 27 had previous breast reconstruction [200]. Time from mastectomy to diagnosis of chest wall recurrence, overall survival, and distant metastasis-free survival were not significantly different between women with and without breast reconstruction, although the statistical power to detect clinically meaningful differences in this study is unclear.

If an assumption is made that early detection of chest wall recurrences could improve clinical outcomes, identification of a group of women at higher risk for chest wall recurrence could help to improve the application of post-breast reconstruction mammography. Certain patient and tumour characteristics have been identified that may be indicative of increased local recurrence risk post mastectomy, such as young age, multicentricity, lymphovascular invasion, and positive surgical margins. Utilization of postreconstruction imaging, along with clinical examination, in this population of women may provide improved clinical outcomes. However, these risk factors have also been identified as increased risk for distant metastasis,
so the perceived benefit maybe over-estimated. Further studies in this area are required to determine the benefit.

The timing and imaging regimen for surveillance mammography after reconstruction was only described in one of the case reports in the systematic review by Barnsley et al. (semiannual screening) [31]. The only imaging modality evaluated in the literature to date for the follow-up of women with breast reconstruction is mammography. There is no clearly defined strategy for the application of surveillance imaging and evidence on appropriate application is nonexistent.

In the studies reviewed, most recurrences were identified following development of symptoms, such as pain or a palpable mass. A low index of suspicion for evaluation should be considered and symptomatic patients should be evaluated by imaging such as ultrasound and mammography and should be referred to a surgeon.

Based on the current literature there is insufficient evidence to suggest that routine screening mammography following breast reconstruction would improve the clinical outcomes of breast cancer recurrence.

CONFLICT OF INTEREST

Information regarding conflict of interest declarations can be found in Appendix I.
Breast cancer reconstruction surgery (immediate and delayed) across Ontario: Patient indications and appropriate surgical options

Section 5: Internal and External Review

INTERNAL REVIEW

Program in Evidence-Based Care (PEBC) guidelines are reviewed by a panel of content experts—Expert Panel and a methodology panel—Report Approval Panel (RAP). Both panels must approve the document. The Working Group was responsible for incorporating the feedback and required changes of both of these panels. The details of these reviews and actions taken are described below. Appendix I provides a list of members of the Working Group, RAP and Expert Panel and summarizes conflict of interest declarations for all members.

Expert Panel Review and Approval

Of the 11 members of the Expert Panel, eight members cast votes and three abstained, for a total of 72% response in August and September 2015. Of those that cast votes, eight approved the document (100%). The main comments from the Expert Panel and the Working Group’s responses are summarized in Table 5-1.

Table 5-1. Summary of the Working Group’s responses to comments from the Expert Panel.

<table>
<thead>
<tr>
<th>Comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. P4 Recommendation (Rec) 2 ‘Qualifying Statement (QS)’ mentions ‘three characteristics’ but only two are listed. Should psychiatric illness be on the list or not?</td>
<td>No, psychiatric illness should not be in this list. We have removed it and modified the text to reflect this.</td>
</tr>
<tr>
<td>2. P5 Rec. 6 QS ‘ontologically’ should be oncologically.</td>
<td>This has been corrected.</td>
</tr>
<tr>
<td>3. P7 Rec 9 QS should be ‘outcomes in select women’, ‘in’ is currently missing.</td>
<td>This has been corrected.</td>
</tr>
<tr>
<td>4. P9 Rec 2 The list numbers are 3 &amp;4; should be 1 &amp; 2</td>
<td>This has been corrected.</td>
</tr>
<tr>
<td>5. P9 Rec2 QS Only 2 characteristics are listed but it states ‘three’.</td>
<td>We have corrected this (see comment 1)</td>
</tr>
<tr>
<td>6. P10 top line “Older age is qualified as &lt;50.” Shouldn’t this be &gt; 50?</td>
<td>This has been corrected.</td>
</tr>
<tr>
<td>7. P11 Rec4 ‘Tp53’ should be TP53.</td>
<td>This has been corrected.</td>
</tr>
<tr>
<td>8. P13 Rec 6 QS ‘ontologically’ should be oncologically</td>
<td>This has been corrected.</td>
</tr>
<tr>
<td>9. P16 ‘Interpretation of evidence’ The last sentence is confusing and should be</td>
<td>We have modified this sentence to help improve clarity.</td>
</tr>
</tbody>
</table>
Report Approval Panel Review and Approval

Three RAP members reviewed this document from April to June of 2015. Two RAP reviewers approved of the Guideline and one RAP reviewer conditionally approved the Guideline on June 24, 2015. The summary of main comments from the RAP and the Working Group’s modifications/actions/responses taken in response are showed in Table 5-2.
Table 5-2. Modifications/actions/responses regarding main comments from RAP

