123Library

FOUNDATION YEARS JOURNAL

MAY 2017

Volume 11, Issue 5: **Anesthesia**

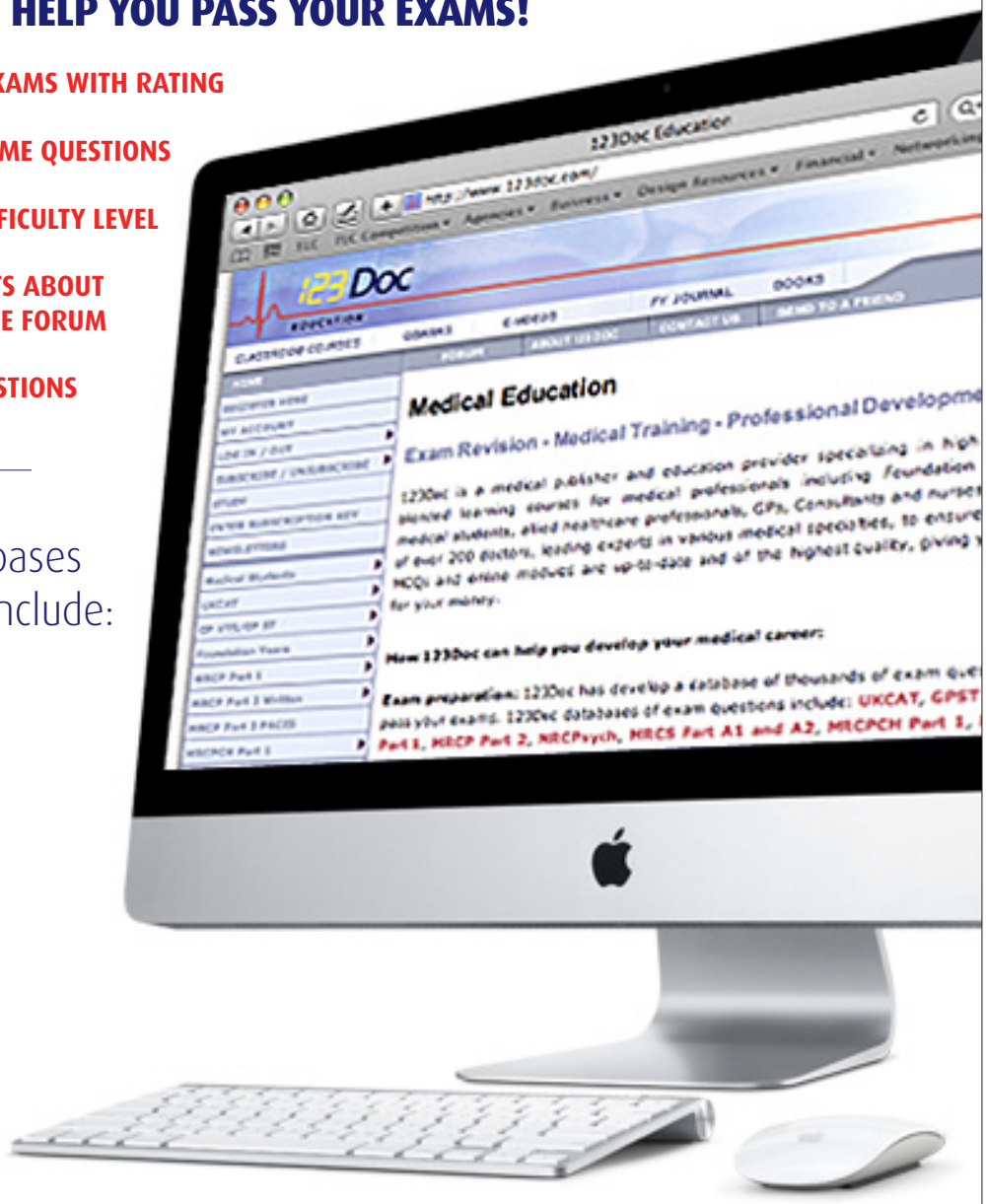
ONLINE COURSES.
YOUR REVISION'S LIFELINE.

123DOC.COM has developed a database of thousands of exam questions to **HELP YOU PASS YOUR EXAMS!**

- **UNLIMITED TIMED MOCK EXAMS WITH RATING**
- **100+ NEW PAST EXAM THEME QUESTIONS**
- **STUDY BY TOPIC OR BY DIFFICULTY LEVEL**
- **OPTION TO POST COMMENTS ABOUT A QUESTION TO OUR ONLINE FORUM**
- **THOUSANDS OF EXAM QUESTIONS**

123DOC.COM databases of exam questions include:

- ✓ **UKCAT**
- ✓ **GPST / GPVTS**
- ✓ **MRCP Part 1**
- ✓ **MRCP Part 2**
- ✓ **MRC Psych**
- ✓ **MRCS Part A1 and A2**
- ✓ **MRCPCH Part 1**
- ✓ **MRCPCH Part 2**
- ✓ **FRCA Primary**
- ✓ **Primary FRCR**
- ✓ **PLAB Part 1**
- ✓ **Medical Student**
- ✓ **MRCOG**



123Doc.com
ONLINE COURSES

123Library

4-5
EDITORIAL BOARD
Anesthesia

6-10
GOOD CLINICAL CARE
A Is For Airway: The (Paediatric) Airway
A Roopra, G Castrisios, A Kaliappan

11-15
PATIENT MANAGEMENT
Tracheostomy Emergencies
M Armstrong, D Conway, V Cunningham

16-20
PATIENT MANAGEMENT
Anaesthesia For The Patient With Marfan Syndrome
C McGenity, D Bell

21-25
CASE BASED DISCUSSION
Delirium In A Patient On Extracorporeal Respiratory Support
PM Murphy, M Gimenez-Mila, A Vuylsteke

26-31
CASE BASED DISCUSSION
Post Cardio-Pulmonary Resuscitation Care - A Systems Based Review
K Mead, G Glover

32-34
TEACHING & TRAINING
Intra-Operative Cell Salvage
A Roopra, L Rahman, R Khan, A Kumar

35-38
GOOD CLINICAL CARE
Physiological Changes In Pregnancy
L Rahman, R Khan, A Kumar

39-44
PATIENT MANAGEMENT
Pre-operative Investigations - A Guide For Foundation Doctors
UM McHugh, M Pachucki, SPK Linter

45-49
CASE BASED DISCUSSION
Severe Obstructive Sleep Apnoea Complicating An Already Difficult Airway
T Rudnick, S Acharya

50-55
TEACHING & TRAINING
Severe Traumatic Brain Injury & Organ Donation After Neurological Death
KW Tan, D Fraser, V Cunningham

56-60
PATIENT MANAGEMENT
The Obese Surgical Patient For Non-Bariatric Surgery
SA Howell, MV Copp

61-63
PATIENT MANAGEMENT
The Risk Of Contamination Of Re-usable Spray Bottles When Used with Disposable Atomizer Nozzles
A Polson, D Bondin, P Morar

64-67
PRACTICAL PROCEDURES
Ultrasonography For Junior Doctors
TR Barrow, R Kong

68-75
TEACHING & TRAINING
Uncommon Complications Of Dural Puncture And Epidural Puncture That Can Present To Junior Doctors On The Wards
R Harrison, M Hitchcock

FOUNDATION YEARS JOURNAL 2017

Volume 11

Foundation years journal

Foundation Years Journal is an international peer-viewed journal which seeks to be the pre-eminent journal in the field of patient safety and clinical practice for Foundation Years' doctors and educators. The Journal welcomes papers on any aspect of health care and medical education which will be of benefit to doctors in the Foundation training grade in the UK or international equivalents.

Editor in chief

Publisher's office

Abhishek Agrawal & Sophie Wood (Managing Editors)
123 Library, 72 Harley Street, London, W1G 7HG
Tel: +44 (0)207 253 4363 | Email: sophiewood@123doc.com

Editorial board

Foundation years journal

Foundation Years Journal is the ONLY journal for Foundation Years, doctors and educators, specifically written according to the MMC curriculum. It focuses on one or two medical specialties per month and each issue delivers practical and informative articles tailored to the needs of junior doctors. The Journal closely follows the Foundation Years syllabus to provide the best educational value for junior doctors. In addition to good clinical and acute care articles, assessment questions give junior doctors the chance to gauge their learning. Each issue provides comprehensive clinical cases for trainees as well as practical teaching assessments for educators. Readers will benefit from:

- **MMC CURRICULAR-BASED CONTENT** to enhance understanding of the core competencies required from future leading doctors.
- **FOCUS ON SPECIALTY-SPECIFIC CLINICAL CASES** each month to form broad subject coverage.
- **ADDITIONAL IN-DEPTH** good clinical and acute care articles aligned with the case-based discussion assessments.
- **TRAINING GUIDE FOR FOUNDATION YEAR (FY)** educators with proposed clinical cases for teaching sessions.
- **PRACTICAL & INFORMATIVE** articles written by senior doctors & consultants.
- **EXTRA REVISION** with comprehensive assessment. Questions & Picture Quiz.

Financial statement

The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources, and authors are not paid. The decision to accept or refuse an article for publication in the Foundation Years Journal is free from financial considerations and is solely the responsibility of the Editorial Panel and Editor-in-Chief.

Conflict of interest

The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors" **(https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Animal & human rights

When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Informed consent

123library recognises patients' right to privacy. We require Authors to maintain patients' anonymity and to obtain consent to report investigations involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Guidelines for authors

The Guideline for Authors can be found on our website at: **https://www.123library.org/ejournals/foundation-years-journal.**

How to order foundation years journal

Orders for subscriptions should be made by email **(subscriptions@123doc.com)** or with a credit card through the 123 Library website **(www.123library.org).** Or by returning the subscription form included in the Journal to:

123Doc Education
72 Harley Street, London, W1G 7HG

Order online	www.123library.org
Order by email	subscriptions@123doc.com
Order by phone	0203 0313 866

How to advertise in foundation years journal

Advertising orders and enquiries can be sent to sabine@123doc.com.
Tel: +44 (0)207 253 4363.

Photocopying

Single photocopies of single articles may be made for personal use as allowed by national copyright laws. Permission of the publisher and payment of a fee is required for all other photocopying, including multiple or systematic copying, copying for advertising or promotional purposes, resale and all forms of document delivery.

Electronic storage or usage

Permission of the publisher is required to store or use electronically any material contained in this Journal, including any article or part of an article. Except as outlined above, no part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without prior written permission of the publisher.

Notice

No responsibility is assumed by the publisher for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein. Because of rapid advances in the medical sciences, in particular, independent verification of diagnoses and drug dosages should be made. Although all advertising material is expected to conform to ethical (medical) standards, inclusion in this publication does not constitute a guarantee or endorsement of the quality or value of such product or of the claims made of it by its manufacturer.

A IS FOR AIRWAY: THE (PAEDIATRIC) AIRWAY

A Roopra, G Castrisios, A Kaliappan

Abstract

Airway management requires swift assessment and intervention. Failure to recognise and treat airway compromise may lead to fatal consequences. In the paediatric cohort the majority of cardiorespiratory arrests can be attributed to respiratory causes. This is in comparison to adults where the cause is often a primary cardiac arrest (1, 2). Therefore it is essential for foundation year doctors to understand how to initiate management for airway and breathing problems in children, which often come hand in hand, whilst awaiting senior help. It is important to remember that children are not just "little adults", and that paediatric patients which include neonates and teenagers demonstrate vast differences in their weight, anatomy, physiology and even psychological response.

This article focuses on paediatric airway anatomy and its clinical importance for airway management, an approach to airway assessment and basic management for the foundation year doctor whilst waiting for expert help to secure the airway safely. The paediatric patient can comprise the neonate (a baby within 44 weeks of age from the date of conception), infant (up to 12 months of age), child (1 to 12 years) or adolescent (13 to 16 years).

Basic Airway Anatomy

Having a basic understanding of anatomy in children is important for airway management (Figure 1). As children grow, the differences between their airway anatomy and that of an adult lessens. There is no defined age at which this occurs but it is likely that adolescents will have an airway more comparable to an adult and therefore management of a teenager versus a neonate will differ. Table 1 describes the key anatomical features of the airway in the neonate, infant and child.

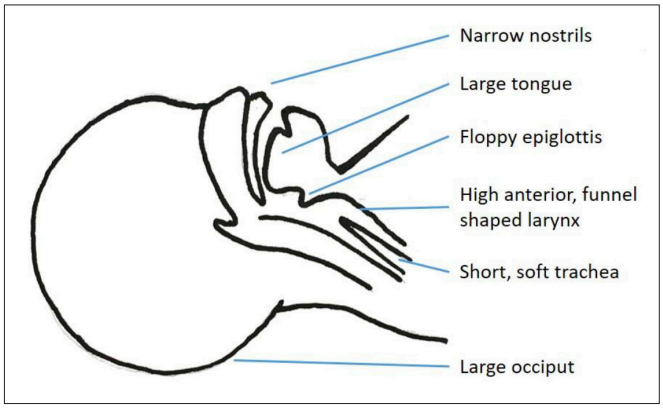


Figure 1: Upper airway anatomical features in neonates, infants and young children.

