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Post-mastectomy breast reconstruction

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Breast cancer is the most common cancer in women, with almost 1.38 million new cases a year worldwide; it accounts for 23% of all cancers and 14% of deaths from cancer.[1] However, mortality from breast cancer is declining—increasing numbers of women are long term survivors (>5 years) (currently 549 000 in the United Kingdom).[2 3] Surgery remains a mainstay of treatment, either breast conservation or mastectomy, but any breast surgery can greatly alter breast aesthetics and body image.

Breast reconstruction restores breast symmetry after a mastectomy by creating a breast mound, similar in size, shape, contour, and "out of bra position" to the contralateral breast. In England and Wales in 2002, about 10% of women had immediate breast reconstruction; by 2009 this had risen to 21%.[4] Post-mastectomy breast reconstruction is associated with improved body image, quality of life, self confidence, and wellbeing.[5]

In this review, we outline the indications for breast reconstruction along with the timing and techniques available to patients after mastectomy.

What is post-mastectomy breast reconstruction?

Breast reconstruction is a surgical procedure that restores shape to the breast after mastectomy. Although it will not re-create the exact look and feel of a natural breast, it aims to create a breast mound contour similar to that before mastectomy.

When, and to whom, should breast reconstruction be offered?

In 2009 the National Institute for Health and Clinical Excellence (NICE) revised guidance on improving breast cancer outcomes. It recommended discussing immediate reconstruction with all patients having a mastectomy and offering it unless serious comorbidity or the need for adjuvant therapy precludes this option. It also recommended offering and discussing all appropriate breast reconstruction options with patients, irrespective of whether they are available locally.[6] Fifty three per cent of women having surgery for breast cancer will undergo mastectomy (box 1).[7 8]

In the UK and United States, bilateral mastectomy is increasingly being used for risk reduction in *BRCA* carriers, for those with a high risk of developing breast cancer (lifetime risk of 30%), or as a planned management strategy for unilateral cancer (fig 1, bmj.com).[9-15] In general, bilateral mastectomy is associated with a higher rate of breast reconstruction. A recent Cochrane review showed that bilateral prophylactic (risk reduction) mastectomy reduced the incidence of, and death from, breast cancer, but it highlighted that more rigorous prospective studies are needed to assess absolute risk reduction.[16] The review also found that although contralateral prophylactic (risk reduction) mastectomy decreases the incidence of cancer in the contralateral breast, it is unclear whether, and for whom, this practice improves survival.[16]

How is a mastectomy performed?

When performing a mastectomy, the anatomical (oncological) plane between breast tissue and subcutaneous fat needs to be identified. It is, however, impossible to remove all breast tissue because the oncological plane is not uniform throughout the breast. A standard (simple) mastectomy removes the breast skin envelope, but a skin sparing mastectomy preserves the breast skin envelope

SUMMARY POINTS

- Breast reconstruction should be discussed with all women who undergo mastectomy
- The type of mastectomy undertaken directly influences the reconstructive outcome and aesthetics
- All reconstructive options should be discussed with the patient regardless of local expertise and appropriate referral made to specialist centres if necessary
- If radiotherapy is needed, delayed reconstruction minimises the risk of complications and improves aesthetic outcomes
- Follow-up studies show that women have a high level of satisfaction with the reconstructive option they chose, although those who opted for no reconstruction also report a high level of satisfaction

SOURCES AND SELECTION CRITERIA

We searched Medline, Embase, and the Cochrane collaboration for articles using the keywords "breast reconstruction". Wherever possible we used evidence from randomised controlled trials, systematic reviews, and meta-analyses from the past five years to provide an up to date review. We also consulted the Association of Breast Surgeons (ABS) guidelines (2009), ABS and British Association of Plastic Reconstructive and Aesthetic Surgeons guidelines (2012), and the fourth annual report of the National Mastectomy and Breast Reconstruction Audit (NMBRA) 2011.