<table>
<thead>
<tr>
<th>Main comments</th>
<th>Modifications, actions, or responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Please add expertises of the Expert Panel and Working Group to the tables in Appendix 1</td>
<td>We have modified Table a.1 and a.2 to include the affiliations and expertises of the Working Group and Expert Panel</td>
</tr>
<tr>
<td>2. Consistency with acronyms are needed</td>
<td>We have updated the acronyms in the Guideline to improve consistency.</td>
</tr>
<tr>
<td>3. Please clarify the role of the expert panel as it related to the development of the Guideline</td>
<td>We have amended Section 3 to include a more detailed description of the roles and responsibilities of the Working Group and the Breast Reconstruction Expert Panel</td>
</tr>
<tr>
<td>4. Please clarify the definitions that are used for “older age” and “advanced disease”</td>
<td>We have modified the recommendation regarding older age to: “There is no age at which breast reconstruction is contraindicated”</td>
</tr>
<tr>
<td></td>
<td>There is no consistent definition in the evidence as to what age group is “older age”. Because the evidence does not find age to be a contraindication to breast reconstruction we have modified the recommendation to reflect this.</td>
</tr>
<tr>
<td></td>
<td>We have clarified what is meant be advanced disease: advanced disease (T4, or N2 or N3)</td>
</tr>
<tr>
<td>5. There is an objective reporting of health-related outcomes. It is not clear what, if any, ‘weighting’ of benefits or risks was undertaken or if this is deferred to the Expert Viewpoint. In the multiple tables of evidence, there quite a bit of detail regarding the NEGATIVE outcomes (surgical complications, re-operation rates, etc) but the actual positive benefits, such as health-related quality of life (HRQoL, pain), function, esthetic satisfaction are scantily documented --mostly in Table 6.</td>
<td>All evidence, both positive and negative outcomes were reviewed, described and presented when available for transparency. This was done to ensure there was no selection bias on the results that were reported. Negative outcomes were found to be reported more frequently in the evidence that was deemed eligible for inclusion in the Guideline. The Working Group evaluated all outcomes, both positive and negative, when developing the Recommendations; however, no quantitative weighting of benefits and harms was conducted.</td>
</tr>
<tr>
<td></td>
<td>As a result of this we have added the following statement in the Study Design and Quality section: There was no specific weighting of benefits and risks or selection bias on what is reported. The tables present the available evidence and outcomes and represent the constraints of the literature.</td>
</tr>
<tr>
<td>6. The recommendations are unambiguous but there are some that are too strong for the level of evidence provided. In general, recommendations 1-5 are aligned with the evidence and provide</td>
<td>a. In response to this comment the Working Group has modified the statement to read: “SSM/NSM can be offered...”</td>
</tr>
<tr>
<td>Main comments</td>
<td>Modifications, actions, or responses</td>
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<td>--------------</td>
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</table>
| excellent clinical direction.  
  a. *Recommendation 6*, the idea that SSM/NSM should be offered is misaligned with the largely retrospective/observational data and possibly selected population providing positive outcomes that cannot be generalized.  
  b. *Recommendations 9 and 10*, the reviewer is left with an impression that these are options that should be considered (but when?? And in what circumstance?), with no definitive positive outcomes and in the case of acellular dermal matrix, many negative consequences. I think the Working Group may wish to consider how it phrases these. | b. The Working Group is aware that the use of ADM and autologous fat grafting is still being evaluated and the literature regarding the optimal timing of these procedures is currently unclear. We agree with the reviewer that based on the current level of evidence, no recommendation can confidently be made for or against the use of ADM or fat grafting and we have modified the recommendations accordingly. As with all PEBC Guidelines, this Guideline will be subject to a yearly review. If any new literature regarding the use of these procedures is uncovered in this updating process, the recommendations will be revised and updated appropriately. |
| 7. This is an excellent document in so many aspects. It provides a timely ‘assemblage’ of the literature in many domains, most crucially as to the timing of immediate breast reconstruction (IBR) and the pitfalls/complications of many available techniques. There have been seemingly many advances in this area and it is good to find them addressed in one document objectively. Much of the reconstruction literature seems to focus on esthetic outcomes and this document provides a detailed account of the potential complications and adverse outcomes that can serve to inform patients and providers better. There are some areas which are overstated as documented in comments above. The authors need to carefully re-read the document and ensure certain facts are stated correctly.  
  a. eg “In 2013, approximately 23,800 Canadian women were diagnosed with breast cancer, and breast cancer continues to be the most commonly diagnosed cancer in Canadian women over the age of 20 (38). Since 39% (really??) of Canadians undergo mastectomy for breast cancer, and the five-year survival rate for breast cancer is approximately 88%....” I know what the author’s intent is but the figure is mis-stated | The Working Group agrees that this statement was erroneous in the way that it was written. We have addressed/modified it appropriately to read: “Since 39% of Canadians diagnosed with breast cancer undergo mastectomy, and...” |
<table>
<thead>
<tr>
<th>Main comments</th>
<th>Modifications, actions, or responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8.</strong> What is missing is some statement as to what the actual scope of the problem is. It is not just a mastectomy rate or the fact that IBR rates in Canada ‘lag’ behind the United States, but somewhere in the document the authors need to convince the reader (and the policy makers) that this issue matters. This could be in the introduction or in the discussion. Is reconstruction the ‘norm’, a standalone ‘quality indicator’ or the natural continuum post mastectomy to ensure optimum HRQoL (whether performed for prophylaxis or therapy of breast cancer)?</td>
<td>The Working Group believes this is an excellent point. We have added a statement in the Introduction that outlines the rationale for the development of this Guideline.</td>
</tr>
<tr>
<td><strong>9.</strong> Statement about women with active psychiatric illness. There are no data and I am not compelled by the rationale provided by the group (see my alternative interpretations and concerns). I think no statements can be made about women in this clinical state. I would be inclined to drop that bit.</td>
<td>The psychiatric illness recommendation is based on personal experience from some members, but the Working Group agrees that there is limited actual evidence to support it. Since this is an evidence-based document, the Working Group agrees with the reviewer that this contraindication for breast reconstruction should be removed.</td>
</tr>
<tr>
<td><strong>10.</strong> Recommendation 5. I think I am more compelled by the evidence than are the panel members. I am not sure you need the caveat about women who want immediate reconstruction. While many outcomes show no difference, there are a series of outcomes that do show a difference in favour of waiting until after radiation therapy is complete. I think the panel could be a bit more bold and consider dropping the qualifying statement.</td>
<td>This statement was put in because the decision is patient-driven. The Working Group members believe it should be kept in because there is a subgroup of patients who still demand it, and plastics’ expert opinion is that it is safe to perform – just the delay to adjuvant therapy and potential poor esthetic outcome.</td>
</tr>
<tr>
<td><strong>11.</strong> In the summary of the literature results - it might be nice to differentiate between SRs attached to CPGs from SRs not attached to CPGs. I would provide a better logic model for recommendation 1.</td>
<td>Evidence to support these recommendations was based both on a review of evidence is supported by other clinical practice guidelines. There were no systematic reviews included that were attached to clinical practice guidelines. This has been clarified in the results section.</td>
</tr>
</tbody>
</table>
EXTERNAL REVIEW
External Review by Ontario Clinicians and Other Experts

