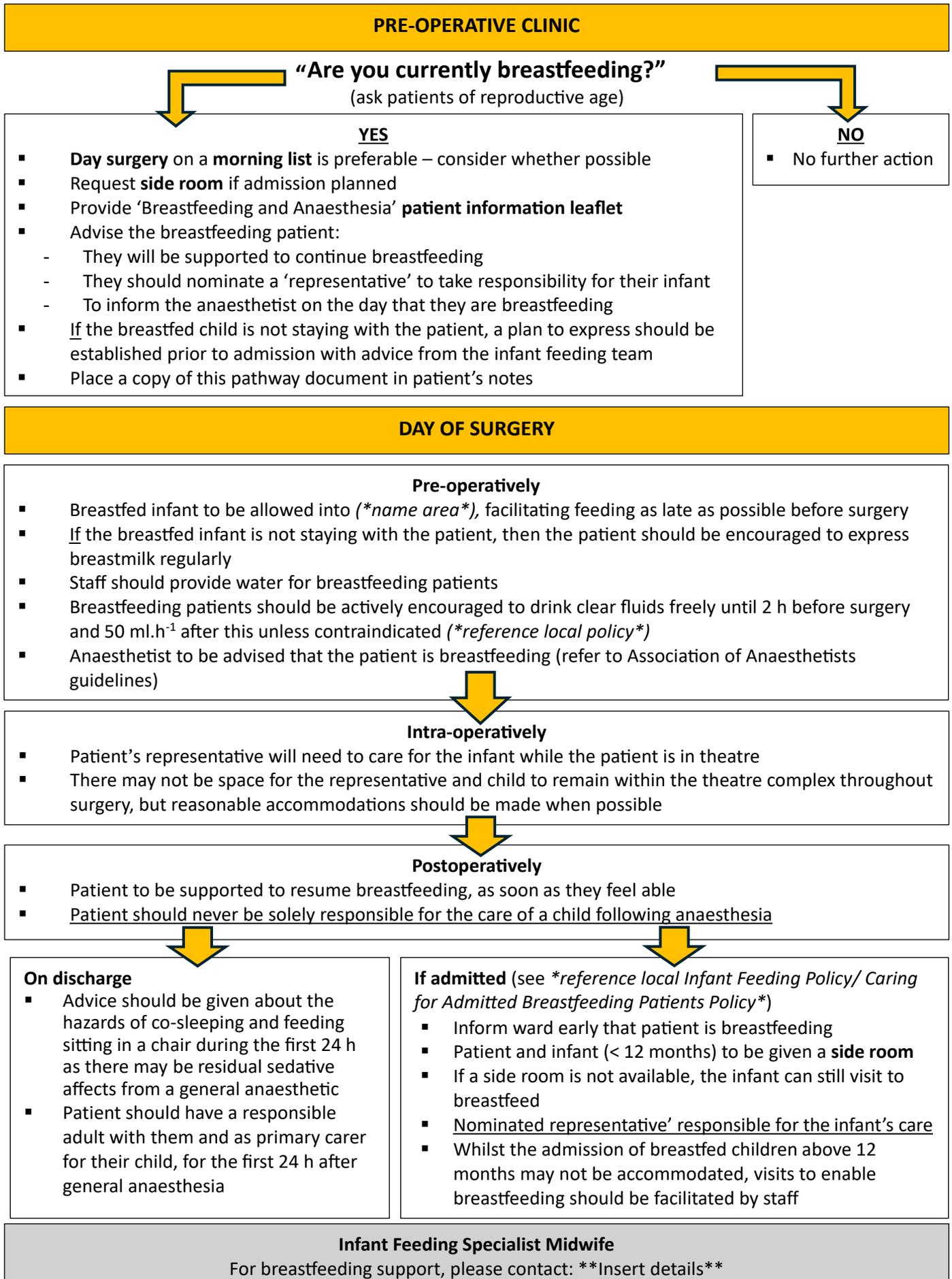


Appendix S1. Example of a peri-operative breastfeeding pathway

It should be assumed that breastfeeding patients undergoing surgery wish to continue breastfeeding. They should be supported to continue breastfeeding in the peri-operative period



Appendix S2 Resources for professionals and patients.