Box 1 | Indications for mastectomy

- Large tumour size to breast volume ratio
- Breast conserving surgery did not work
- Multicentric disease (multiple foci in more than one quadrant)
- Large in situ tumour
- Patient choice
- Recurrence in a previously conserved breast
- Patient not suitable for radiotherapy—for example, patient has already received mantle radiotherapy for Hodgkin's disease

Type of primary reconstruction in women in the National Mastectomy and Breast Reconstruction Audit[24]		
Type of surgery	Immediate reconstruction (n (%))	Delayed reconstruction (n (%))
Implant or expander only	1246 (37)	281 (16)
Pedicle flap + implant or expander	735 (22)	438 (25)
Pedicle flap (autologous)	932 (27)	446 (26)
Free flap	476 (14)	566 (33)
Total	3389	1731

(with or without the nipple) along with the inframammary crease. Skin sparing mastectomy is the technique of choice for immediate breast reconstruction because it gives a more favourable aesthetic outcome, although it is associated with a 10-22% risk of skin flap necrosis.[17] The incidence of local recurrence is similar to that seen for simple mastectomy (2.9% at 10 years in a recent retrospective review).[18] In patients with large breasts and excess skin a controlled reduction in the skin envelope can be achieved.

Preservation of the native nipple-areola complex (NAC) is the ultimate extension of breast envelope preservation.[19] A questionnaire study of women in a single unit compared nipple sparing mastectomy and reconstruction (n=310) with simple mastectomy and reconstruction (n=143, including NAC reconstruction).[20] Body image was more positive and satisfaction with the final appearance of the nipple was higher in the NAC sparing group.[20]

However the nipple is affected in 5-31% of invasive or in situ breast cancers.[21] Two large retrospective case series found that tumour size (particularly >4 cm) and distance of the tumour from the NAC were independent predictors of nipple involvement.[22 23] One large single institution retrospective case series review of nipple sparing mastectomies found a nipple necrosis rate of 20% (partial 19%; total 2%); risk factors included hypertension, diabetes, obesity, smoking, and larger breast size (although this last factor was not significant).[24] Other complications include nipple malposition or asymmetry and reduced sensation in the preserved nipple. A novel technique called "nipple delay" seeks to reduce the risk of nipple necrosis in women at high risk of nipple loss and is performed seven to 21 days before mastectomy.[25] During the procedure, a skin flap is elevated in the plane of a therapeutic mastectomy beneath the nipple-areola complex and surrounding mastectomy skin.

Box 2 | Advantages and disadvantages of breast reconstruction techniques

Implant based

Advantages

Less invasive

Less operative time with shorter recovery time

No donor site morbidity

Disadvantages

Requires numerous tissue expansions postoperatively

Does not feel "natural"

Difficult to match ptosis in large breast

May require implant exchange

Implant infection and removal

Autologous

Advantages

Does not degrade

More natural appearance and feel

Disadvantages

Flap failure (partial or complete) and fat necrosis

Donor site morbidity

Long operative time

Large scar (usually in the abdomen after a deep inferior epigastric perforator flap reconstruction)

When should breast reconstruction be performed?

Breast reconstruction can be performed at the time of mastectomy (immediate/primary) or at any later date (delayed/secondary). Patients who are uncertain about reconstruction are best advised to consider delayed reconstruction. The main advantage of immediate reconstruction is preservation of the native breast skin envelope and inframammary fold, which enables a more natural and symmetrical outcome. However, immediate reconstruction can delay adjuvant therapy if postoperative complications arise.

Delayed reconstruction is best for patients who want to focus on the cancer treatment or need more time to consider the various breast reconstruction options. Delayed breast reconstruction is technically more challenging because the native skin envelope is removed at the time of standard mastectomy. Extra skin must therefore be recruited from skin expansion (where an expander implant is used to stretch the skin) or from a donor site. This can result in a less natural and symmetrical appearance and longer scars.

The UK National Mastectomy and Breast Reconstruction Audit (NMBRA) prospectively evaluated complications and patient reported outcomes in a cohort of patients from more than 200 centres between January 2008 and March 2009.[26] Nearly 17 000 women underwent mastectomy—21% had immediate and 11% had delayed reconstruction (table). Outcome questionnaires were completed at baseline, three months, and 18 months (fig 2, bmj.com). The audit found that patients who chose delayed reconstruction had better satisfaction scores after reconstruction, possibly because they had lived with a flat chest wall before reconstruction.[26]

Immediate breast reconstruction is associated with a higher complication rate than delayed reconstruction.[27 28] The latest Cochrane review found no clear evidence to support immediate reconstruction over delayed reconstruction.[29] Further research is needed to provide reliable evidence for patients to make more informed decisions about the best type and most appropriate timing of breast reconstruction.

What options are available for breast reconstruction?