Targeted Peer Review

Four targeted peer reviewers from Ontario who are considered to be clinical and/or methodological experts on the topic were identified by the Working Group and expert panel. Two agreed to be the reviewers and both their responses received. Their affiliations and conflict of interest declarations are in Appendix 1. Results of the feedback survey are summarized in Table 5-3. The comments from targeted peer reviewers and the Working Group’s responses are summarized in Table 5-4.

Table 5-3. Responses to nine items on the targeted peer reviewer questionnaire.

<table>
<thead>
<tr>
<th>Question</th>
<th>Reviewer Ratings (N=2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lowest Quality (1)</td>
</tr>
<tr>
<td>1. Rate the guideline development methods.</td>
<td>0</td>
</tr>
<tr>
<td>2. Rate the guideline presentation.</td>
<td>0</td>
</tr>
<tr>
<td>3. Rate the guideline recommendations.</td>
<td>0</td>
</tr>
<tr>
<td>4. Rate the completeness of reporting.</td>
<td>0</td>
</tr>
<tr>
<td>5. Does this document provide sufficient information to inform your decisions? If not, what areas are missing?</td>
<td>0</td>
</tr>
<tr>
<td>6. Rate the overall quality of the guideline report.</td>
<td>0</td>
</tr>
<tr>
<td>7. I would make use of this guideline in my professional decisions.</td>
<td>Strongly Disagree (1)</td>
</tr>
<tr>
<td>8. I would recommend this guideline for use in practice.</td>
<td>0</td>
</tr>
<tr>
<td>9. What are the barriers or enablers to the implementation of this guideline report?</td>
<td>The targeted peer reviewers indicated a possible barrier for those practicing in outside centre would be the difficulty in receiving the inputs of plastic surgeons in a timely manner, especially at Multidisciplinary Cancer Conference or pre-operatively.</td>
</tr>
</tbody>
</table>

Table 5-4. Responses to comments from targeted peer reviewers.

<table>
<thead>
<tr>
<th>Comments</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Excellent format- I like the summary followed by the supporting evidence.</td>
<td>Thank you.</td>
</tr>
<tr>
<td>2. The relatively low evidence could be emphasized further. Consider adding more about consensus method.</td>
<td>Members of the Working Group believe that the consensus method was adequately described.</td>
</tr>
<tr>
<td>3. The recommendations are very technical re. surgical methods. There could be more specific recommendations about who is a candidate for reconstruction, especially in the high risk/prophylactic category</td>
<td>Members of the Working Group made some modifications to the recommendations to help clarify. The target population is also described in detailed on page 3.</td>
</tr>
</tbody>
</table>
4. The guideline does not really address the significant barriers to reconstruction in Ontario. Given the limited resources, should there be a way to prioritize patients?

Members of the Working Group recognize that there are multiple considerations before such a program can be implemented. The Surgical Oncology Program is addressing ways to overcome them.