- **UK Drugs in Lactation Advisory Service (UKDILAS)** provides evidence-based information to all UK healthcare professionals on the use of drugs during the breastfeeding period. The service is provided via the UK Medicines Information Network by the Trent and West Midlands Regional Medicines Information Centres.
 - <https://www.sps.nhs.uk/category/usage/safety-in-lactation-usage>
- **Drugs and Lactation Database (LactMed)** is a database sponsored by the USA National Library of Medicine which contains information on maternal and child levels of drugs, possible effects on breastfed children and any effect on lactation [3].
 - <https://toxnet.nlm.nih.gov/newtoxnet/lactmed.htm>
- **e-lactancia**, online source in Spanish and English for free-access information about the compatibility of medications with breastfeeding.
 - <https://e-lactancia.org/>
- **The Breastfeeding Network** provides evidence-based information regarding breastfeeding and medication and is a useful resource for patients and staff. The information is provided by qualified pharmacists who are also trained breastfeeding supporters.
 - <https://www.breastfeedingnetwork.org.uk/drugs-factsheets>
- Mummy Star, a charity which supports patients and families with a diagnosis of cancer during pregnancy and up to a year after birth.
 - <https://www.mummysstar.org/>
- Human Milk Foundation, a charity which may be able to provide screened and pasteurised human milk if the mother is unable to breastfeed due to cancer.
 - <https://humanmilkfoundation.org/>
- Available texts include:
 - Hale TW. *Medications and Mothers Milk Online* [106].
 - Jones W. *Breastfeeding and Medication* [33]

References are available in the main manuscript.

Appendix S3 Sample patient information leaflet

Patient information leaflet: having an anaesthetic whilst breastfeeding

We hope this leaflet will answer any questions you might have if you are breastfeeding and need surgery.

Please make sure that your surgeon and anaesthetist know that you are breastfeeding, so that it is considered during planning and performing your operation. If you have any more questions after reading this leaflet, please feel free to ask a member of the anaesthetic staff, or the breastfeeding specialist in your hospital.

Do I have to stop breastfeeding if I need an anaesthetic?

No, breastfeeding is of great value to both you and your child. The hospital should make special arrangements for you to make sure that you can breastfeed as normally as possible. You should ask for support to help you breastfeed if you feel that this is not being offered.

Do medicines used during my operation get into my breastmilk?

Yes, they will get into the breastmilk in small amounts. Your team can answer any worries that you have.

What medicines can affect my child?

Almost all medicines are safe to use and do not have any effect that can be seen, because the dose that the child receives is so low. Some medicines can make you sleepy, especially if you have lots of doses, and in this case the medicine might build up in your breastmilk and then affect your child as well. If the medicine makes you feel drowsy it is more likely that it will make your child drowsy

How does the anaesthetist give an anaesthetic when I have my operation? Can I choose?

The type of operation often determines which kind of anaesthetic you need (local or general) Your anaesthetist will advise you on this but will also consider what you prefer.

Local anaesthetic For some operations, an injection of a medicine to numb the nerves (local anaesthetic) is used. This may be done where the operation is being done, at a nerve away from the operation such as in the armpit or groin (regional anaesthetic), or in the back to numb the lower half of the body (spinal or epidural anaesthetic). This may be preferred if you are breastfeeding, as it has some advantages: you can drink and eat soon after; it should not affect your ability to breastfeed; and you should need less painkillers. You recover quickly afterwards, and the medicines will not affect your child.

Sedation This is when medicines are given to relax you during a procedure. It ranges from a small amount of medicine given to reduce anxiety (light sedation), to being very sleepy and not remembering some of the details of the procedure (deep sedation). Sedation is often used in addition to local anaesthesia. You can breastfeed as soon as you feel awake enough to hold your child.

General anaesthesia This is when you are made unconscious ('put to sleep') for the procedure. You may also be given local anaesthetic during the operation to numb an area and help you feel more comfortable following the operation.

What happens around the time of the operation?

You should breastfeed as normal until you go to the operating theatre. You should drink and eat until the time that you are told to stop. You can breastfeed again after your operation as soon as you are back with your child, and awake and alert. You may need some help to start with. You should ask for medication if you feel sick.

Can I take pain killers after my procedure?

Yes. It is important that you are comfortable after your procedure, so you should make sure that you have a supply of pain killers and take them if you need to.

Paracetamol is a good medicine to take regularly, as it is safe for you and your child. It is a painkiller that has few side effects for you, and so it is best to take it regularly; this means that you are likely to need less of the stronger painkillers that may have more side effects. The amount that your child would receive from breast milk is much lower than the dose which she or he would get if having it to treat a temperature or teething.

Anti-inflammatory drugs (such as ibuprofen, diclofenac or naproxen) are suitable for you to take and breastfeed as normal as very low levels of the medicine pass into breastmilk. They can be taken with paracetamol.