Various techniques are available for breast reconstruction. The process can take 12-24 months and multiple surgical procedures may be needed to achieve the optimal outcome. Aesthetic outcomes are unpredictable and the reconstructed breast can be insensate. The reconstruction technique used depends on individual requirements, determined by patient choice, advice of the reconstructive surgeon, comorbidities (body habitus, smoking, diabetes), potential loss of high end function (with the latissimus dorsi or transverse rectus abdominus myocutaneous (TRAM) flap), cancer biology, and anticipated post-mastectomy therapy, particularly the need for radiotherapy. Options for reconstruction include silicone tissue expander/implants, autologous tissue flaps, or a combination of the two (box 2).

Implant with or without acellular dermal matrices

Implant based reconstruction accounts for 61% and 37% of reconstructions in the US and UK, respectively.[26 30] It enables formation of a breast mound without the donor site scaring and morbidity associated with autologous reconstruction. Reconstruction can be a one stage or two stage procedure. An implant is placed in a pocket created under the pectoral muscle with a port (remote or integrated) to enable volume expansion. To achieve complete submuscular coverage, a portion of the serratus muscle can be raised laterally and sutured to the pectoralis muscle. The expansion process begins two to three weeks postoperatively, resulting in gentle stretching of the overlying skin and soft tissue until the desired volume is achieved. The tissue expander is replaced three to six months later with a definitive fixed volume implant. A one stage procedure (using a fixed volume implant) avoids a second operation, but a two stage procedure enables adjustments to be made if necessary. Box 3 lists the associated complications.

Fig 4 | Woman with left sided breast cancer treated with left skin sparing mastectomy and reconstruction with acellular dermal matrix and implant, left nipple reconstruction, and areola tattoo. She subsequently underwent risk reducing skin and nipple sparing (envelope) mastectomy of the right breast, together with reconstruction with acellular dermal matrix and implant. Picture courtesy of Katy Hogben, consultant oncoplastic breast surgeon, Charing Cross Hospital, London

Tissue coverage of the inferior pole of the implant may also be provided by a de-epithelialised inferior pole dermal sling (using tissue from the lower pole of the patient's breast) or an acellular dermal matrix. Acellular dermal matrices are collagen sheets derived from human, bovine, and porcine tissues, which become incorporated into the host tissue over time (figs 3 and 4). These grafts have several benefits—shorter operative time; no need to recruit serratus anterior muscle (decreases chest wall

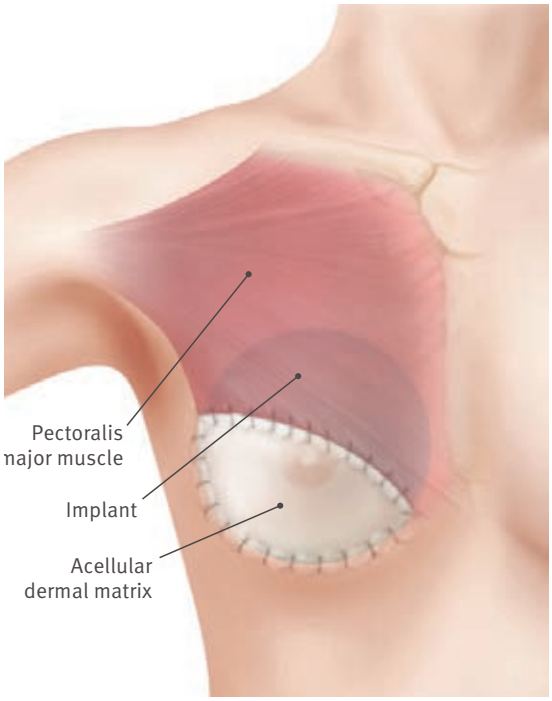

Fig 3 | Illustration showing the usual placement of an acellular dermal matrix in an implant based reconstruction. Reproduced, with permission, from LifeCell

Box 3 | Complications after breast reconstruction

Implant based reconstructions

- Implant infection or rotation
- Extrusion or rupture of implant
- Capsular formation
- Seroma or haematoma
- Implant rippling (wrinkling or creasing)
- Inframammmary fold problem and bottoming out (inferior displacement of the implant)
- Skin flap necrosis
- Siliconoma or gel bleed

Autologous reconstructions (deep inferior epigastric perforator, transverse rectus abdominus myocutaneous, or latissimus dorsi flap)