**Professional Consultation**

Feedback was obtained through a brief online survey of healthcare professionals and other stakeholders who are the intended users of the guideline. A list of pathologists, radiation and medical oncologists, general and plastic surgeons from Ontario was provided by the Surgical Oncology Program and the PEBC contacted them by email to inform them of the survey. Five hundred sixty-three were included. Forty-one (7.3%) responses were received. The results of the feedback survey from 41 people are summarized in Table 5-5. The main comments from the consultation and the Working Group’s responses are summarized in Table 5-6.

Table 5-5. Responses to four items on the professional consultation survey.

<table>
<thead>
<tr>
<th>General Questions: Overall Guideline Assessment</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lowest Quality (1)</td>
</tr>
<tr>
<td>1. Rate the overall quality of the guideline report.</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2. I would make use of this guideline in my professional decisions.</td>
<td>0 (0)</td>
</tr>
<tr>
<td>3. I would recommend this guideline for use in practice.</td>
<td>0 (0)</td>
</tr>
<tr>
<td>4. What are the barriers or enablers to the implementation of this guideline report?</td>
<td>The barriers listed included lack of plastic or general surgeons with the expertise in some centres, access to care and geographical issues for patients, time constraints in the clinical setting to discuss and coordinate care and help patients understand all the options, challenge to stay within Ministry of Health and Long Term Care wait times, need for administrative support, lack of reconstructive surgeons to participate in multidisciplinary discussions, low quality evidence and the absence of patient input.</td>
</tr>
<tr>
<td></td>
<td>Enablers listed included a very lucid structure, covers all main aspects immediate and delayed postmastectomy breast reconstruction, comprehensive collection of evidence with reasonable interpretative summaries, addresses key areas and a good summary of evidence, enables individual practice changes by surgeons and team, changing culture, long-needed voice of patients, and psychosocial impact in patient centered OCPF.</td>
</tr>
</tbody>
</table>
Table 5-6. Modifications/Actions taken/Responses regarding main written comments from professional consultants.

<table>
<thead>
<tr>
<th>Comments</th>
<th>Modifications, actions, or responses</th>
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<tbody>
<tr>
<td>There were few comments on Recommendation 1 and the qualifying statements. These included:</td>
<td>In response to the comments made about Recommendation 1 and the qualifying statements, members of the Working Group:</td>
</tr>
<tr>
<td>1. Removing multidisciplinary from second bullet point</td>
<td>1. Have removed the multidisciplinary from the second bullet point.</td>
</tr>
<tr>
<td>2. Excluding the last sentence in the fourth bullet point. “imaging results should be available at the time of surgical consult”</td>
<td>2. Have excluded the last sentence in the fourth bullet point.</td>
</tr>
<tr>
<td>3. Missing information on appropriate patient selection on the basis of disease extent and location in the breast</td>
<td>3. Have clarified the target population by adding the following “For women who have chosen or been recommended for therapeutic mastectomy” as a precursor to the bullet points.</td>
</tr>
<tr>
<td>There were a few comments on Recommendation 2 and the qualifying statements. These included:</td>
<td>In response to the comments made about Recommendation 2 and the qualifying statements, members of the Working Group:</td>
</tr>
<tr>
<td>1. In delayed reconstruction, women should be told of a higher complication rate with body max index (BMI) &gt; 30 kg/m² and strongly encouraged to lose weight</td>
<td>1. have elaborated on the qualifying statement to include information on BMI &gt;30 kg/m²</td>
</tr>
<tr>
<td>2. There is no age cut off for breast reconstruction, does this mean that we need to discuss with every 75, 80 or 85 year old with multiple co-morbidities who is having a mastectomy?</td>
<td>2. have clarified the recommendation on advanced age.</td>
</tr>
<tr>
<td>3. Missing information on appropriate patient selection on the basis of disease extent and location in the breast</td>
<td>3. have clarified the target population by changing the title of the recommendation to “Contraindications for immediate or delay reconstruction” and by changing the first bullet point to include “relative medical (non-cancer-related) contraindications for breast reconstruction”.</td>
</tr>
<tr>
<td>4. Psychiatric contraindications are mentioned here for the first time; if this issue is to be included, it should be mentioned elsewhere.</td>
<td>4. have excluded psychiatric contraindications.</td>
</tr>
<tr>
<td>5. The small section on psychological issues out of place and not supported by evidence mentioned. Considered reviewing the evidence or excluding this small section.</td>
<td>5. agree and have excluded this small section on psychological issues.</td>
</tr>
<tr>
<td>Qualifying statement for Recommendation 3, a commenter indicated that while it is of opinion to wait two years, the statement would be stronger with more specifics either in the recommendations or supporting documentation.</td>
<td>Members of the Working Group have clarified the second qualifying statement by adding “optimal to wait two to three years before undergoing reconstruction when the risk of recurrence is lower”</td>
</tr>
</tbody>
</table>
There were a few comments on Recommendation 4 and the qualifying statements. These included:

1. Define low likelihood in bullet point 5
2. Information on appropriate patient selection on the basis of disease extent and location in the breast is not sufficiently stated
3. Recommendation is about timing of reconstruction, but includes some indications for mastectomy which really don’t belong here. e.g. tumour size relative to breast size
4. Sentence about positive margins should be revised to read: positive margins but no indication for post mastectomy radiotherapy

In response to the comments made about recommendation 4 and the qualifying statements, members of the Working Group:

1. believe it should stay as written as there was no evidence identified to define low likelihood of nodal disease.
2. believe it is sufficiently stated. Please refer to guidelines on postoperative radiation therapy and guidelines on post-mastectomy radiation.
3. have changed to recommendation title to help clarify.
4. have combined Recommendation 4 and 5 to help clarify. There is now one recommendation along the same theme.