Anatomical feature	Clinical importance
Large heads **Prominent occiputs** **Short neck**	Positioning of the infants head must be in the neutral position to maintain patency of airway
Frontonasal process less prominent	Predisposes to air leakage around facemask
Narrow nasal passages	Easily occluded by secretions and can compromise airway; particularly in infants less than 6 months who are obligate nose breathers
Large tongues	Tends to obstruct airway and may make laryngoscopy difficult
Larynx is more anterior and cephalad	Visualisation of the larynx for intubation requires a different technique
Larynx is funnel shaped with the cricoid cartilage as its narrowest part	More vulnerable to pressure from a tightly fitting tube
Narrow, floppy epiglottis angled away from trachea	More difficult to lift epiglottis
Trachea is relatively short, and soft	Slight movement of the neck may alter the length of the trachea (chance of endobronchial intubation or extubation) More prone to collapse and obstruction

Table 1: Anatomical characteristics of the airway in neonates, infants and young children.

Although breathing problems are not discussed in this article, it is worth knowing that in addition to upper airway anatomy, the paediatric population demonstrates key differences in their respiratory physiology. For example, infants have a greater oxygen consumption and respiratory rate (Table 2), more compliant lungs, fewer fatigue resistant type 1 fibres and relatively small airways that can be obstructed; all of which render the infant more susceptible to respiratory compromise that may warrant airway protection (3).

Age (years)	Respiratory rate (breaths/min)
<1	30-40
1-2	25-35
2-5	25-30
5-12	20-25
>12	15-20

Table 2 : Respiratory rates at rest according to age (3)

Airway Assessment

The approach to airway assessment can be simply remembered by LOOK, LISTEN and FEEL as summarised in Table 3.

Primary assessment		Abnormal clinical features
LOOK	Chest and abdominal movements	Increased or decreased respiratory rate, recession, accessory muscle use, flaring of the nostrils, head bobbing, cyanosis
LISTEN	Breath sounds	Reduced, absent, asymmetrical, inspiratory (stridor) expiratory (wheeze, grunting) noises
FEEL	Expired air	

Table 3: The airway assessment.

Recognition of the child with airway compromise or a potentially evolving airway problem and promptly requesting expert help, are key early steps in management and prevention of deterioration. Finally it is important to remember "BCDE" assessments, particularly because breathing problems may prelude airway compromise such as those listed in Table 4.

A IS FOR AIRWAY: THE (PAEDIATRIC) AIRWAY

A Roopra, G Castrisios, A Kaliappan

Mechanism	Examples
Upper airway obstruction	Croup, epiglottitis, foreign body
Lower airway obstruction	Tracheitis, asthma, bronchiolitis
Disorders affecting the lungs	Pneumonia, pulmonary oedema, pneumothorax, pleural effusion
Disorders affecting the respiratory muscles	Neuromuscular disorders for example muscular dystrophy
Other	Head injury, poisoning, raised intracranial pressure, status epilepticus

Table 4: Disorders which can lead to airway compromise in children

Special considerations: Epiglottitis

Although epiglottitis in the UK is now rare since the introduction of the Haemophilus B vaccination in 1992, it is an important life-threatening airway emergency to know about (4). A study in 2003 found that 10% of those with epiglottitis secondary to Hib infection had been previously vaccinated (5) therefore it is a differential diagnosis worth considering in the child presenting with upper airway obstruction. These children are "toxic" in appearance and may present with high fever, sore throat, dysphagia, stridor, and drooling. They may prefer sitting up and leaning forwards with their mouth open and tongue and jaw protruding as a way of maintaining airway patency. Speech may be muffled or absent.

The key to management is to secure the airway safely by an expert. This means calling for ENT and anaesthetic help early. The epiglottis and surrounding supraglottic tissues may be inflamed at laryngoscopy with a difficult view of the glottic opening. The risk of complete airway obstruction is high and may be precipitated by upsetting the child. Therefore the child should be kept with their parent(s) and procedures like venepuncture avoided. Intravenous cannulation and subsequent antibiotic therapy should only be attempted once the airway is secured by gas induction and tracheal intubation, as well as avoidance of other interventions which may upset the child.

Management Of Airway Compromise

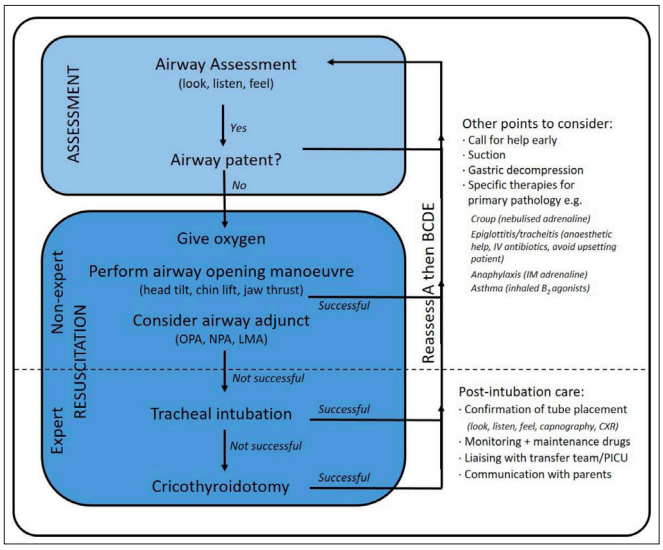


Figure 2: Airway assessment and management.

Basic Airway Manoeuvres

Basic airway manoeuvres aim to open the airway by preventing anatomical structures, primarily the tongue, from obstructing the airway. In children who have sustained trauma, cervical spine immobilisation is performed concurrently with airway management. In children the head is placed in the 'sniffing the air' position. Infants should have their head placed in a neutral position as extension of the neck can obstruct the airway due to their anatomy. Figure 3 demonstrates simple airway opening manoeuvres.

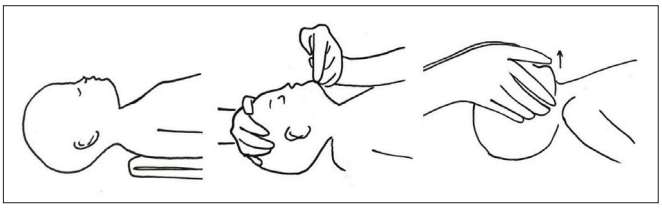


Figure 3: Neutral head position, head tilt chin lift, jaw thrust (left to right).

Airway Equipment & Adjuncts

Foundation year doctors should familiarise themselves with their workplace environment and know the location of the resuscitation/airway trolley and its contents (Table 5).

Airway equipment *
Face masks
Airway adjuncts – oropharyngeal, nasopharyngeal airways
Laryngeal mask airways
Tracheal tubes, introducers and connectors
Capnography
Suctioning equipment
Cricothyroidotomy equipment
** equipment available in variety of sizes*

Table 5: Contents of the paediatric airway trolley.

Facemask

In a child with spontaneous respiration consider a on-rebreathe face mask with a reservoir bag as a source of high flow oxygen. In infants, nasal cannulae may be better tolerated but provide unreliable oxygen delivery and most do not administer high flow oxygen. In the child that requires manual ventilation, face masks and bag-valve-masks can be used. The appropriate mask should be sized against the patient and extend from the bridge of the nose to the chin; care must be taken to avoid the eyes (Figure 4).

Pharyngeal airways

There are two types of pharyngeal airways that can be used to assist with maintaining airway patency. The oropharyngeal or 'Guedel' airway (Figure 4) keeps the mouth open and prevents the tongue from falling back and obstructing the airway. It is used in the unconscious or obtunded patient. Sizing the airway is done by placing the flange at the centre of the incisors with the tip at the angle of the mandible. In children the oropharyngeal airway is inserted using a tongue depressor or laryngoscope in the 'upwards' position; in comparison with adults where it is inserted upside down and turned in the mouth.

A IS FOR AIRWAY: THE (PAEDIATRIC) AIRWAY

A Roopra, G Castrisios, A Kaliappan

The nasopharyngeal airway is an alternative to the Guedel (Figure 4) that may be better tolerated in semi-conscious patients or those with poor mouth opening and can be used for suctioning. It is contraindicated in patients with basal skull fractures. APLS recommends sizing the length by measuring from the nostrils to the tragus and an appropriate diameter would be one that just fits into the nostril and doesn't cause sustained blanching of the nostril.

Laryngeal Mask Airways (LMA)

The LMA has been well established and used in adults and has also been shown to be useful in paediatrics, particularly as a rescue device in the 'can't intubate, can't ventilate' situation (6). The paediatric i-gel may offer some uses for the non-anaesthetist as it may be easier to insert than the classic LMA (7). It does not protect the airway against aspiration of gastric contents and in small children it may be prone to dislodgement.

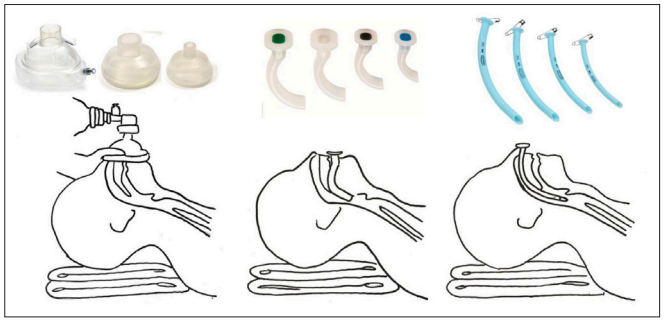


Figure 4: Position and variety of sizes of facemasks, oropharyngeal airways and nasopharyngeal airways (left to right).

The Definitive Airway

Although obtaining the 'definitive airway' through endotracheal intubation is beyond the remit of foundation year doctors, it is important to know when intubation and ventilation (Table 6) is required and by what means it is achieved.

Indications for endotracheal intubation
Inadequate oxygenation or ventilation
Inability to maintain/protect the airway
Potential for clinical deterioration
Patient transport

Table 6: Indications for endotracheal intubation.

Preparation for intubation

Preparation for intubation involves having the appropriate skilled team, namely anaesthetist and assistants, and thorough assessment of the airway and potential determinants of a difficult airway. For example, consider children with congenital abnormalities, poor mouth opening, or any normal anatomical paediatric features (Table 1) which may make intubation more difficult. Following assessment an intubation plan can be made. Equipment should include monitoring, suction, laryngoscopes, as well as adjuncts and tracheal tubes in a variety of sizes.

In neonates and young children the straight blade laryngoscope rather than the Macintosh laryngoscope used in adults, may offer better view of the vocal cords because of anatomical features discussed in Table 1. Table 7 shows important formulae used in paediatrics as per APLS guidelines for estimating weight and calculating tracheal tube size. In paediatrics uncuffed tubes are conventionally used to avoid mucosal irritation, oedema and the sequelae that may.

Important formulae	
Weight	
0-12 months	Weight (kg) = (0.5 x age in months) + 4
1-5 years	Weight (kg) = (2 x age in years) + 8
6-12 years	Weight (kg) = (3x age in years) + 7
Sizing of tracheal tubes (for ages 1 year and over)	
Internal diameter (mm) = (age/4) + 4	
Length (cm) for oral tube = (age/2) + 12	
Length (cm) for nasal tube = (age/2) + 15	

Table 7: Paediatric formulae for calculating weight and tracheal tube size (APLS) (3)

Rapid sequence induction

Rapid sequence induction (RSI) is a skilled technique that is used to safely secure the airway with an endotracheal tube in patients that are not fasted and therefore are at risk of regurgitation and aspiration of gastric contents.

The essential components of the RSI include pre-oxygenation, administration of predetermined doses of an induction agent followed by suxamethonium, cricoid pressure, placement of the endotracheal tube and cuff inflation (if cuffed tube is used), confirmation of the tube and removal of cricoid pressure. Immediate confirmation that the endotracheal tube is in the correct place includes checking that there is chest wall rise bilaterally, auscultation of breath sounds in both axillae and not over the stomach, misting of the tube and end-tidal carbon dioxide. A chest X-ray can be obtained to check the position of the tube. Post-intubation care is described in Figure 2.

Summary

Airway management in paediatrics is not dissimilar to that in adults with a few key differences on anatomy, head positioning, as well as drug dosing and equipment sizing based on weight. Foundation year doctors may encounter the child with potential or evolving airway compromise in the setting of the ward or A&E. Management involves a quick assessment of the airway followed by positioning and airway opening manoeuvres, use of adjuncts and calling for expert help early. It is important to know of the preparation and technique involved in obtaining the 'definitive airway'.