- Flap failure (partial or total)
- Fat necrosis
- Abdominal bulge or hernia (seen with the deep inferior epigastric perforator flap)
- Seroma
- Haematoma
- Donor site morbidity
- Shoulder or back pain (seen with the latissimus dorsi flap)

morbidity); fewer postoperative expansions needed to achieve the desired volume; and the inframammary and lateral mammary folds can be redefined.[31 32] Although expensive, these matrices enable larger initial volume implants to be used and result in lower rates of capsular contracture.[32 33] Higher incidences of seroma, infection, and partial mastectomy flap necrosis have been reported, however.[34]

Closure of the breast implant manufacturer Poly Implant Prothèse, because of the use of unapproved silicone filler, led to the re-establishment of the UK breast implant registry by the Medicines and Healthcare Products Regulatory Agency in June 2013.[35] The registry was initially established in 1993, but was closed in 2005 because too few women wished to take part in the scheme. The Poly Implant Prothèse implant episode highlighted areas where UK and European medical device regulation requires strengthening.

Autologous tissue reconstruction

Autologous breast reconstruction uses the patient's own tissue. It can be performed using pedicled flaps or free tissue transfers (free flaps). Pedicled flaps, such as the latissimus dorsi flap, maintain the existing blood supply to the transferred tissue so avoid microsurgery. Free (perforator) flaps, however, are raised on a pedicle (including a known artery and vein), divided, transferred to the recipient site and then anastomosed to the vessels in the chest or axilla (internal mammary or axillary vessels, respectively).

The major advantage of autologous reconstruction is that revision surgery is less likely because the transferred tissue adjusts to changes in body weight.[36 37] Several patient reported outcome studies suggest that autologous tissue provides a more consistent and durable reconstruction, with higher long term satisfaction, compared with implant based reconstructions.[36 38] However, in one retrospective review, patients with an expander or implant based reconstruction had the highest satisfaction scores (compared with latissimus dorsi flaps and TRAM flaps), despite having higher reoperation rates and lower aesthetic scores.[39]

Pedicled flaps include latissimus dorsi and TRAM flaps. Refinements in microsurgical techniques have led to the advent of perforator flaps, such as the deep inferior epigastric perforator (DIEP; fig 5) flap, superior inferior epigastric artery flap, and transverse upper gracilis flap (fig 6). Autologous breast reconstruction is technically challenging, with a longer operative time and hospital stay than implant based reconstructions. Patients with a history of obesity, diabetes, autoimmune disease, and smoking may not be suitable owing to increased perioperative morbidity.[40]

Non-abdominal based autologous breast reconstruction

Latissimus dorsi flap reconstruction involves the pedicled transfer of the latissimus dorsi with its overlying fat and skin. This is one of the most commonly used flaps for breast reconstruction in the UK.[26] This flap can be used on its own to reconstruct a small to moderately sized breast defect or it can be used in conjunction with an implant to provide increased volume. If used alone, an extended autologous latissimus dorsi flap can incorporate a larger volume of muscle and fat to increase the bulk of the flap. The NMBRA showed that the pedicled latissimus dorsi flap is extremely robust, with a reported failure rate of 1%, but it is associated with a high rate of donor site seroma formation (50-80%).[26 41] Patients may also experience shoulder pain, back pain, tightness when stretching the arm, and difficulty in carrying or lifting heavy objects (box 3).[26]

The transverse upper gracilis flap is an autologous free flap that is suitable for women with small or medium sized breasts, who may not be suitable for an abdominal based

Fig 5 | Immediate breast reconstruction after right mastectomy using a deep inferior epigastric perforator flap. Nipple reconstruction and tattooing of the areola were carried out separately. The patient then underwent a symmetrising left breast mastopexy. Courtesy of Navid Jallali, consultant plastic surgeon, Charing Cross Hospital, London

Fig 6 | Breast reconstruction after right skin sparing mastectomy and immediate reconstruction using a double transverse upper gracilis flap. The patient subsequently underwent right nipple reconstruction and areola tattooing. Courtesy of Paul Harris, consultant plastic surgeon, Royal Marsden Hospital, London

autologous reconstruction, or may not accept scars on the abdomen, back, or gluteal regions. The flap consists mainly of adipose tissue and is harvested from the inner thigh. This flap is smaller than the DIEP and TRAM free flaps, and it provides a thinner fat pad, so for larger volumes two flaps may be needed.