Opioids (morphine, dihydrocodeine, tramadol and oxycodone) can be used if you have severe pain. The effect of these medicines is different in different people. Some patients are very sensitive and may feel a large effect even after one dose. If you have a large effect from one or several doses, the medicine might build up in your breastmilk and then affect your child as well. If the medicine is making you very sleepy, you should stop taking it. Also, if your child has signs of drowsiness, then you should stop taking it and ask your doctor for advice, as you may need to change to a different medication. If the child has signs of difficulty breathing, you should call for medical advice straight away.

Stopping pain killers after my operation

It is important to ensure that the opioid (strong) pain killers are only used during the early period after surgery and should be stopped as soon as possible after your operation. In general, it is best to reduce and stop any opioid medication that you are taking; then reduce and stop ibuprofen (or similar medicine); then tail off and stop paracetamol last of all.

Can I bed share as normal following my anaesthetic?

You should not bed share with your child on the night following surgery, as you will be less aware of your child. It is important that you do not fall asleep in a chair or on a sofa. If possible, another adult should take responsibility for settling your child.

© Association of Anaesthetists of Great Britain and Ireland 2025

References are available in the main manuscript.

Appendix S4 Pharmacokinetic information for anaesthetics and other drugs.

	Protein binding; %	Milk:plasma ratio (aim < 1)	Half-life	Relative child dose; % (aim < 10%)	Bio-availability; %
Intravenous anaesthetics					
Propofol	99		1-3 d	4.40	0
Ciprofol			2-4 h		
Thiopental	60-96	0.3-0.4	3-8 h	1.77-5.94	
Etomidate	76		75 min		
Ketamine	47		2.5 h		17
Inhalational anaesthetics					
Sevoflurane			1.8-3.8 h		Poor
Isoflurane			20-70 min		
Desflurane			<3 min		
Nitrous oxide			3 min		Low
Halothane		3.5			
Methoxyflurane					
Benzodiazepines					
Midazolam	97	0.15	3 h	0.63	44
Diazepam	99	0.2-2.7	43 h	0.8-7.14	100
Remimazolam	90		7-11 min		
alpha-2 adrenergic agonists					
Clonidine	20-40	2.0-4.0	6-24 h	13.30	65-99
Dexmedetomidine	0.94	<1	<2 h	0.034	16 oral 72 sublingual 82 buccal

Analgesics						
Paracetamol	10-25	0.91-1.42	2 h	6.41-24.23		75-85
Ibuprofen	> 99	0.84-1.59	1.85-2.00 h	0.1-0.7		80
Diclofenac	99.7		1.1 h	0.05		100
Naproxen	99.7	0.01	12-15 h	3.3		95
Celecoxib	97	0.84-1.59	11 h	0.3-0.7		99
Fentanyl	80-85		2-4 h	1.9-5.0		33-76
Alfentanil	92		1-2 h	0.26-0.40		43
Sufentanil	0.91		2.7 h			Poor
Remifentanil	70		0.05-0.17 h			Low
Morphine	35	0.84-1.59	1.5-2 h	9-35		25
Oxycodone	45	0.84-1.59	2-4 h	1-8%		60-87
Tramadol	20	2.4	7 h	2.86		60-75
Dihydrocodeine		19.5-25.1	3.5-5.0 h			20
Codeine	7	1.35-2.50	2.9 h	0.6-8.1		65-100
Hydromorphone	8-19	300	2.6 h oral 3-4 h iv	0.67		50-60
Hydrocodone	19-45%		3.8 h	2.21-3.7		
Pethidine	60-80%	1.1-1.6	3-5 h	0.6-3.5		50-60
Nefopam	71-76%	1.2	3-8 h	2.6		Good
Magnesium	30%	1.9	<3 h	0.2		4
Anti-emetics						
Ondansetron	70-75		3-4 h	1.6-3.3		60
Granisetron	65		4-12 h			60
Cyclizine			13 h			
Prochlorperazine	91-99	0.01	8-9 h			12.5
Dexamethasone	77		3.3 h			70-78
Metoclopramide	30	0.5-4.1	5-6 h	4.7-14.3		75
Domperidone	93	25	7-14 h	0.01-0.35		15-20