A IS FOR AIRWAY: THE (PAEDIATRIC) AIRWAY

A Roopra, G Castrisios, A Kaliappan

Test Yourself

1. Which of the following feature is true of infant airway anatomy and physiology?

a) The thyroid cartilage is the narrowest part of the larynx.
b) Infants are obligate mouth breathers.
c) Infants have less compliant lungs.
d) Infants have large tongues which may obstruct the airway.
e) Normal respiratory rate is 15-20 breaths per minute.

2. Which of the following is true with respect to airway opening manoeuvres and adjuncts in children?

a) Oropharyngeal airway are sized from the corner of the mouth to the angle of the jaw and inserted 'upside down' along the palate and then turned to the correct position once inside the mouth.
b) A correctly sized facemask extends from the bridge of the nose to the chin.
c) Airway adjuncts should only be inserted by an anaesthetist.
d) LMAs protect the airway against aspiration by gastric contents.
e) Nasopharygeal airways are sized by estimating the diameter of the patients little finger.

3. Regarding paediatric calculations and tracheal tubes, which of the following is true?

a) An 18 month old boy would have an estimated weight of 13kg.
b) A 2 year old girl with a weight of 13kg would require an endotracheal tube with an internal diameter of 4.5 mm and length of 13cm.
c) Chest X-ray is only way to confirm correct tracheal tube position.
d) Cuffed tubes are contraindicated in infants.
e) Endotracheal tubes should not be used in children with suspected base of skull fractures.

4. While preparing for endotracheal intubation which of the following is false?

a) Equipment available should include face masks and bag-valve-mask, airway adjuncts, tracheal tubes, capnography, suctioning and cricothyroidotomy equipment
b) Airway adjuncts and tracheal tubes should be available in different sizes.
c) Gastric decompression with a nasogastric tube should be considered.
d) Calculations for estimating the child's weight (if unknown) and tracheal tube internal diameter and length should be done prior to intubation.
e) Pre-oxygenation prior to intubation can be achieved with nasal cannulae.

5. Which of the following is false with regards to Epiglottitis?

a) Is a valid differential diagnosis in the child presenting with stridor.
b) Initial first steps of management should include intravenous cannulation and antibiotics.
c) Is commonly caused by bacterial infection.
d) Securing the airway is the first priority before any other interventions.
e) Intubation may be difficult due to oedema of the epiglottis.

Test Yourself Answers

Answer 1

a) False: The larynx is funnel shaped with the cricoid cartilage as its narrowest part.
b) False: Infants are obligate nose breathers.
c) False: Infants have more compliant lungs.
d) True
e) False: Normal respiratory rate for <1 year is 30-40 breaths per minute.

Answer 2

a) False: Oropharyngeal airways are sized by placing the flange at the centre of the incisors with the tip at the angle of the mandible and in children and babies it should be inserted with concave side down using a tongue depressor in order to avoid trauma to the palate due their small anatomy.
b) True
c) False: Insertion of airway adjuncts are a good first step in the management of children with airway compromise and can be inserted by the non-expert.
d) False: LMAs do not provide a definitive airway and therefore do not protect against aspiration unlike the endotracheal tube.
e) False: Although this method has been traditionally taught, it is inaccurate and APLS recommends that the ideal diameter of the NPA is one that just fits into the nostril without causing sustained blanching of the nostril.

Answer 3

a) False: Using the formula Weight (kg) = (2 x age in years) + 8 for children aged 1-5 years, an 18 month old would have an estimated weight of (2 x 1.5) + 8 = 11 kg.
b) True: Internal diameter = (2/4) + 4 = 4.5mm, length = (2/2) + 12 = 13cms. Note that these are approximations and that there should be tracheal tubes of different sizes to hand (in this example, 4mm and 5mm internal diameter tubes should also be available).
c) False: Immediate confirmation of correct endotracheal intubation should be done by 'look, listen, feel, capnography' which involves checking that there is chest wall rise bilaterally, auscultation of breath sounds in both axillae and not over the stomach, misting of the tube and end tidal CO2. CXR should be obtained in addition but after initial confirmatory checks are made.
d) False: Although cuffed tubes increase risk of mucosal trauma and oedema, low-pressure cuffs are available and can be considered.
e) False: Nasopharyngeal airways are contraindicated in base of skull fractures because of the risk of further trauma. Endotracheal intubation can be considered in the child with a head injury, for example, if the child cannot maintain or protect their airway. C-spine protection is also important.

A IS FOR AIRWAY: THE (PAEDIATRIC) AIRWAY

A Roopra, G Castrisios, A Kaliappan

Answer 4

a) True: The listed equipment is essential and should be available from the resuscitation trolley.
b) True
c) True: Especially if the patient is being manually ventilated with bag-mask-valve as this can insufflate the stomach and increase the risk of regurgitation and aspiration.
d) True: Calculations for weight and tracheal tubes should be done well in advance of intubation and for every sick child for quick reference in case of deterioration.
e) False: Pre-oxygenation before intubation is essential to de-nitrogenate the lungs and fill the functional residual capacity with oxygen and is achieved with a tightly fitting face mask. Nasal cannulae do not provide reliable inhaled concentrations of oxygen at high flows.

Answer 5

a) True: Other differential diagnoses to consider include croup, foreign body inhalation and retropharyngeal or tonsillar abscess.
b) False: Care must be taken not to upset the child and cause rapid airway deterioration. Cannulation and IV antibiotics can be started once the airway is secured.
c) True: Causative organisms include haemophilus influenzae type b (most common), and also beta-haemolytic streptococci, staphylococci, and pneumococci.
d) True: It is important to call for anaesthetic / ENT help early to aid in securing the airway.
e) True: Laryngoscopy may reveal an oedematous epiglottis, surrounding sub-glottic structures and glottis opening making it more difficult to pass the endotracheal tube.

Author

Dr Amrit Roopra
Anaesthetic core trainee year 1 (CT1)
Basildon and Thurrock University Hospitals
Basildon, Essex, SS165NL

Dr Garifalia Castrisios
Paediatrics specialist registrar year 6 (ST6)
Southend University Hospital
Prittlewell Chase, Southend-on-Sea, SS0 0RY
gcastrisios@gmail.com

Dr Agilan Kaliappan
Anaesthetics and Intensive Care consultant
Basildon and Thurrock University Hospitals
Basildon, Essex, SS165NL
agilan.kaliappan@btuh.nhs.uk

Corresponding Author

Dr Amrit Roopra
roopra.amrit@gmail.com

References

1. Royal College of Paediatrics and Child Health, National Children's Bureau and British Association for Child and Adolescent Public Health. Why children die: death in infants, children and young people in the UK Part A. May 2014.
2. Gupta P, Tang X, Gall CM, Lauer C, Rice TB, Wetzel RC. Epidemiology and outcomes of in-hospital cardiac arrest in critically ill children across hospitals of varied center volume: A multi-center analysis. Resuscitation 2014;85:1473-9.
3. Advanced Life Support Group. Advanced Paediatric Life Support: A Practical Approach to Emergencies (APLS) 6th Edition. 2016. Wiley-Blackwell.
4. McVernon J, Slack MP, Ramsay ME. Changes in the epidemiology of epiglottitis following introduction of Haemophilus infuenzae type b (Hib) conjugate vaccines in England: a comparison of two data sources. Epidemiology and infection 2006; 134: 570–2.
5. Maloney, E, Meakin, G. Acute stridor in children. Continuing Education in Anaesthesia, Critical Care & Pain. 2007; 7: 83-86.
6. Patel, P, Bingham R. Laryngeal mask airway and other supraglottic airway devices in paediatric practice. Continuing Education in Anaesthesia, Critical Care and Pain 2009; 9: 6-9.
7. Lee JR1, Kim MS, Kim JT, Byon HJ, Park YH, Kim HS, Kim CS. A randomised trial comparing the i-gel (TM) with the LMA Classic (TM) in children. Anaesthesia. 2012 Jun;67(6):606-11
8. Ashtekar, CS, Wardhaugh A. Do cuffed endotracheal tubes increase the risk of airway mucosal injury and post-extubation stridor in children? Archives of Disease in Childhood. 2005; 90: 1198-1199.

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

TRACHEOSTOMY EMERGENCIES

M Armstrong, D Conway, V Cunningham

Abstract

Patients with tracheostomies are increasingly present at ward level care. The indications for tracheostomy are varied and they are not without complications both in the short and long term. We describe management of tracheostomy emergencies using the National Tracheostomy Safety Project Guidelines (NTSP) (1). Familiarity with tracheostomies and the ability to troubleshoot and manage acute tracheostomy problems until senior help arrives are vital skills. Awareness of the NTSP guidance and first responder measures when managing an obstructed tracheostomy are discussed.

Discussion

The number of patients with a tracheostomy on the ward is ever increasing. A tracheostomy is a tract directly into the trachea where it passes superficially in the anterior neck. They are constructed to assist patients who require ventilatory support in the medium to long term and in those with pathology, or requiring procedures which compromise the upper airway. For patients recovering from prolonged critical illness or with neurological conditions, a tracheostomy may help by avoiding the need for sedation and assisting in management of secretions (2).

Tracheostomies can be performed on the critical care unit using a percutaneous technique or in theatre using a traditional surgical technique.

The tubes are classified according to internal diameter, similar to oral or nasal endotracheal tubes. Standard tubes have a fixed length which sits in the trachea, a cuff with pilot balloon, and a wing like attachment, called the flange, around a standard breathing circuit connector which allows the tube to be secured with stitches or a neck tie.

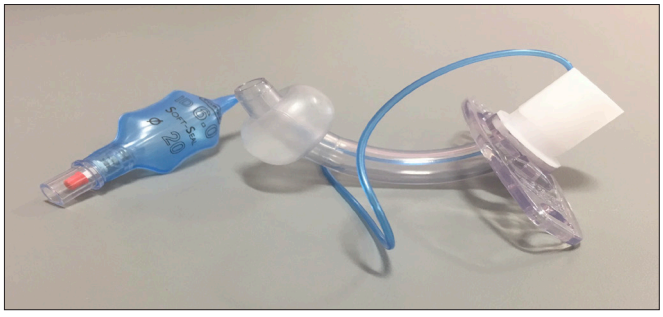


Figure 1: A cuffed tracheostomy tube with visible pilot balloon.

Most tubes have a removable inner tube to help manage secretion build up. The inner can be removed and cleaned or changed. A spare inner must be available in case of removal for cleaning as the breathing connector may only work with the inner tube in situ. Some tubes have neither a cuff, nor inner tube and there are also those where the position of the flange attachment on the tube can be varied for patients with shorter necks.

Stomas which have been established for a while will remain well formed if the tube is removed, indeed removing it will often restore airway patency if an obstructing tube can not be unblocked. Letting the cuff down may help if the lumen of the tube is blocked or the distal end of the tube slips and becomes obstructed against solid anatomy rather than being open to the tracheal lumen. Some tubes have holes called fenestrations, which help to create an airway around about the tracheostomy tube as well as within it.

This allows air through the larynx, which means that patients can use their voice. A speaking valve attached to the tube's opening makes this even easier. When you press it, it helps direct expired air upwards instead of out through the tracheostomy. Because it bypasses the natural air humidification system, the nose, air reaching the trachea must be artificially humidified. This can be done via a 'T piece' breathing circuit or a Swedish nose. A Swedish nose has a hydrophobic filter which humidifies air going in and these may be present at the tube opening.

Complications of tracheostomies (3)

Immediate	Early	Late
Haemorrhage	Blockage secretions	Granulomata of trachea
False tract	Infection stoma site	Persistent sinus
Pneumothorax	Tracheal ulceration	Oesophageal fistula
Cuff herniation	Tracheal necrosis	Tracheomalacia
Surgical emphysema	Tube migration	Tracheal stenosis
Damage to trachea	Positional occlusion	Scar formation
Loss of airway	Accidental decannulation	
	Accidentally dislodged	
	Haemorrhage	

Another subset of patients with airway stomas are laryngectomy patients. They are permanent neck breathers with no connection to the upper airway. They are less likely to have a tube in the stoma than tracheostomy patients but both can run into problems with acute airway crises. Tracheostomies will have a connection to the upper airway when the cuff is not inflated creating a sealed circuit. This means that facemask oxygenation is possible provided the stoma is effectively sealed off to avoid creating a large leak. Laryngectomy patients have no connection upwards hence oxygenation will only be effective though the stoma.

Although laryngectomy stomas tend to be well-formed as they are permanent such patients may have a stoma button or short tube in place to help keep the stoma open and aid with humidification. They may wear a bib over their stoma (a 'Buchanan' bib) which aids humidification and filtration. There may be a tracheo-oesophageal puncture ('TEP') valve in situ to aid in oesophageal speech.The latter sits on the back of the trachea extending back into the oesophagus and should not be removed but stoma buttons can be in the event of an emergency (1).

TRACHEOSTOMY EMERGENCIES

M Armstrong, D Conway, V Cunningham

Sometimes laryngectomy stomas are situated lower down on the trachea than tracheostomies. This predisposes to the risk of a tube sliding down distal to the carina and becoming endobronchial. In this situation only one lung would be ventilated and a large ventilation perfusion shunt would be created. This may present with low oxygen saturations, which should improve with pulling the tube out or back into the trachea from the bronchus so that both lungs are ventilated.