The superior gluteal artery perforator flap is the second choice if the abdominal donor site is unavailable. Its major drawback is that it leaves a scar on the buttock and the consistency of the fat does not match the breast as closely as abdominal fat.[42-44]

Abdominal based autologous breast reconstruction

The abdomen is the main choice for autologous reconstruction because a large enough volume of tissue is usually available. Furthermore, the fat has a similar consistency to breast tissue and closely matches its feel. Several abdominal based flaps are available but the two most common variants are the TRAM and DIEP flaps. For the TRAM flap, skin, subcutaneous fat, and rectus abdominus muscle are harvested from below the umbilicus, either as a pedicled or free flap. The major drawback is that the loss of the rectus abdominus muscle can result in an abdominal bulge and increases the risk of hernia formation. The pedicled TRAM is the most common autologous reconstruction performed in the US.[45] Both pedicled and free TRAM flaps are associated with an increased risk of abdominal hernia, umbilical necrosis, and partial or complete flap necrosis.[46]

The DIEP flap is an evolution and refinement of the TRAM flap—it preserves the entire rectus abdominus muscle and sheath, allowing transfer of skin and subcutaneous fat only. Retrospective reviews have shown that despite being more complex, this procedure results in significantly lower donor site morbidity, shorter hospital stay, decreased postoperative pain, and better recovery of sensation than a traditional TRAM flap. It is also more cost effective.[47 48] In our units, the default option is to carry out a DIEP flap, reverting to a muscle sparing TRAM option if the perforators are poor.

What secondary procedures might be necessary after breast reconstruction?

NAC reconstruction

Patient reported outcome studies have found that NAC reconstruction significantly improves patient satisfaction with breast reconstruction.[49-51] The ideal nipple reconstruction should be symmetrical in shape, site, size, texture, and pigmentation. The procedure is often delayed until three to four months after reconstruction of the breast mound. Loss of projection of the reconstructed nipple remains a problem and can require revision. The nipple can be reconstructed using several techniques including the use of local flaps (subdermal and pedicle based), grafting from distant sites, nipple sharing, and nipple banking. Nipple sharing is performed after a unilateral breast reconstruction, once the breast mound is complete. Half of the contralateral nipple is harvested and then grafted on to a patch of de-epithelialised skin on the reconstructed breast. Nipple banking is performed at mastectomy. The areola is harvested as a full thickness graft combined with the nipple and temporarily transferred to the prearranged banking site, usually the groin, abdomen, or buttocks. Frozen sections are often taken from the base of each nipple, intraoperatively, to determine malignant involvement. Three months after reconstruction, the "banked" nipple is replanted on to the new breast mound. The areola is commonly reconstructed with intradermal tattooing. This procedure is undertaken in an outpatient clinic setting (20-30 minutes) and may require local anaesthetic. Tattoos fade with time, and further tattooing procedures might be needed.

Lipomodelling

This procedure is performed under general anaesthesia and involves the transfer of autologous fat by blunt needle aspiration from a donor site (usually abdomen, hips, and inner thigh) to the breast. It improves breast shape, symmetry, and volume after breast conserving surgery or a breast mound reconstruction. Several procedures may be needed to obtain an optimal outcome because fat reabsorption results in a loss of 10-30% of volume after injection.[52 53] Complications include liponecrosis, infection, calcification (potentially affecting radiological follow-up), and formation of an unspecified palpable mass.[52] Furthermore, care must be taken not to sacrifice autologous donor sites, such as the abdomen, for future use.

Symmetrisation procedures

Once the mastectomy site has been reconstructed, the next step may involve creating a symmetrical contralateral breast. Contralateral mastopexy (breast lift), reduction mammoplasty (breast reduction), or augmentation may be performed at the same time as the reconstruction or delayed.

What happens if the patient needs radiotherapy?

Radiotherapy after immediate reconstruction can have a detrimental effect on long term aesthetic outcomes owing to tissue fibrosis, oedema, and microvascular changes.[54-61] The effects are worse for implant based techniques, with capsular contracture, loss of shape and volume, pain, and higher revision rates.[58 62] Radiotherapy also affects autologous tissue flaps, resulting in flap contracture and loss of volume.[63 64] Randomised trials are currently assessing the impact of radiotherapy on implant and autologous techniques.

Before surgery it can be difficult to determine the need for post-mastectomy reconstruction and radiotherapy. Some units recommend against immediate reconstruction if radiotherapy is planned. Post-radiotherapy reconstruction is particularly challenging, owing to the poor quality of the irradiated tissue, and usually requires an autologous technique. If a patient who has opted for autologous reconstruction needs radiotherapy, a delayed procedure may therefore be recommended.