There were a few comments on Recommendation 5 and the qualifying statements. These included:

1. The discussion does not support the strongly worded recommendation to avoid immediate reconstruction if postoperative radiotherapy is possible/probably/planned. Clinical guidance is needed as to whether to agree to immediate reconstruction in the face of post mastectomy radiation if the patient requests it and accepts the risks.
2. Qualifying statement indicates willingness to do something that is not right because the patient wants it. This not evidence based care and ignores societal perspective. Why would we be doing something that we do not believe is the correct course?

There were comments on both sides on the issue, showing the clinical community is divided on this issue. Members of the Working Group have decided to leave the recommendation as is and keeping it neutral and evidence based.

There were numerous comments on Recommendation 6 and the qualifying statements. These included:

1. Are skin-sparing mastectomy (SSM) and nipple-sparing mastectomy (NSM) not recommended for node positive women because of issues with radiation post reconstruction?

In response to the comments made about Recommendation 6 and the qualifying statements, members of the Working Group:

1. have clarified by modifying the sub bullets in the recommendation.
2. have clarified by adding a definition on SSM, NPM and ASM to the recommendation.
2. Disagree that SSM or ASM are not appropriate for women with early stage breast cancer and lymph node positive status and agree that NSM is not appropriate. Might be helpful to define what it meant by SSM? Term can mean very different things to different surgeons.

3. The rational for the statement of “no NSM if node positive” should be presented. Is it because these patients will receive radiotherapy? There is no mention of any aesthetic considerations in the selection of suitable candidates for NSM (e.g. very ptotic breasts).

4. Disagree with the suggestion that ductal carcinoma in situ or invasive carcinoma “within 2cm of the nipple” should have an intraoperative frozen section from base of nipple; would favour a preoperative nipple biopsy. However, patient selection is stressed in terms of selection or NSM, should this group of patients be excluded from NSM? Should there be uniformity in the definition of “within 2cm of the nipple”?

5. A qualifying statement about who should determine the likelihood of the positivity of the nodes should be included.

6. Should also add the option of a standalone sentinel node biopsy.

7. Surprised there is no discussion of the use of an initial sentinel node biopsy to determine the nodal status prior to making definitive plans for surgery in women with invasive cancer and clinically node negative.

8. Define clear margins FS for breast is almost obsolete, suggest removing that statement, instead of putting patients at risk for false positive results and pathologist for litigation.

3. have added a new qualifying statement on suitable candidates for NSM.

4. have modified and clarified the recommendation.

5. have made no modification. This has been addressed and is the qualifying fourth bullet.

6. Agrees and have added the following to the last qualifying statement “when required, for women with invasive breast cancer and clinically negative nodes, a standalone sentinel lymph node biopsy may evaluate lymph node status prior to definitive mastectomy for women.

7. have address this suggestion with the above changes in comment #6.

8. agree and have removed this qualifying statement.

9. have changed the wording to “may consider”
9. The evidence is low to moderate in quality. How strong this recommendation comes across is inconsistent within the document. Language should be changed to “should be” language in the body of text be weakened.

- There was a comment on Recommendation 7. A reviewer mentioned the evidence indicates that the complication rate with latissimus dorsi (LD) flaps is lower than either tissue expander or autologous abdominal flaps, yet LD flaps are listed as an alternative form of reconstruction. Some justification for this is required.
  
  In response to the reviewers comment, members of the Working Group have clarified the wording on the recommendation.

- There was a comment on Recommendation 9. A reviewer questioned if the increased risk of complications seen in acellular dermal matrix (ADM) compared to without ADM, or with radiation compared with no radiation when ADM is used. Please clarify.
  
  There was limited evidence on the use of ADM and the certainty of the evidence is low. Members of the Working Group did not make a recommendation for or against the use of ADM as an adjunct to implant-based breast reconstruction.

- There is no mention on the latest evidence that is coming available slowly on the association of textured breast implants used for reconstruction and anaplastic large cell lymphoma. This is probably slightly outside the scope of the report but should be mentioned as needing to be part of the discussion with the patient when presenting options.
  
  Members of the Working Group believe this is an excellent point. We have added a more information on the emerging evidence on anaplastic large cell lymphoma to the discussion section.