The National Tracheostomy Safety Project

Following a series of adverse incidents involving airway crises in neck stoma patients, the UK National Tracheostomy Safety Project (NTSP) developed as a collaboration of many different stakeholders. It produced a series of guidelines by expert consensus for first responders in relation to airway emergencies in patients with tracheostomies and laryngectomies. It takes account of the fact that first responders may be any member of the healthcare team and may well be dealing with something unfamiliar to them. The guidelines fit into the standard ABCDE assessment of the critically ill patient. Definitive diagnosis is not key to managing this problem successfully. The key issues are:

- Waveform capnography has a prominent role at an early stage in emergency management.
- Oxygenation of the patient is prioritized.
- Trials of ventilation to assess patency via a potentially displaced tracheostomy tube are avoided.
- Suction is only attempted after removing a potentially blocked inner tube.

The NTSP has produced recommended bedhead information signs (figure 2), which should be found around the bedspace of all patients with tracheostomies or laryngectomies. The templates can be found online at www.tracheostomy.org.uk and via a NTSP app.

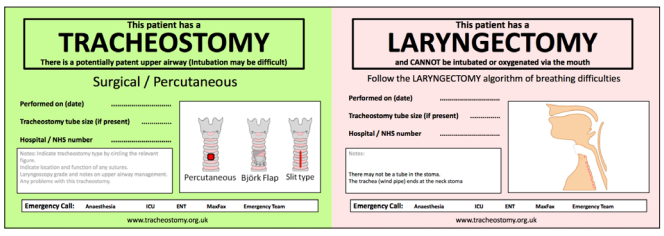


Figure 2: Tracheostomy and Laryngectomy bedhead signs.

Recommendations

- There should be a sign at the bedspace about the nature of the stoma and a box with appropriate equipment for any emergency which might arise. If you do not know if the stoma is a laryngectomy or tracheostomy, treat as if there is potential upper airway patency. The principles are the same as dealing with any critically ill patient.
- Call for airway expert help. The sign at the bedside should indicate who the first person to call is. If not, the on call anaesthetist will help. Things can change quickly in airway emergencies and you are justified in using a fast bleep. You should say where you are, that you have an airway emergency and that you need senior help immediately.
- Look, listen and feel at the mouth and the stoma for breathing – Mapleson C breathing circuit (fig. 3) and waveform capnography may help with this (fig. 4). The purpose of the breathing circuit at this stage is to detect breathing through a patent airway. You should not initiate ventilation until you have established airway patency as positive pressure through a tube where the distal tip is not in the airway can cause harm.

Figure 3: Mapleson C breathing circuit.

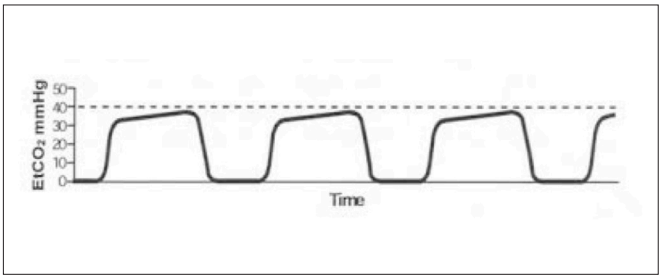


Figure 4: Waveform capnography.

TRACHEOSTOMY EMERGENCIES

M Armstrong, D Conway, V Cunningham

The algorithm

1 - Is the patient breathing?

Take 10 seconds to assess for signs of life – can be simultaneous with initial assessment of breathing efficacy. If no signs of life commence CPR and call resuscitation team.

If the patient is breathing apply high flow oxygen to both mouth and stoma, with whatever normal oxygen mask is available, e.g. Hudson or non-rebreathe bag over the mouth and the same or "trache mask" over the stoma.

Three further key questions will help determine whether the tracheostomy is patent or not.

Remove any speaking valve, Swedish nose or inner tube and try to pass a suction catheter.

2 - Can you pass a suction catheter?

If you can pass a suction catheter via the tracheostomy a partial obstruction may be the cause of the problem.

The airway may be sufficiently patent to attempt ventilation if the patient is not breathing.

Breathing can be assisted or the patient ventilated using the Mapleson C circuit or self inflating bag valve mask (BVM). Attach waveform capnography if available.

Check that the chest rises and falls with each breath and release and that the capnography (if available) shows CO_2 on expiration.

In cardiac arrest capnography becomes much less reliable as it is dependent on cardiac output which stops in cardiac arrest.

Some tubes may require re-insertion of the inner tube or a new inner tube to permit connection to a standard airway connector.

If the successful ventilation starts to fail, go back and reassess using the algorithm.

If you cannot pass a suction catheter, deflate the cuff.

3 - Does deflating the cuff lead to improvement or stabilisation?

If ventilation becomes easier with deflation of the cuff, the tracheostomy was partially obstructed or displaced. Continue A-E assessment.

If deflating the cuff produces no improvement- remove the tracheostomy tube.

As previously discussed not all tracheostomy tubes have a cuff.

4 - Does removal of the tracheostomy tube improve ventilation and oxygenation?

Continue mask oxygen delivery to both oral and stoma airway using waveform capnography and Mapleson C circuit with tight fitting mask to face and Hudson/trachy mask to neck stoma Check for misting on the mask to assist assessment of breathing and delivery of oxygen. Continue your A-E assessment

If patient is not breathing, call resuscitation team and start CPR including emergency oxygenation.

Primary Emergency Oxygenation during CPR

If the tracheostomy is removed, cover the stoma with dressing or hand to stop air leakage.

Attempt standard oral oxygenation with bag and mask ventilation

- Airway opening manoeuvres (head tilt, chin lift, jaw thrust).
- Oropharyngeal or nasopharyngeal airways.
- Laryngeal mask airway (LMA).

Or

If there is a laryngectomy attempt stoma ventilation with paediatric face mask or inflated laryngeal mask firmly applied over the stoma site.

These simple measures will buy time until expert help arrives.

TRACHEOSTOMY EMERGENCIES

M Armstrong, D Conway, V Cunningham

Secondary Emergency Oxygenation during CPR

This is advanced airway management and most likely will be performed by your expert help.

In Summary

A blocked tracheostomy is an Airway (A) problem.

Specific guidelines are available and should be followed but the key principles in assessing a critically ill patient apply and you should take an integrated approach.

1. Undertake an initial assessment and re-assess regularly.

2. Always assess the effects of treatment or other interventions.

3. Always correct life threatening abnormalities before moving on to the next part of the A to E assessment.

4. The assessment of the acutely ill patient is often multidisciplinary, with senior help required at an early stage.

Definitive diagnosis is not key to managing this problem successfully and use of the algorithms provided by the National Tracheostomy Safety Project are instrumental in successful management.

MCQs

1. Assessment of the acutely ill patient: Which of the following is NOT recommended as part of the management of acute tracheostomy problems?

a) Passing a suction catheter down the tracheostomy

b) Removing the tracheostomy inner liner

c) Applying facemask oxygen

d) Leaving the stoma site uncovered if tracheostomy is removed

e) Deflating the cuff

2. Tracheostomy: The size of the tracheostomy tube refers to which of the following?

a) External diameter in mm

b) Internal diameter in mm

c) Length of the tracheostomy

d) External diameter of the inner liner in mm

e) None of the above

3. Airway anatomy: Which of the following statements is true?

a) Patients post laryngectomy have a patent upper airway

b) In adults, the narrowest part of the upper airway is at the cricoid cartilage

c) The trachea is a structure with complete cartilaginous rings

d) All adults have the same number of tracheal rings

e) The thyroid isthmus lies anterior to the second to fourth tracheal rings

4. Breathing circuits:Which of the following statements regarding the Mapleson C circuit during assessment of an airway crisis in a neck stoma patient is true?

a) Should be fully inflated in order to ventilate the patient orally

b) Can be attached without an inner tube of the tracheostomy

c) Should be connected to waveform capnography to determine the cause of the airway obstruction

d) Should be connected to the waveform capnography to assist assessment of whether the patient is breathing

e) Only comes after assessment of breathing, suctioning and removal of the inner tube.

5. Assessment and management: Which of the following statements is not true? Positive pressure ventilation can be attempted:

a) Through the tracheostomy if a suction catheter can't be passed

b) Only through a patent airway

c) Only after removal of the tracheostomy tube

d) Always requires re-insertion of the inner tube

e) Only when the stoma site is covered if the tracheostomy tube has been removed.

TRACHEOSTOMY EMERGENCIES

M Armstrong, D Conway, V Cunningham

Answers

1. D.

If a blocked or dislodged tracheostomy tube is removed it is essential to cover the open stoma at the front of the neck (in all patients but those with laryngectomies). Covering an open stoma is required prior to any attempt to oxygenate and/or bag mask ventilate via the upper airway to avoid a leak. Passing a suction catheter helps to identify if the tube is patent.

Removing the inner tube may reveal a blockage. Application of facemask oxygen is essential during simultaneous assessment and resuscitation. Deflating the cuff may help restore upper airway patency as it allows a conduit to the upper airway.

2. B.

Tracheostomy tube sizes refer to the inner diameter of the tube in millimetres, similar to endotracheal tubes.

3. E.

The thyroid isthmus typically sits anterior to the second to fourth tracheal rings. It is retracted upwards or divided during the formation of a surgical tracheostomy. Patients post laryngectomy have no patient upper airway and are obligate neck breathers. The narrowest part of an adult airway is at the level of the vocal cords.

4. D.

A Mapleson C (or 'Water's) circuit may be found at the bedspace of patients with tracheostomy and can be used to deliver oxygen, assess ventilation (visible via bag movement in a breathing patient with a patent airway) and ventilate by tightening the attached valve. Ventilation usually requires replacement of the inner tube of the tracheostomy. The circuit can be used to assess presence and adequacy of breathing but will not determine the ultimate cause of airway obstruction.

5. A.

The inability to pass a suction catheter implies lack of patency of the tracheostomy and ventilation should NOT be attempted through this. If a suction catheter can be passed, the trachestomy tube is patent and positive pressure ventilation can be attempted if the patient is not breathing.

Author

Dr Maria Armstrong
Specialty Registrar in Anaesthetics
Glasgow Royal Infirmary
Department of Anaesthetics
84 Castle Street, Glasgow G4 0SF

Dr Deirdre Conway
Specialty Registrar in Anaesthetics
Glasgow Royal Infirmary.
Department of Anaesthetics
84 Castle Street, Glasgow G4 0SF
d.conway@nhs.net

Dr Valerie Cunningham
Consultant Anaesthetist
Institute of Neurological Sciences, Glasgow
valeriecunningham@nhs.net

Corresponding Author

Dr Maria Armstrong
maria.armstrong5@nhs.net

References

1. McGrath B, Bates L, Atkinson D, Moore J. Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies. Anaesthesia. 2012;67(9):1025-1041.
2. Cheung L, Napolitano L. Tracheostomy: Epidemiology, Indications, Timing, Techniques, and Outcomes. Respiratory Care. 2014; 59 (6).
3. NHS Greater Glasgow and Clyde Acute Division. Guidelines for the care of patients with a tracheostomy or laryngectomy. Available online at: http://www.staffnet.ggc.scot.nhs.uk/Acute/Surgery%20Anaesthetics/Critical%20Care/QEUH_CCU/Documents/Tracheostomy_Guidelines_FINAL.pdf.

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"**(https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

ANAESTHESIA FOR THE PATIENT WITH MARFAN SYNDROME

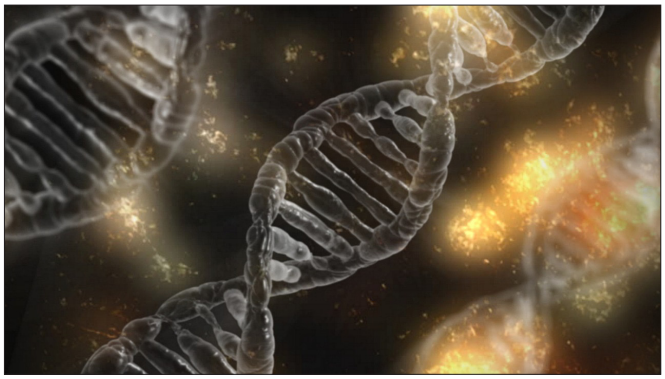
C McGenity, D Bell

Abstract

Marfan syndrome patients present for surgery relatively commonly with related conditions as well as coincidental pathology. (1) Anaesthetists need to be aware of the multisystem impact of this condition and undertake a comprehensive preoperative assessment. (2) This article looks at a case and its implications for the airway, cardiovascular, respiratory, neurological and musculoskeletal systems, anaesthetic techniques and related disorders.