Does chemotherapy affect breast reconstruction?

Retrospective reviews have shown that chemotherapy given before (neo-adjuvant) or after (adjuvant) mastectomy does not significantly affect the long term outcome of breast reconstruction.[65 66] A retrospective review

ADDITIONAL EDUCATIONAL RESOURCES

Resources for healthcare professionals

Association of Breast Surgery (www.associationofbreastsurgery.org.uk)—Information about different types of breast reconstruction surgery, including how to find a surgeon

British Association of Plastic, Reconstructive and Aesthetic Surgeons (www.bapras.org.uk)—Provides details about specific plastic surgery procedures and techniques involved in breast reconstruction

Resources for patients

American Society of Plastic Surgeons (www.plasticsurgery.org/Reconstructive-Procedures/Breast-Reconstruction.html)—Provides information on breast reconstructive techniques, costing preparation for surgery, and postoperative recovery

Cancer Research UK (www.cancerresearchuk.org/cancer-help/type/breast-cancer/treatment/surgery/reconstruction/about-breast-reconstruction)—Cancer charity, providing a detailed overview on breast cancer management, including including breast reconstruction

Breast Cancer Care (www.breastcancercare.org.uk/breast-cancerinformation/treating-breast-cancer/surgery/reconstruction)—Information and support for everyone affected by breast cancer; patients discuss their reasons for deciding whether to have breast reconstruction after surgery

Macmillan Cancer Support (www.macmillan.org.uk/Cancerinformation/Cancertreatment/Treatmenttypes/Surgery/Breastreconstruction/Breastreconstruction.aspx)—Practical, medical, and financial support; helps patients understand what breast reconstruction is and the possible benefits and difficulties they might experience

(n=665) found that patients receiving neo-adjuvant chemotherapy were less likely to undergo immediate reconstruction and more likely to undergo delayed reconstruction than those receiving adjuvant chemotherapy.[67]

Evidence about whether immediate breast reconstruction delays adjuvant chemotherapy (systemic cancer directed treatment given after completion of definitive surgery and before recurrence) is conflicting; most of the studies were single institution ones, with small cohorts.[66 68-72] One large (n=3643) multicentre cohort study found that immediate breast reconstruction was associated with a modest, but significant, delay in starting treatment, particularly in patients with a high body mass index (>35).[73] Both the Danish Breast Cancer Cooperative Group and the British Columbia Cancer Agency found no difference in overall survival between patients given chemotherapy early (less than three weeks) or later (up to 12 weeks postoperatively).[74 75] However, delays of more than three months after surgery are associated with reduced disease-free survival and overall survival.

Informed consent and managing expectations in breast reconstruction

The weeks after a diagnosis of breast cancer are psychologically challenging. Women must be allowed to take part in the decision making process, particularly when considering the risk and benefits of the reconstructive options available. An option for no reconstruction must be included. Appropriate management of the patient's expectations for breast reconstruction should include what she will expect at the different postoperative stages, highlighting that reconstruction will not restore the original breast, and a reconstructed breast will not look or feel the same. Exploring the patient's expectations allows the surgeon to recognise those patients who have unrealistic expectations and deal with this problem preoperatively through individualised patient education. This may avoid the disappointment of having an outcome that is not what the woman had envisioned. A small single centre study found that patients who took an active part in the decisions about their treatment were more satisfied with the results of treatment, with more positive outcomes.[76]

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References are in the version on bmj.com.

ANSWERS TO ENDGAMES, p 38 For long answers go to the Education channel on bmj.com

PICTURE QUIZ

An unusual cause of breathlessness

1 The trachea is deviated to the right.

2 This woman has a large goitre that is causing serious tracheal deviation and breathlessness on exertion. For these reasons surgical intervention is indicated. She was referred to an endocrine surgeon and underwent a total thyroidectomy.

3 Bleeding, haematoma, injury to the recurrent laryngeal nerve(s), and hypoparathyroidism. The patient will require lifelong thyroxine replacement.

4 Dysphagia, dysphonia, cough, and symptoms of hyperthyroidism.

STATISTICAL QUESTION

The nocebo effect

Statement *c* best describes the nocebo effect in relation to the administration of a placebo or sham treatment.