- From limited evidence available, there should be a recommendation against/ caution for fat grafting into wide local excision or lumpectomy defects with or without radiation as this has shown to be associated with local recurrence. This is a separate situation from fat grafting to a mastectomy and reconstruction site
  
  Recommendation is for total mastectomy population. Lumpectomy is not within the target population and is outside the scope of the guideline.

- Family physicians not included in the “intended users”. Women who have undergone mastectomies and are under the care of their family physicians may not be aware of their breast reconstruction options.
  
  Members of the Working Group agree and have added “other referring physicians” to the intended users.

- The recommendations favour large centres with lots of resources to do breast construction and biased against small centre surgeons
  
  This guideline is an evidence-based guideline with an extensive literature search that summarizes the best available evidence. It is not meant to favour small or large centres and there is no bias against small centres.

- No discussion regarding barriers to access/resources
  
  Issues related to the implementation of recommendations with respect to feasibility, patient considerations, equity, provider considerations, and system considerations were also considered by
the Working Group and Breast Reconstruction Expert Panel. A formal implementation Considerations statement was prepared and sent to the leadership of Cancer Care Ontario's Surgical Oncology Program.

Conclusion
The final guideline recommendations contained in Section 2 and summarized in Section 1 reflect the integration of feedback obtained through the external review processes with the document as dragged by the Guideline Development Group (GDG) Working Group and approved by the GDG Expert Panel and the PEBC RAP.
References


16. Tsoi B, Ziolkowski NI, Thoma A, Campbell K, O’Reilly D, Goeree R. Systematic review on the patient-reported outcomes of tissue-expander/implant vs autologous abdominal tissue


140. de Oliveira RR, do Nascimento SL, Derchain SF, Sarian LO. Immediate breast reconstruction with a Latissimus dorsi flap has no detrimental effects on shoulder motion or postsurgical complications up to 1 year after surgery. Plastic & Reconstructive Surgery. 2013;131(5):673e-80e.
146. Macadam SA, Ho AL, Cook EF, Jr., Lennox PA, Pusic AL. Patient satisfaction and health-related quality of life following breast reconstruction: patient-reported outcomes


165. !!! INVALID CITATION !!! [28, 165-175].


Appendix I. Members of the Working Group, the Breast Reconstruction Expert Panel, Report Approval Panel, external reviewers and their conflict of interest declarations.

Table a.1: Working Group.

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Declarations of interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toni Zhong</td>
<td>Plastic and Reconstructive Surgeon</td>
<td>Professional interest: Principal investigator for a clinical trial involving the objects of study (multi-centred Canadian acellular dermal matrix randomized controlled trial published a clear opinion regarding the objects of study (MCCAI trial)</td>
</tr>
<tr>
<td>Kirsty Boyd</td>
<td>Plastic Surgeon</td>
<td>Financial interest: serves as a consultant for LifeCell. Financial interest from professional income: as a breast reconstruction surgeon, income may either increase or decrease depending on guidelines but not related to industry. Professional interest: received an educational grant from Allergen (co-chair) to run chief resident review course.</td>
</tr>
<tr>
<td>Renee Hanrahan</td>
<td>Surgical Oncologist</td>
<td>None</td>
</tr>
<tr>
<td>Muriel Brackstone</td>
<td>Surgeon</td>
<td>None</td>
</tr>
<tr>
<td>Tim Whelan</td>
<td>Radiation Oncologist</td>
<td>None</td>
</tr>
<tr>
<td>Karen Spithoff</td>
<td>Health Research Methodologist</td>
<td>None</td>
</tr>
</tbody>
</table>

Appendices - January 5, 2016
Table a.2: Members of Cancer Care Ontario (CCO) Staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Declarations of Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amber Hunter Manager</td>
<td>CCO, Surgical Oncology Program Toronto, Ontario</td>
<td>None</td>
</tr>
<tr>
<td>Robin McLeod Surgeon</td>
<td>Mount Sinai Hospital Toronto, Ontario and CCO, Toronto, Ontario</td>
<td>None</td>
</tr>
<tr>
<td>Jonathan Irish Surgeon</td>
<td>University Health Network Toronto, Ontario</td>
<td>None</td>
</tr>
</tbody>
</table>

Table a.3: Breast Reconstruction Expert Panel

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Declarations of Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice Wei Surgical Oncologist CCO-Clinical Lead Surgical Oncology</td>
<td>Toronto General Hospital Toronto, Ontario</td>
<td>None</td>
</tr>
<tr>
<td>Susan Done Pathologist</td>
<td>Princess Margaret Hospital Toronto, Ontario</td>
<td>None</td>
</tr>
<tr>
<td>Deepa Kumar Surgical Oncologist</td>
<td>Credit Valley Hospital Mississauga, Ontario</td>
<td>None</td>
</tr>
<tr>
<td>Dr. Nancy Down Surgeon</td>
<td>North York General Hospital Toronto, Ontario</td>
<td>None</td>
</tr>
<tr>
<td>Orit Freedman Medical Oncologist</td>
<td>Durham Regional Cancer Centre Oshawa, Ontario</td>
<td>None</td>
</tr>
<tr>
<td>Sandip SenGupta Pathologist</td>
<td>Kingston General Hospital Kingston, Ontario</td>
<td>None</td>
</tr>
<tr>
<td>Sundeep Shahi Radiation Oncologist</td>
<td>Grand River Regional Cancer Center Kitchener, Ontario</td>
<td>None</td>
</tr>
</tbody>
</table>
Conflict of Interest