Introduction

Marfan syndrome is a connective tissue disorder that affects multiple body systems. (1,3) Cases are mostly inherited through an autosomal dominant pattern but approximately 25% of cases occur sporadically. (3,4) The syndrome is most commonly associated with mutation of the FBN1 gene and was first depicted in medical literature by Antoine-Bernard Marfan in 1896 when he described the skeletal features of a young girl named Gabrielle. (4,5)



It is thought to have an incidence of approximately 1 in 3000-5000 individuals, and most anaesthetists are likely to see these patients during their career. (1,6) This article looks at implications for the body systems in the context of anaesthesia. Readers must be mindful that although the pathophysiology of Marfan syndrome is well documented, the evidence in this area related to clinical practice in anaesthesia is mostly limited to case studies.

Clinical vignette

A 40 year old man with Marfan syndrome arrives at the pre-assessment clinic prior to an elective laparoscopic hernia repair. He has never received a general anaesthetic in the past. On inspection he has pectus carinatum, a scoliosis and reduced upper segment/lower segment ratio of the limbs. On examination of the airway he has a high-arch palate. He tells you he is nervous about the operation and receiving an anaesthetic, given his medical problems. You contemplate the additional considerations for an anaesthetic in a patient with Marfan syndrome.

Airway issues

In considering the safe management of the airway, the anaesthetist must be aware of the possible variations in anatomical structure within the syndrome. A high-arch palate may make intubation more challenging. (7) These patients are also at risk of temporomandibular dislocation when manipulating the jaw during laryngoscopy. (1)

Tracheomalacia has also been reported which increases the risk of airway obstruction when a patient is first anaesthetised or following extubation. (8) This can create confusion with bronchial asthma or laryngospasm, but unlike these cases may respond to continuous positive airway pressure, with more extreme cases requiring intubation or reintubation.(8) However, other reports demonstrate very little difficulty in intubation for Marfan patients. (9) In this gentleman, intubation was uneventful despite his high-arch palate and there was no evidence of tracheomalacia.

Cardiovascular implications

In Marfan syndrome the aortic root progressively enlarges and is at risk of dissection and rupture. (10) The patient's aortic anatomy can be examined through magnetic resonance imaging (MRI) scan, computed tomography (CT) scan or transthoracic echocardiogram (TTE) prior to surgery, to see the extent of dilatation if they are considered high risk. (4,10) This gentleman was known to have an aortic root dilatation for which he attended surveillance appointments and the dilatation was measured at 3.9cm on preoperative CT scan.

In the context of anaesthesia, clinicians must be aware that sympathetic stimulation induced by laryngoscopy and intubation, or from the surgical procedure can cause a sudden rise in blood pressure and increase the risk of dissection in these vulnerable patients. (11) Controlling the blood pressure with use of beta blockers pre-operatively can help to minimise the risk of this complication and careful haemodynamic monitoring is key in managing these patients intraoperatively. (12,13)

Placement of arterial lines and other access must however be done with great care as defects in connective tissue make the skin and vessels more vulnerable to damage. (14) There is evidence that ACE inhibitors and diuretics may also be helpful in controlling arterial pressure in Marfan syndrome. (15) The patient was taking bisoprolol prior to surgery and his usual dose was taken on the morning of the procedure. His blood pressure was monitored using an arterial line throughout the surgery and his blood pressure was kept within normal range for most of the procedure. He did have some post-operative bruising despite insertion with relative ease on the first attempt.

ANAESTHESIA FOR THE PATIENT WITH MARFAN SYNDROME

C McGenity, D Bell

Dilatation around the aortic root can also lead to aortic regurgitation, and mitral valve insufficiency is another feature of Marfan syndrome. (7,15) Perioperative antibiotic prophylaxis against infective endocarditis is however no longer recommended in native valvular disease unless there is a prosthetic heart valve, or a previous history of infective endocarditis. (16, 17) In addition to the above complications, there is also a greater chance of a cardiac conduction defect in these patients. (2) electrocardiogram (ECG) and echocardiography are therefore essential in preoperative assessment of cardiac function in Marfan syndrome. (7)

A simple chest xray can help define aortic dilatation but additional imaging may be needed in individuals with higher risk of aortic disease. (4,7) This gentleman's preoperative echocardiogram showed overall preserved left and right ventricular function, with some mild aortic regurgitation. ECG showed sinus rhythm. He had no history of infective endocarditis or prosthetic valve and he had low-risk surgery so antibiotic prophylaxis was withheld.

Respiratory implications

An awareness of the problems affecting the respiratory system in Marfan syndrome is essential in a preoperative assessment of such a patient. (7) Skeletal abnormalities such as scoliosis, pectus excavatum and pectus carinatum can cause thoracic insufficiency syndrome and reduce lung function. (7)

There is also a risk of spontaneous pneumothorax in Marfan patients, which may be further increased by the use of positive pressure ventilation during anaesthesia. (1) This gentleman had no respiratory history and despite his scoliosis, his lung function tests were within the normal range. He did not experience a pneumothorax despite use of positive pressure ventilation and the reduction in lung compliance induced by the pneumoperitoneum as a requirement for laparoscopy.

Neurological considerations

There are reports of dural ectasia posing a problem in spinal anaesthesia for Marfan patients.(18) A case has been documented where a thecal sac formed next to the spinal cord and prevented spread of the local anaesthetic agent, thereby limiting an adequate sensory block.(18) Additionally, spinal and epidural blocks may be technically difficult to perform and higher doses of local anaesthetic agents may be needed in neuraxial procedures due to deformity, increased spinal length and cerebrospinal fluid (CSF) volume in these patients. (19) Performing an MRI scan of the spine can be helpful before attempting spinal or epidural procedures to look for these structural problems.(1) No spinal or epidural procedures were attempted in this gentleman as general anaesthesia was the most appropriate in this situation. It would however have been challenging to attempt central neuraxial blockade (CNB) in the view of the scoliosis.

Musculoskeletal considerations

Possibly the most visible features of Marfan syndrome are the musculoskeletal manifestations, with a variable severity of scoliosis, joint laxity, arachnodactyly, chest deformities and dolichostenomelia (unusually long limbs).(20) These conditions may necessitate orthopaedic surgical correction in themselves and cause problems for surgery in other areas.(20) The joints are more vulnerable to dislocation and patient positioning needs close attention to avoid injury. (20)

Due to the range of deformities of the thorax and spine that may occur and potential underlying respiratory problems discussed above, optimal positioning during surgery is essential to ensure effective ventilation of the lungs. (20) This gentleman was very tall and had both a chest and a spinal deformity. Cushioning was placed around the joints where possible and joints supported by members of the theatre team when moving him to and from the trolley to the operating table. He did not report any postoperative injury.

Other considerations

Ophthalmological issues such as lens dislocation and myopia may lead to Marfan patients presenting for ocular procedures. (1) The ligaments of the lens may be weaker than average which can result in lens dislocation. (21) These patients are also vulnerable to retinal detachment and glaucoma. (21) Marfan patients also have weaker connective tissue in the skin, making them at greater risk of scarring and hernias. (21) The patient wore glasses for myopia but did not have a history of the other potential eye complications. He did experience bruising associated with the arterial line but the hernia wound healed well.

ANAESTHESIA FOR THE PATIENT WITH MARFAN SYNDROME

C McGenity, D Bell

Choice of anaesthetic

There are advantages and disadvantages to using both local anaesthetic techniques and general anaesthesia and it is not clear which is best in Marfan syndrome. (1) In high risk cases, general anaesthesia carries the advantage that in the event of aortic dissection, the patient would be intubated, and the airway protected for an emergency repair of the aorta. (1) The disadvantage of general anaesthesia is the risk of stimulation through intubation, causing a rise in blood pressure and increasing the risk of dissection. (1)

As mentioned above, regional anaesthesia may be difficult to perform and may require higher doses of local anaesthetic but it does not have the risks associated with intubation. (21) It is important to establish the clotting profile prior to surgery as patients will be on anticoagulants if they have a mechanical heart valve. (21) High quality post-operative pain management is essential in preventing post-operative hypertension. (14)

General anaesthesia was used in this gentleman with a remifentanil infusion, propofol induction, rocuronium for paralysis and maintenance with sevoflurane in an air/oxygen mix, and intubation and extubation were both performed without problems. The patient denied pain immediately postoperatively and regular oral analgesia was provided for the first few days following surgery.

Related disorders

It is useful to be aware of the differential diagnoses of Marfan syndrome and their features. This includes Ehlers-Danlos syndrome, another genetic connective tissue disorder, also associated with aneurysms and valvular disease, as well as characteristic facial and skin features. (22) In Ehlers-Danlos syndrome dissection, pneumothorax and haemorrhage are risks with anaesthesia.

(12) Loeys-Dietz syndrome is another example with risk of aneurysm and dissection, but is often associated with skin abnormalities and oropharyngeal structural defects such as cleft palate and bifid uvula. (22) Osteogenesis imperfecta is a condition where patients have osteoporosis and a high incidence of pathological fractures. ( ) Like Marfan syndrome they may have problems associated with kyphoscoliosis and chest deformities leading to reduced lung function but they are higher risk for dental injury due to weaker teeth. (23)

Conclusion

General anaesthesia was performed for a 40 year old male patient with Marfan syndrome for an elective laparoscopic hernia repair. Intubation and extubation were uneventful and blood pressure was closely monitored and controlled during the procedure. No antibiotic prophylaxis was indicated. Epidural and spinal procedures were not required in this case but may have been difficult given his history.

He had musculoskeletal features of Marfan syndrome and measures were taken to reduce the risk of injury during the procedure. He recovered well, denied pain immediately postoperatively and was discharged home the day following surgery. There were no problems with wound healing.

Multiple Choice Questions

1. Which clinical criteria are used to diagnose Marfan syndrome?

a. Brighton score

b. McDonald criteria

c. Amsterdam criteria

d. Ghent nosology

e. Child Pugh classification

2. Which of these is a most likely to be a problem with the airway in Marfan syndrome?

a. Pharyngeal pouch

b. Cleft palate

c. High arch palate

d. Micrognathia

e. Laryngeal cysts

ANAESTHESIA FOR THE PATIENT WITH MARFAN SYNDROME

C McGenity, D Bell

3. Which is most likely to be a cardiovascular component of Marfan syndrome?

a. Aortic root dilatation

b. Rhabdomyoma

c. Ebstein's anomaly

d. Tricuspid regurgitation

e. Tetralogy of Fallot

4. Which is most likely to present a respiratory problem in anaesthetising someone with Marfan syndrome?

a. Bronchiectasis

b. Pneumothorax

c. Tuberculosis

d. Alpha 1 antitrypsin deficiency

e. Asthma

5. Which neurological structural abnormality has been reported to have presented problems for anaesthetics in Marfan syndrome?

a. Spina bifida

b. Hydrocephalus

c. Microcephaly

d. Craniosynostosis

e. Dural ectasia

Answers

1 – d. Ghent nosology.

Formed in 1996 to replace the former Berlin criteria. (5) It provides a classification system for diagnosing patients both with and without a family history of the condition. (5) It includes a scoring system of systemic features. It also distinguishes between the diagnosis of marfan syndrome, MASS (mitral valve, aorta, skin and skeletal features) and mitral valve prolapse syndrome. (5)

2 – c. High arch palate

A recognised feature in many patients with Marfan syndrome. (7) The other airway issues as discussed above are temporomandibular joint dysfunction and tracheomalacia. (1,8)

3 – a. Aortic root dilatation

The aortic root progressively dilates and becomes at risk of dissection in Marfan syndrome. (10) Other common cardiovascular components are aortic regurgitation and mitral regurgitation. (15,7) Some patients with Marfan syndrome may have a prosthetic valve as treatment for these valvular diseases. (17)

4 – b. Pneumothorax

Patients with Marfan syndrome as well as those with other connective tissue disorders such as Ehlers-Danlos syndrome are at greater risk of spontaneous pneumothorax compared to the rest of the population. (1,12) This risk is increased by positive pressure ventilation. (1) Thoracic insufficiency syndrome can also occur in Marfan patients secondary to scoliosis and other skeletal abnormalities of the thorax. (7)

5 – e. Dural ectasia

Dural ectasia has been reported patients with Marfan syndrome. (18) It has been found to present difficulty in creating an adequate spread of anaesthetic agents in epidural and spinal anaesthesia. (18) Higher doses of local anaesthetic may be required in such patients. (19)

ANAESTHESIA FOR THE PATIENT WITH MARFAN SYNDROME

C McGenity, D Bell

Author

Dr Clare McGenity
Foundation Year One Doctor
Leeds General Infirmary
Great George Street
Leeds, LS1 3EX

Dr Dominic Bell
Consultant Anaesthetist
Leeds General Infirmary
Great George Street
Leeds, LS1 3EX
dominic.bell@nhs.net