Droperidol	85-90		2.2 h		
Neuromuscular blocking drugs/antagonists					
Suxamethonium			0.13h		0
Neostigmine	15-25	0	0.25-1h		1-2
Sugammadex			2 h		0
Cardiovascular drugs					
Atropine			3 h		90
Glycopyrronium	38-44		1 h i.v.		<25
Ephedrine	4.9		3-6 h		88
Phenylephrine	95		2-3 h		38
Amiodarone	96	4.6-13	26-107 d	0.5-43.1	35-65
Noradrenaline	25		2.4 min		0
Adrenaline			1.2-4.8 min		0
Vasopressin			12-18 min		0
Hydrocortisone	90		1-2 h		96
Metoprolol	10-12	2.4	3-7 h	0.5-3.8	40-50
Labetalol	50	1-2.6	4-8 h	0.05-0.45	25-40
Proton pump inhibitors					
Omeprazole	95-97%		30-60 min	0.9	30-60
Lansoprazole	97%		1-2 h		80
Esomeprazole	97%	0.07	1-1.4 h	1.8	64-89
Emergency drugs					
Dantrolene	High		8.7 h		35
Intralipid			13.7 min		

Appendix S5. Pharmacokinetic terms and implications

The information below is based on information from Breastfeeding and Medication [33], but should not be further reproduced without further permission from the author.

Oral bioavailability

The oral bioavailability of a drug is the percentage of the drug absorbed into the system having passed through the gut, liver or lungs. First-pass metabolism will reduce the availability. Most drugs given by injection only (i.e. there is no oral formulation available) have poor bioavailability (e.g. insulin, heparin).

First-pass metabolism

Drugs which are inactivated by first-pass metabolism are preferred for use during lactation.

Active metabolites

The half-life of active metabolites needs to be taken into consideration where necessary.

Plasma protein binding

When drugs enter the maternal bloodstream following absorption, they either become bound to plasma proteins or remain free. Only the free part of the drug can penetrate the biological membranes. The more drug that is bound, the less is free to diffuse. Some drugs compete for binding sites normally occupied by bilirubin in the first week after birth.

Milk:plasma ratio

This measurement refers to the concentration of the protein-free fractions in milk and plasma. Any ratio over 1 implies that the drug may be unsuitable to be prescribed for a lactating patient. This ratio is not available in standard drug information texts but may be found in specialist texts.

Molecular weight

The larger the molecule, the harder it is for it to pass into breast milk.

Drug half-life

The longer the half-life of a drug, the greater the risk of accumulation in the patient and in the child. The half-life of a drug is defined as the time taken for the serum concentration to decrease by 50%. It is determined by the rate of absorption, metabolism and excretion. Five half-lives must elapse before steady state is reached. After this period, timing feeds to avoid peak levels has a minimal effect. Similarly, after five half-lives without further medication, almost all (98%) of the drug has been eliminated from the body. Neonates do not metabolise medication as fast as adults, because of immaturity of the liver.

Therapeutic range

If the level of the drug that reaches the child comes into the therapeutic range, it would have the expected effect of that drug on the child. If the level exceeds the maximum therapeutic concentration side effects would be noted in the child. However, as in the vast majority of cases the amount of drug passing through breast milk is below the therapeutic level for that drug, no effect will be seen.

Relative child dose

The relative child dose is being increasingly recognised as a valuable guide to the safety of a drug taken by a patient who is breastfeeding. A drug with proportion < 10% is considered to be the preferred option.

$$\text{Relative child dose (\%)} = \frac{\text{dose in the child via breastmilk (mg. kg}^{-1}\text{. day}^{-1}\text{)}}{\text{dose in the patient (mg. kg}^{-1}\text{. day}^{-1}\text{)}} \times 100$$

Doses can be obtained from e.g. Hale and Krutsch [5].

Theoretical dose calculation

Dose calculation of drug ingested by a child can be calculated if the milk: plasma ratio is known, in conjunction with the volume of milk ingested.

$$\text{Dose} = C \times (\text{M/P}) \times V$$

Dose = total dose of drug ingested by child (mg)

C = maternal plasma concentration of drug during suckling (mg.l⁻¹)

(M/P) = milk/plasma concentration ration

V = volume of milk ingested by the child (l)

This assumes that all the ingested drug is absorbed; however, many drugs have low oral bioavailability, which is a protective factor.

Summary of points to determine when a drug is likely to be compatible with use during breastfeeding

- relative child dose < 10%
- M/P ratio < 1
- plasma protein binding > 90%
- molecular weight of the drug > 200 Da
- poor oral bioavailability
- short half-life of active metabolites
- drug is licensed for paediatric use

References are available in the main manuscript.