In accordance with the PEBC Conflict of Interest (COI) Policy, the guideline authors, Breast Reconstruction Expert Panel members, and internal and external reviewers were asked to disclose potential conflicts of interest. Two authors declared that they had conflicts of interest (TZ, KUB). The PEBC director waived the requirement that the lead author have no professional interest as per the PEBC COI Policy. The conflicts declared did not disqualify any individuals from performing their designated role in the development of this guideline. To obtain a copy of the policy, please contact the PEBC office by email at ccopgi.mcmaster.ca.

For the Expert Panel, eight members declared they had no conflicts of interest (JI, SD, DK, NK-D, OF, SS, AW, SS), and four (AD, RS, JJ, DM) declared conflicts. AD has reported publishing a research study (Strang B, Murphy K, Seal S, Dal Cin A. Does the presence of an implant including expander with internal port alter radiation dose? An ex vivo model. Can J Plast Surg. Spring 2013 Vol 21:1, 37-40), as well as a presentation entitled “Tissue expansion followed by radiation in a porcine model: a pilot study” at the Canadian Association of

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Table a.4 External Review Targeted Peer Reviewers

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrea Eisen</td>
<td>Sunnybrook Health Sciences Centre</td>
<td>None</td>
</tr>
<tr>
<td>Kristen Gyetvai</td>
<td>Windsor Regional Hospital</td>
<td>None</td>
</tr>
</tbody>
</table>

---

Guideline 17-10

Robert Shenker
Plastic Surgeon
The Cosmetic Surgery Clinic
Waterloo, Ontario

Financial Interest: travel support from a business entity to attend a symposium, but no financial information about the trip was available. Financial interest from professional income: as an owner of a cosmetic surgery center, income may either increase or decrease depending on guidelines but not related to industry.

Other: Frequently speaks publically about breast reconstruction

Julia Jones
Surgical Oncologist
Taunton Surgical Centre
Oshawa, Ontario

Financial interest from professional income: as a general surgeon, income may either increase or decrease depending on guidelines but not related to industry.

Doug McKay
Plastic and reconstructive surgeon
Kingston General Hospital
Kingston, Ontario

Financial Interest: attended a Breast Bioskins Lab on October 17-18, 2014 sponsored by LifeCell.
Laboratory Animal Science Meeting in 2010. AD also reported applying for more than $5000 for a single year from the Breast Reconstruction Fellowship Fund sponsored by Allergan and Mentor; however, as of the Conflict of Interest declaration (December 3, 2014) no response has been received. RS reported receiving travel support from a business entity to attend a symposium, but no financial information about the trip was available. RS is also the owner of a cosmetic surgery center and performs breast reconstructions. He is unsure how this guideline will affect his professional income. RS also frequently speaks publicly about breast reconstruction. JJ indicated that she is a general surgeon who performs mastectomies and is unaware how this guideline will affect her professional income. DM declared that he attended a Breast Bioskins Lab on October 17-18, 2014 sponsored by LifeCell.
Appendix II. Search for existing evidence-based guidelines.
In March 2013, a search was conducted to identify existing evidence-based guidelines that were suitable for adaptation in the Ontario context. Guidelines that were published in the English language between 2008 and March 2013, were based on a systematic review of evidence, and addressed one or more topics of interest were considered. A search was conducted in the Standards and Guidelines Evidence (SAGE) directory of cancer guidelines (www.cancerview.ca/sage). This search was supplemented with a Google search using the terms “breast reconstruction” and “recommendations” or “guideline” and a search of the Medline and EMBASE databases. In addition, the Working Group was aware of a guideline on breast reconstruction being developed by Alberta Health Services.

In total, 28 guidelines were identified that addressed one or more topics of interest related to breast reconstruction. These guidelines were reviewed for relevancy, currency, quality and suitability for adaptation. Fifteen of the 28 guidelines were excluded because they did not include a systematic review of the evidence. Others were excluded due to incomplete coverage of the topics of interest or because their literature searches were out of date.

The Alberta Health Services guideline [66] was published online in September 2013 and was considered for adaptation. The Working Group reviewed the content of the guideline and assessed its quality using the AGREE II instrument [36]. Following thorough review, the Working Group decided not to adapt the Alberta Health Services guideline and instead decided to conduct its own literature search and develop its own recommendations for breast reconstruction in the Ontario context. The clinical questions from the Alberta Health Services guideline were used as the basis for the CCO PEBC guideline.
Appendix III. Literature Search Strategies.