Corresponding Author

Dr Clare McGenity
clare.mcgenity@nhs.net

References

1. Bagirzadeh L, Guglielminotti J, Loeys B. Orphan Anesthesia. Anesthesia recommendations for patients suffering from Marfan syndrome. http://www.orphananesthesia.eu/en/rare-diseases/published-guidelines/cat_view/61-rare-diseases/60-published-guidelines/83-marfan-syndrome.html
2. von Kodolitsch Y, Robinson PN. Marfan's syndrome. In: Yentis SM, Hirsch NP, Ip JK eds. Anaesthesia and Intensive Care A-Z, 5th edn. London: Churchill Livingstone Elsevier 2013, 370.
3. Nimmo, S. Nimmo, GR. Intercurrent disease and anaesthesia. Aitkenhead, AR. Moppett, IK. Thompson, JP. (eds). Textbook of Anaesthesia, 6th ed. London: Churchill Livingstone; 2013. Pp. 417
4. Hiratzka, LF. Bakris, GL. Beckman, JA. Bersin, RM. Carr, VF. Casey, DE. et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the Diagnosis and Management of Patients with Thoracic Aortic Disease. Circulation 2010; 121: e266-e369
5. Loeys, BL. Dietz, HC. Braverman, AC. Callewaert, BL. De Backer, J. Devereux, RB et al. The revised Ghent nosology for the Marfan syndrome. J Med Genet 2009; 47(7).
6. Wells, DG. Podolakin, W. Anaesthesia and Marfan's syndrome: case report. Canadian Journal of Anaesthesia 1987;34(3).
7. Aguirre, JA. Borgeat, A. Marfan syndrome. Pollard, BJ (eds). Handbook of Clinical Anaesthesia, 3rd ed. Florida: CRC Press; 2011. Pp. 251-252.
8. Ah Young, O. Yang Hyun, K. Bo Kyung, K. Hee-Soo, K. Chong Sung, K. Unexpected Tracheomalacia in Marfan Syndrome During General Anesthesia for Correction of Scoliosis. Anesthesia & Analgesia 2002; 95(2).
9. Verghese, C. Forum: Anaesthesia in Marfan's syndrome. Anaesthesia 1984; 39: 917-922
10. NICE Guideline (IPG394). External aortic root support in Marfan syndrome: Interventional procedures guidance. National Institute for Health and Clinical Excellence 2011.
11. Butler, MG. Hayes, BG. Hathaway, MM. Begleiter, ML. Specific Genetic Diseases at Risk for Sedation / Anesthesia Complications. Anesthesia & Analgesia 2000; 91:837-55
12. Hocking, G. Lloyd, J. Uncommon conditions. Allman, KG. Wilson, IH (eds). Oxford Handbook of Anaesthesia, 3rd ed. Oxford: Oxford University Press; 2011. pp. 317
13. Singh, SL. Brooks, C Dobkowski, W. General Anesthesia using remifentanil for Cesarean delivery in a parturient with Marfan's syndrome. Canadian Journal of Anaesthesia 2008; 55(8).
14. Araujo, MR. Marques, C. Freitas, S. Santa-Barbara, R. Alves, J. Xavier, C. Marfan syndrome: new diagnostic criteria, same anesthesia care? Case report and review. Brazilian Journal of Anesthesiology 2014; 66(4): 408-413
15. Ghatak, T. Samanta, S. Samanta, S. Anesthetic management of a patient with Marfan syndrome and severe aortic root dilatation undergoing cholecystectomy and partial hepatic resection. Saudi Journal of Anaesthesia 2013; 7(4): 461-463
16. Wilson, W. Taubert, KA. Gewitz, M. Lockhart, PB. Baddour, LM. Levison, M et al. Prevention of infective endocarditis: guidelines from the American heart foundation. Circulation 2007; 116:1736-1754
17. NICE Guideline (CG64). Prophylaxis against infective endocarditis: antimicrobial prophylaxis against infective endocarditis in adults and children undergoing interventional procedures. National Institute for Health and Clinical Excellence 2008.
18. Lacassie, HJ. Millar, S. Leithe, LG. Muir, HA. Montana, R. Poblete, A et al. Dural ectasia: a likely cause of inadequate spinal anaesthesia in two parturients with Marfan's syndrome. British Journal of Anaesthesia 2005; 94:500-504
19. Kaye, CI. Sloan, TB. Marfan Syndrome. Bready, LL. Mullins, RM. Noorily, SH. Smith, RB (eds). Decision Making in Anesthesiology: An Algorithmic Approach. 4th ed. Missouri: Mosby; 2007. pp. 242-243
20. Kaissi, AA. Zwettler, E. Ganger, R. Schreiner, S. Klaushofer, K. Grill, F. Musculo-Skeletal Abnormalities in Patients with Marfan Syndrome. Clinical Medicine Insights: Arthritis and Musculoskeletal Disorders 2013; 6: 1-9
21. Bosenberg, MT. Bosenberg, AT. Anaesthesia for Marfan's Syndrome. Southern African Journal of Anaesthesia and Analgesia 2007; 13(4): 15-19
22. Radke, RM. Baumgartner, H. Diagnosis and treatment of Marfan syndrome: an update. Heart 2014; 100:1362-1391
23. Jones, AEP. Pelton, DA. An index of syndromes and their anaesthetic implications. Canadian Anaesthetists' Society Journal 1976; 23(2)

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

DELIRIUM IN A PATIENT ON EXTRACORPOREAL RESPIRATORY SUPPORT

PM Murphy, M Gimenez-Mila, A Vuylsteke

Abstract

A 23-year-old male patient was accepted to our Cardiothoracic Intensive Care Unit for respiratory support via Extracorporeal Membranous Oxygenation (ECMO), following acute onset respiratory failure due to suspected bronchopneumonia. During support, the patient presented a severe hyperactive delirium with aggressive behaviour that became a concern for his treatment team. In this case report, we discuss the patient's condition, the diagnosis and management of delirium in critically ill patients and the risks that a severe delirium can cause. Hyperactive delirium while on extracorporeal support is a hazardous condition demanding dynamic nursing and medical interventions.

Case History

A 23-year-old male patient was referred to our Cardiothoracic Intensive Care Unit for consideration of respiratory Extracorporeal Membranous Oxygenation (ECMO) due to worsening respiratory failure despite appropriate therapy and support including mechanical ventilation. He was a coffee-shop worker and smoker, without history of recent foreign travel or animal contact.

Previously fit and well, he presented with a 7 day prodrome of fever and cough, progressing to scant haemoptysis, unresponsive to antibiotics targeting community acquired pneumonia. He attended his local hospital following deterioration and was found to be in acute respiratory failure. Invasive mechanical ventilation was instituted but gas exchange remained poor. A CT chest showed interstitial bronchopneumonia, thereby implying a reversible cause to his deterioration.

In keeping with the indications set in the National Respiratory ECMO service specifications (1), the patient was subsequently referred to our specialist team who travelled to assess him. Following review, peripheral veno-venous ECMO was initiated on site, correcting his ventilation, and he was safely transferred to our specialist centre.

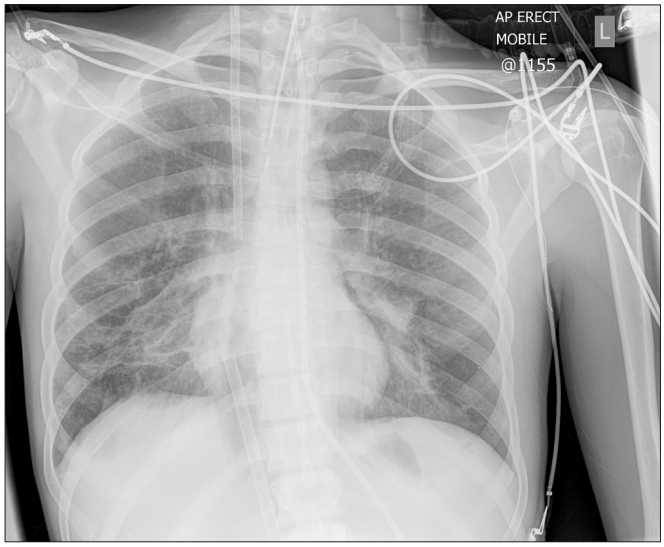


Figure 1: A chest x-ray at time of admission.

Investigation on arrival included a full body CT (Head, Thorax, Abdomen) and a broad infection screen, including sputum, urine, blood and bronchial alveolar lavage. Extensive PCR assays are used in these screens and indicated the possibility of a mycoplasma infection. An extensive autoimmune screen was negative.

While remaining intubated, ventilated and with extracorporeal support, he required continuous infusions of high dose propofol, midazolam, morphine, ketamine and clonidine to maintain adequate sedation. This was to prevent cough and dyssynchrony with the ventilator, which causes constant fluctuation in intrathroacic pressure, altering blood flow in the ECMO circuit and increasing the risk of circuit failure. We used the Richmond Agitation-Sedation Scale (RASS) to assess sedation levels, and in this case aimed a score of -4 or less (Deep Sedation - no response to voice, some response to physical stimulation; Table 1). He received antimicrobials, as well as high dose steroid to manage possible inflammatory pathologies.

Richmond Agitation-Sedation Scale		
Score	**Term**	**Description**
+4	Combinative	*Overtly combative or violent; immediate danger to staff*
+3	Very agitated	*Pulls on or removes tube(s) or catheter(s) or has aggressive behaviour toward staff*
+2	Agitated	*Frequent nonpurposeful movement or patient–ventilator dyssynchrony*
+1	Restless	*Anxious or apprehensive but movements not aggressive or vigorous*
0	Alert and Calm	
-1	Drowsy	*Not fully alert, but has sustained (more than 10 seconds) awakening, with eye contact, to voice*
-2	Light Sedation	*Briefly (less than 10 seconds) awakens with eye contact to voice*
-3	Moderate Sedation	*Any movement (but no eye contact) to voice*
-4	Deep Sedation	*No response to voice, but any movement to physical stimulation*
-5	Unrousable	*No response to voice or physical stimulation*

Table 1: The Richmond Agitation-Sedation Scale (20)

At 7 days, he received a tracheostomy to assist waking while still on respiratory support from ECMO. In keeping with local ECMO protocol, the patient was allowed to regain consciousness while being supported by ECMO. One of the most significant challenges of his day-to-day supportive management on ICU was the lack of attention and agitation he developed upon waking.

At worst, he would repeat questions to staff and become disoriented and distressed; he was uncooperative and at times aggressive during nursing interventions; he often refused to engage in medical and physiotherapeutic treatments, thereby delaying his overall recovery; and he persistently pulled at his lines in agitation, including his large-bore ECMO cannula and tracheostomy tube. The CAM-ICU score measured regularly by the bedside nurse was most often 'positive', indicating the presence of delirium.

DELIRIUM IN A PATIENT ON EXTRACORPOREAL RESPIRATORY SUPPORT

PM Murphy, M Gimenez-Mila, A Vuylsteke

In keeping with best practice, his delirium was managed by ensuring all potential causes were treated (i.e. fever, pain, medication-related) and by continuous orientation to time and space (with invaluable assistance from visiting relatives). Unsafe outbursts led to frequent pharmacological interventions to protect his self and staff from harm. At times, he would even require deep sedation with anaesthetic agents to ensure control.

After several weeks of treatment, his lung condition improved and he was eventually weaned from ECMO on day 49. He was repatriated to his initial hospital four days later. He had no apparent residual cognitive deficit on discharge from our unit.

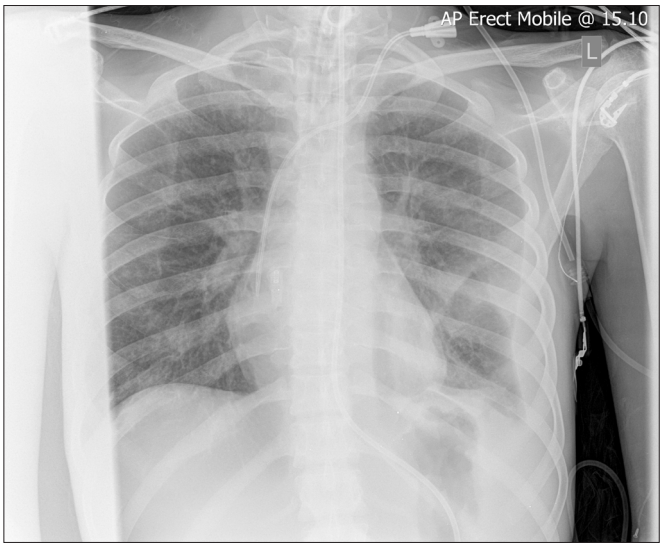


Figure 1b: Post-ECMO chest x-ray.

Discussion

Delirium is a clinical condition defined in International Classification of Diseases (ICD-10) as a temporary, fluctuant impairment in cognition and attention, often with secondary behavioural agitation (2). Patients, as well as becoming disoriented to time, place and person, may be un-cooperative and liable to emotional distress. It is classically subdivided into hypoactive, hyperactive or mixed. During hyperactive periods, particularly on ICU, an agitated delirious patient such as the above may engage in 'line pulling' – tugging on cannulas, catheters and other monitoring equipment. In any hospital setting, delirium has the potential to worsen clinical outcomes, increase mortality, prolong mechanical ventilation time and extend a hospital stay (3).

On the ICU in particular, morbidity occurs both directly (for example, by causing tissue damage and bleeding by improper line removal, or injury from impulsive and unsafe mobilisation) or indirectly (such as an impaired ability to properly monitor a patient). A potential risk to life can be easily extrapolated - a dislodged nasogastric tube or endotracheal tube compromising an airway or, in our ECMO patient, a displaced cannula causing either catastrophic haemorrhage or obstructed blood flow. It is a common finding that hypoactive delirium is the more prevalent subtype with greater long-term morbidity and mortality, though may be less clinically apparent and more often forgotten by the medical practitioner. (4,5)

Screening for delirium should be considered in all intensive care patients. It is part of the standard "ABCDEF" bundle of ICU management (6), where D represents "Delirium Monitoring and Management." A commonly adapted screening tool, and that used by our own trust, is the Confusion Assessment Method (CAM-ICU), developed in 1990 for bedside assessment of a rousable patient (RASS -3).

It uses a brief questionnaire to assess a patient's attention, cognition and consciousness (7). As fluctuation is an expected aspect of delirium, screening should be repeated daily. It is particularly helpful to detect those hypoactive deliriums that, despite being more prevalent, are less apparent to clinicians than the more disruptive hyperactive states. In addition, it helps in monitoring pharmacological management.

The incidence of delirium in critically ill patients has been estimated to be as much as 80% (8). A point prevalence study in the East of England Critical Care Network reported that around 20% of ICU patients have delirium at any given time-point, and that 29% of patients will develop delirium during their ICU stay (9).

Risk factors are numerous, and include host factors (e.g. age, sensory impairment, smoking, dementia), illness factors (e.g. fever and sepsis, metabolic disturbance, respiratory disease) and iatrogenic factors (e.g. immobilisation, medications, sleep disturbance) (3). Our patient, and indeed many of those on ECMO, accumulate several of these factors – with metabolic disturbance, respiratory disease, active infection, administration of certain classes of drugs (such as steroids or benzodiazepines) and immobilisation being almost inherent to the population (8).

DELIRIUM IN A PATIENT ON EXTRACORPOREAL RESPIRATORY SUPPORT

PM Murphy, M Gimenez-Mila, A Vuylsteke

Management of delirium is a vital element in the management of Critical Care patients. Non-pharmacological management is essential, such as frequent patient reorientation using clocks and noticeboards or controlling causative agents such as sleep disturbance, pain, medications, and minimising sedation. Simple measures such as ensuring the use of the patient's usual glasses or hearing aids, can be very beneficial in preventing sensory impairment and disorientation.

Inevitably, due to the risks outlined in our case, some patients will require pharmacological management of delirium for their own safety – most commonly, as conscious sedation. Natural variation between patients should be anticipated, and a trial of multiple agents is typically necessary.

The antipsychotic, haloperidol, is a common first line agent in managing delirium on both wards and ICU, as recommended by NICE Clinical Guidance in the UK (10). However, while effectively reducing the risk-to-self a delirious patient poses, it has not been shown to change the incidence or duration of delirium (11) and poses a risk to elderly patients through its extrapyramidal side-effects, and cardiology patients through its potential arrhythmogenic effect (12). Newer atypical antipsychotics, such as olanzapine, are increasing in popularity but are not currently a part of most national guidelines (10).

Benzodiazepines, particularly midazolam, and propofol are commonly used sedatives in Intensive Care, for a variety of indications. They similarly manage the behavioural concerns of a hyperactive delirium, but have the disadvantage of a significantly reduced level of consciousness. An evidence-based convention in most intensive care units is that a patient's time spent sedated and mechanically ventilated ought to be minimised, and this is particularly true of ECMO and respiratory compromise, as in our patient (13). There is, in addition, some evidence that these agents – especially midazolam - can in fact increase the risk of developing delirium in a cognitively-intact patient (11).

Alpha-2-agonists, such as clonidine, are used in critical care as hypotensive and analgesic agents. It is used in low doses to treat anxiety and delirium due to these sedative effects, mediated by central α_2-receptors in the Locus Coeruleus. Dexmedetomidine is a costly alternative – a member of the same class, but with greater α_2 specificity (α_2:α_1 binding ratio of 1600:1, compared to clonidine's 200:1) (15).

Clonidine may, however, have a lower incidence of unwanted side effects and might be better at inducing a "rousable sedation" – that is, a sedated state in which a patient awakens to verbal or tactile stimuli (15). Evaluations have suggested improved outcomes on certain measurements in the use of dexmedetomidine in delirium, when compared to placebo (16), lorazepam (17) or haloperidol (18).

While on ECMO, patients have increased sedation requirements, explaining the need for multiple infusions to maintain adequate sedation in this young critical ill patient. Explanatory theories include the increased volume-of-distribution due to the extracorporeal circuit and the contribution of the ECMO oxygenator to drug elimination, but evidence explaining the mechanisms of increased sedation requirement is limited (19).

Overall, this discussion exemplifies that delirium is a significant contribution to morbidity and that the risk factors of delirium are increased while on ECMO. In addition, the threat of a hyperactive state to patient wellbeing is amplified, and the drug metabolism state is complexly altered and only partially understood. Awareness of the diagnostics and management of delirium, as well as their daily practice, is vital for good patient care.

Multiple Choice Questions

1. Which of the following is the first-agent for management of hyperactive delirium in an intensive care setting?

a. Midazolam

b. Propofol

c. Haloperidol

d. Olanzapine

e. Clonidine

2. A 75 year old woman is receiving care in your hospital's Intensive Care Unit. In recent days, she has been noted to be agitated and has received midazolam to manage a suspected delirium. You are asked to assess this patient's conscious level. You call her name loudly, and she briefly raises her right hand in your direction. She does not open her eyes or respond verbally. What is her RASS Score?

a. 0 (Alert and calm)

b. -1 (Drowsy)

c. -2 (Light Sedation)

d. -3 (Moderate Sedation)

e. Cannot be determined from this information

DELIRIUM IN A PATIENT ON EXTRACORPOREAL RESPIRATORY SUPPORT

PM Murphy, M Gimenez-Mila, A Vuylsteke

3. What is the intended mechanism of action when administering clonidine to an agitated patient?

a. Central α_1 agonism

b. Central α_2 agonism

c. Peripheral α_1 agonism

d. Peripheral α_2 agonism

e. Mixed peripheral and central α^1 and α^2 agonist activities

4. Which of the following abbreviations represents an example of a screening tool for delirium in the intensive care setting?

a. APACHE-II

b. MMSE

c. RASS

d. CAM-ICU

e. IPAT

5. Which of the following is NOT a risk factor for delirium in a critically ill patient?

a. Immobilisation

b. Use of benzodiazepines

c. Depression

d. Young Age

e. Sleep Disturbance

Answers

1. C

As on a medical ward, the antipsychotic Haloperidol is the standard first line agent for the management of a hyperactive delirium on critical care, as per NICE Guidelines on the subject (CG 103). However, care should always be taken to ensure this is the appropriate agent for your patient. Elderly patients, or those at risk of extrapyramidal side effects (e.g. Parkinson's Disease) should never receive haloperidol due to its dopamine antagonism and potentiation of Parkinsonian Symptoms. Management of delirious patients is often preferred to be with conscious sedation, and a different agent may achieve this more easily for a given patient.

2. D

The patient is implied to be asleep on arrival, meaning she cannot be RASS 0. She has neither sustained (>10 sec, RASS -1) nor brief (<10 sec, RASS -2) eye contact during your assessment. She responds to voice with physical movement only, so is Moderately Sedated. Physical stimulation is not required to assess RASS score unless there is no response to voice present, so option E is incorrect.

3. B

Clonidine is a specific α_2-agonist (α_2:α_1 binding specificity of 200:1), useful for managing hypertension, pain and sedation. While having significant action in the peripheral nervous system, the question asked specifically about its action in agitation. The intention in that case is to achieve a degree of sedation, mediated by α_2-agonism at the Locus Coeruleus of the pons, involved in arousal, attention and behavior. Clonidine is beneficial in hypertension due to its peripheral α_2-agonism, causing venodilatation. Its role in pain medicine is complex, and likely involves central and peripheral mechanisms.

4. D

APACHE-II (Acute Physiology and Chronic Health Evaluation II) is a scoring system for severity-of-disease on Intensive Care Units. The Mini-Mental State Examination (MMSE) is a cognitive screening tool, more commonly used to detect dementia than delirium, and found most-often on medical wards and in the community. The Richmond Agitation-Sedation Score (RASS) allows assessment for changes in conscious level and agitation in ICU patients, but is not a screening tool and is not specific to delirium. The Intensive Care Psychological Assessment Tool (IPAT) is indeed a psychological assessment tool used on ICU, but is more appropriate to assess for acute distress (possibly contributory to future psychological morbidity) and not delirium.

The Cognitive Assessment Method-ICU (CAM-ICU) is the correct answer, and appropriately assesses time-course, attention, cognition and consciousness to allow diagnosis of delirium, and is sufficiently brief to be used as a daily screening tool.

DELIRIUM IN A PATIENT ON EXTRACORPOREAL RESPIRATORY SUPPORT

PM Murphy, M Gimenez-Mila, A Vuylsteke

5. D

Extracorporeal support is a risk factor for delirium, by correlating with metabolic and respiratory disturbance, introducing a number of independent risk factors such as immobilisation, and the associated risks of bacteraemia or infection due to its large indwelling vascular cannula which themselves predispose to delirium.

Benzodiazepines, despite being used to manage an agitated delirious patient, have been associated with delirium in previously cognitively intact critically ill patients.

Pre-existing depression, as well as cognitive impairment, sensory impairment, alcoholism or smoking, predisposes to the development of delirium during an intensive care admission.

Research into sleep disturbance is ongoing, but early results suggest a correlation between sleep deprivation and delirium, with some evidence suggesting a possible benefit from simple measures such as ear-plugs.

Being of a young age is not in itself a risk factor for delirium. Older patients are at higher risk, particularly those with a pre-existing dementia or other co-morbidities.

Author

Dr Piers M Murphy
FY2, Intensive Care Medicine
Papworth Hospital NHS Foundation Trust
Papworth Everard, Cambridge, CB23 3RE

Dr Marc Gimenez-Mila
Consultant in Anaesthesia and Intensive Care Medicine
Papworth Hospital NHS Foundation Trust
Papworth Everard, Cambridge, CB23 3RE
marc.gimenez@nhs.net

Dr Alain Vuylsteke
Consultant Intensivist
Papworth Hospital NHS Foundation Trust
Papworth Everard, Cambridge, CB23 3RE
a.vuylsteke@nhs.net