MEDLINE (OVID)
1. exp breast neoplasms/
2. (breast adj6 (cancer: or neoplasm: or carcinoma: or tumour: or tumor:)).mp.
3. (mastectom: or (breast and reconstruct:)).mp.
4. or/1-3
5. exp mammaplasty/
6. (mammaplast: or mammoplast:).mp.
7. breast implants/
8. "prostheses and implants"/
9. Reconstructive Surgical Procedures/
10. exp Surgical Flaps/
11. (breast adj6 reconstruct:).mp.
12. ("deep inferior epigastric" or DIEP) adj6 flap:).mp.
13. ("transverse rectus abdominus" or TRAM) adj6 flap:].mp.
14. ("superficial inferior epigastric" or SIEA) adj6 flap:].mp.
15. ("latissimus dorsi" or LD) adj6 flap:].mp.
16. breast implant:.mp.
17. ("skin sparing" or "skin-sparing" or "nipple sparing" or "nipple-sparing") adj6 mastectomy).mp.
18. acellular derm:.mp.
19. ("fat grafting" or lipomodelling or "fat transfer" or fat injection: or lipofilling).mp.
20. or/5-19
21. 4 and 20
22. (case reports or letter or comment or editorial or news).pt.
23. 21 not 22
24. exp animals/ not humans/
25. 23 not 24
26. limit 25 to english language
27. limit 26 to yr="2010 -Current"

MEDLINE In-Process & Other Non-Indexed Citations (OVID)
1. (breast adj6 (cancer: or neoplasm: or carcinoma: or tumour: or tumor:)).mp.
2. (mastectom: or (breast or reconstruct:)).mp.
3. 1 or 2
4. (mammaplast: or mammoplasty:).mp.
5. (breast adj6 reconstruct:).mp.
6. ("deep inferior epigastric" or DIEP) adj6 flap:].mp.
7. ("transverse rectus abdominus" or TRAM) adj6 flap:].mp.
8. ("superficial inferior epigastric" or SIEA) adj6 flap:].mp.
9. ("latissimus dorsi" or LD) adj6 flap:].mp.
10. breast implant:.mp.
11. ("skin sparing" or "skin-sparing" or "nipple sparing" or "nipple-sparing") adj6 mastectomy).mp.
12. acellular derm:.mp.
13. ("fat grafting" or lipomodelling or "fat transfer" or fat injection: or lipofilling).mp.
14. or/4-13
15. 3 and 14
16. limit 15 to English language
17. limit 16 to yr="2010 -Current"

EMBASE (OVID)
1. exp breast cancer/
2. breast tumor/
3. (breast adj6 (cancer: or neoplasm: or carcinoma: or tumour: or tumor:)).mp.
4. (mastectom: or (breast and reconstruct:)).mp.
Guideline 17-10

5. or/1-4
6. exp breast reconstruction/
7. (mammoplast: or mammoplast:).mp.
8. exp breast implant/
9. exp "prostheses and orthoses"/
10. plastic surgery/
11. Surgical Flaps/
12. (breast adj6 reconstruct:).mp.
13. ("deep inferior epigastric" or DIEP) adj6 flap:.mp.
14. ("transverse rectus abdominus" or TRAM) adj6 flap:.mp.
15. ("superficial inferior epigastric" or SIEA) adj6 flap:.mp.
16. ("latissimus dorsi" or LD) adj6 flap:.mp.
17. breast implant:.mp.
18. ("skin sparing" or "skin-sparing" or "nipple sparing" or "nipple-sparing") adj6 mastectomy).mp.
19. acellular derm:.mp.
20. ("fat grafting" or lipomodelling or "fat transfer" or fat injection: or lipofilling).mp.
21. or/6-20
22. 5 and 21
23. (editorial or letter or note or journal editorial or journal letter or journal note or conference abstract).pt.
24. 22 not 23
25. limit 24 to english language
26. limit 25 to yr="2010 -Current"
27. limit 26 to exclude medline journals
28. animal/ not human/
29. 27 not 28
Appendix IV. Quality assessment of included systematic reviews (AMSTAR).

<table>
<thead>
<tr>
<th>Systematic review</th>
<th>‘A priori’ design</th>
<th>Duplicate study selection and data extraction</th>
<th>Comprehensive literature search</th>
<th>Status of publication as inclusion criterion</th>
<th>List of included and excluded studies</th>
<th>Characteristics of included studies assessed</th>
<th>Scientific quality of included studies used appropriately in formulating conclusions</th>
<th>Methods used to combine findings of studies appropriately</th>
<th>Likelihood of publication bias assessed</th>
<th>Conflict of interest included</th>
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### Systematic review

#### ‘A priori’ design

- **Comprehensive literature search**
- **Status of publication as inclusion criterion**
- **List of included and excluded studies**
- **Characteristics of included studies provided**
- **Scientific quality of included studies assessed**
- **Scientific quality of included studies used appropriately in formulating conclusions**
- **Method used to combine findings of studies appropriately**
- **Likelihood of publication bias assessed**
- **Conflict of interest included**

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Abbreviations: N: no; N/A: not applicable; Y: yes