Corresponding Author

Dr Piers M Murphy
piers.murphy@nhs.net

References

1. NHS Commisioning Group (Now known as NHS England). Service Specification: 2013/14 NHS Standard Contract for Extra Corporeal Membrane Oxygenation Service for Adults with Respiratory Failure. NHS England, National Programmes of Care and Clinical Reference Groups D05. Adult Critical Care; 2013.
2. ICD 10. International statistical classification of diseases and related health problems. - 10th revision, Fifth edition, 2016. [Internet]. [cited 2017 Jan 29]. Available from: http://apps.who.int/classifications/icd10/browse/2016/en#/F05
3. Girard TD, Pandharipande PP, Ely EW. Delirium in the intensive care unit. Crit Care. 2008;12(Suppl 3):S3.
4. McPherson JA, Wagner CE, Boehm LM, Hall JD, Johnson DC, Miller LR, et al. Delirium in the Cardiovascular Intensive Care Unit: Exploring Modifiable Risk Factors. Crit Care Med. 2013 Feb;41(2):405–13.
5. Brown CH. Delirium in the Cardiac Surgical Intensive Care Unit. Curr Opin Anaesthesiol. 2014 Apr;27(2):117–22.
6. Ely EW. The ABCDEF Bundle: Science and Philosophy of How ICU Liberation Serves Patients and Families. Crit Care Med. 2017 Feb;45(2):321–30.
7. ICU Delirium and Cognitive Impairment Study Group [Internet]. [cited 2017 Jan 29]. Available from: http://www.icudelirium.org/
8. Dittrich T, Tschudin-Sutter S, Widmer AF, Rüegg S, Marsch S, Sutter R. Risk factors for new-onset delirium in patients with bloodstream infections: independent and quantitative effect of catheters and drainages—a four-year cohort study. Ann Intensive Care [Internet]. 2016 Dec [cited 2017 Jan 29];6(1). Available from: http://annalsofintensivecare.springeropen.com/articles/10.1186/s13613-016-0205-x
9. Giraud K, Vuylsteke A. Point-prevalence of delirium in intensive care units. Anaesthesia. 2014 Apr 1;69(4):394–394.
10. NICE Guidance. Delirium: prevention, diagnosis and management | Clinical Guidelines CG103 [Internet]. [cited 2017 Jan 29]. Available from: https://www.nice.org.uk/guidance/cg103/chapter/2-Notes-on-the-scope-of-the-guidance
11. McLaughlin M, Marik PE. Dexmedetomidine and delirium in the ICU. Ann Transl Med. 2016 Jun;4(11):224–224.
12. Witchel HJ, Hancox JC, Nutt DJ. Psychotropic drugs, cardiac arrhythmia, and sudden death. J Clin Psychopharmacol. 2003 Feb;23(1):58–77.
13. Shah FA, Girard TD, Yende S. Limiting sedation for patients with acute respiratory distress syndrome - time to wake up. Curr Opin Crit Care. 2017 Feb;23(1):45–51.
14. Girard T. Delirium in the intensive care unit [Internet]. [cited 2017 Jan 29]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2391269/
15. Miller RD, editor. Miller's anesthesia. Eighth edition. Philadelphia, PA: Elsevier/Saunders; 2015. 2 p.
16. Pandharipande PP, Pun BT, Herr DL, Maze M, Girard TD, Miller RR, et al. Effect of sedation with dexmedetomidine vs lorazepam on acute brain dysfunction in mechanically ventilated patients: the MENDS randomized controlled trial. JAMA. 2007 Dec 12;298(22):2644–53.
17. Reade MC, Eastwood GM, Bellomo R, Bailey M, Bersten A, Cheung B, et al. Effect of Dexmedetomidine Added to Standard Care on Ventilator-Free Time in Patients With Agitated Delirium: A Randomized Clinical Trial. JAMA. 2016 Apr 12;315(14):1460–8.
18. Reade MC, O'Sullivan K, Bates S, Goldsmith D, Ainslie WRSTJ, Bellomo R. Dexmedetomidine vs. haloperidol in delirious, agitated, intubated patients: a randomised open-label trial. Crit Care Lond Engl. 2009;13(3):R75.
19. Shekar K, Roberts JA, Mullany DV, Corley A, Fisquet S, Bull TN, et al. Increased sedation requirements in patients receiving extracorporeal membrane oxygenation for respiratory and cardiorespiratory failure. Anaesth Intensive Care. 2012 Jul;40(4):648–55.
20. Sessler CN, Gosnell MS, Grap MJ, Brophy GM, O'Neal PV, Keane KA, et al. The Richmond Agitation-Sedation Scale: validity and reliability in adult intensive care unit patients. Am J Respir Crit Care Med. 2002 Nov 15;166(10):1338–44.
21. E. Wesley Ely. Confusion Assessment Method in the ICU (CAM-ICU): The Complete Training Manual [Internet]. ICU Delirium and Cognitive Impairment Study Group, Vanderbilt University Medical Center; 2016 [cited 2017 Jan 30]. Available from: http://www.icudelirium.org/docs/CAM_ICU_training.pdf

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

POST CARDIO-PULMONARY RESUSCITATION CARE - A SYSTEMS BASED REVIEW

K Mead, G Glover

Abstract

Cardiac arrest remains a common clinical scenario both in and out of hospital; every year 30,000 people suffer an out of hospital cardiac arrest (OHCA). Whilst resuscitation science is evolving, the prognosis for this patient group remains poor and there is a need for the reliable application of our current knowledge as well as further research. In this article we look at their ongoing management, usually in an intensive care setting, after the return of spontaneous circulation.

Post resuscitation care will be discussed using the ABCD framework, emphasising the key priorities of establishing a secure airway, lung protective mechanical ventilation with optimisation of blood gases and cardiovascular investigation and stabilisation. The prevention of secondary brain, injury with particular reference to temperature management is emphasised, as well as discussing the challenging issue of neuro-prognostication, with a strategy for the multi-modal assessment of the comatose patient.

Introduction

As a Foundation Years doctor it is likely that you will be involved in the cardio-pulmonary resuscitation (CPR) of a patient who suffers cardiac arrest (CA) in hospital. The overall prognosis from CA remains poor. For OHCA patients who are admitted alive but comatose to the Intensive Care Unit (ICU), survival with good neurological outcome is around 50%, whilst for in hospital cardiac arrest (IHCA), survival to discharge is less than 20% (1).

The ALS algorithm is well known and extensively taught to Foundation Years doctors. The steps taken following the return of spontaneous circulation (ROSC), the first on the road to recovery, are also very important, and may make a significant difference to a patient's overall prognosis. However, because post resuscitation care usually occurs in the ICU, it may be less well understood by foundation doctors.

The treatment and support required by a patient following ROSC will vary according to the precipitating cause of the arrest and their resulting condition. Patients will require close monitoring and many will require multiple organ support, in order to optimise their recovery. In this article we have outlined the key management priorities for these patients in an 'ABCD' framework. Figure A summarises the points that are expounded throughout the article, taken from the Resuscitation Council (UK) post-resuscitation care guidelines (1).

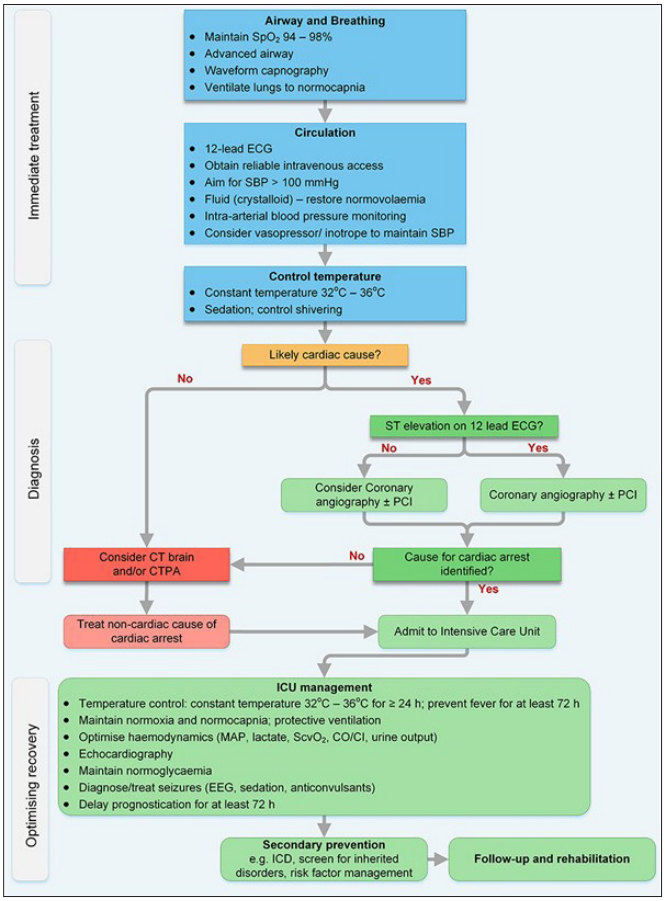


Figure A: Reproduced with the kind permission of the Resuscitation Council (UK) (1)

A – AIRWAY

First and foremost, it is essential that, in a patient with a significantly impaired conscious level following a cardiac arrest, a definitive, subglottic airway should be secured using an endotracheal tube (ETT), by a clinician with appropriate airway training, usually an anaesthetist. If there is any suspicion of trauma, appropriate C-spine precautions should be maintained. Correct placement must be confirmed with equal bilateral air entry on auscultation and waveform capnography.

A chest x-ray should be performed to confirm optimal ETT placement as well as ruling out major pulmonary pathologies (see Breathing below). Having a definitive airway will then allow the patient to be safely transferred, reduce the risk of aspiration, and allow mechanical ventilation (MV) to be managed. Endotracheal intubation may not be required only if the arrest is very brief, the patient regains full consciousness, and is able to maintain their airway. However, this should be repeatedly assessed, as protection of the airway is paramount.

POST CARDIO-PULMONARY RESUSCITATION CARE - A SYSTEMS BASED REVIEW

K Mead, G Glover

B – BREATHING

The control of ventilation and oxygenation following cardiac arrest is very important, and should be monitored closely using peripheral capillary oxygen saturation (SpO_2), partial pressure of carbon dioxide (CO_2) at the end of an exhaled breath (ET CO_2), and arterial blood gas analysis (ABGs). For patients who do not require intubation, the delivery of oxygen via a facemask following a brief period of cardiac arrest is generally considered standard practice. All others will require invasive mechanical ventilation.

Both hypoxaemia and hypercapnia are undesirable as they can increase the possibility of another cardiac arrest and secondary brain injury. It is also important to be aware of the potential harm that hyperoxia can cause soon after ROSC, due to oxidative stress and damage to post-ischaemic neurones (2). Hyperoxia in the post resuscitation period has been shown to be associated with a worse neurological outcome (3).

Whilst it is expected that high concentrations of O_2 will be administered during CPR, once reliable monitoring of blood oxygen saturation is established (using ABGs and /or pulse oximetry), the FiO_2 should be titrated with the aim of maintaining saturation in the range of 94-98%. Overventilation, leading to hypocapnia may also have the potential to worsen neurological outcome by causing harmful cerebral vasoconstriction. Hypocapnia itself causes a left shift in the oxygen-haemoglobin dissociation curve, which increases the haemoglobin's affinity for oxygen, in turn worsening oxygen delivery to the tissues.

It is advisable to adopt a lung protective ventilator strategy, with tidal volumes of 6-8 mL kg-1 ideal body weight and positive end expiratory pressure (4,5), and through careful monitoring of ABGs aim for normocapnia (normal range PaCO2 40-45 mmHg) (6). Patients with tracheal intubation will usually require sedation (see Disability below) in order to facilitate ETT tolerance and controlled MV as well as to reduce their oxygen consumption.

A chest radiograph (CXR) should be obtained to detect any rib fractures (and potential pneumothorax) resulting from CPR, pulmonary oedema or possible aspiration. Impaired ventilation can also arise from gastric distension caused by artificial ventilation, which acts to 'splint' the diaphragm. This can be overcome by inserting a naso-gastric tube (NGT) to decompress the pressure in the stomach and which can also be used for administration of enteral drugs and later for enteral nutrition. The CXR will also assess the position of the NGT, as well as the ETT and central venous lines if sited (see Circulation below).

Should we give antibiotics?

Aspiration pneumonia is a common complication following cardiac arrest; present in between 20-60% of patients. Identification of infection is often difficult due to inadequate emergency chest radiography, non-specific increase in inflammatory markers and targeted temperature management (TTM) masking pyrexia. There is evidence to suggest that early prophylactic administration of antibiotics reduces the occurrence of pneumonia, improves survival and shortens overall ICU stay (7,8,9) and it is standard practice in our institution to give 3 days of co-amoxiclav (provided not allergic). Figure B below shows typical radiological changes associated with aspiration pneumonia.

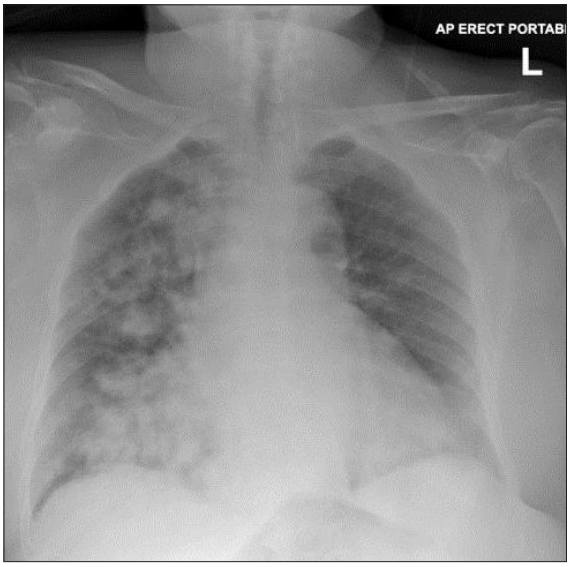


Figure B
http://www.svuhradiology.ie/case-study/aspiration-pneumonia/

C - CIRCULATION

Following ROSC patients can suffer haemodynamic instability due to myocardial dysfunction, a Systemic Inflammatory Response Syndrome (SIRS) related to ischaemia-reperfusion and aspiration, or the adverse effects of positive pressure ventilation and sedation. This can result in arrhythmias, a low cardiac output, loss of systemic vascular resistance and vasodilatation with resulting hypotension and end organ hypoperfusion (shock) (10,11). Therefore, it is important that these patients have stringent monitoring including blood pressure via an arterial line, continuous ECG, SpO_2, hourly urine output and the assessment of central venous oxygen saturation and plasma lactate.

Bedside screening echocardiography should be performed to identify major pathologies such as right and left ventricular size and function, global or regional wall motion abnormalities, significant valve lesions or pericardial collection, as well as filling status. For patients with significant cardiovascular instability, requiring vasoactive drugs, or with evidence of end organ hypoperfusion that does not rapidly improve post ROSC, cardiac output monitoring may be helpful to guide therapy.

An intravenous fluid bolus, for example with a physiological crystalloid (e.g. Hartmanns solution) is a reasonable first line therapy for hypotension, provided there is no overt evidence of pulmonary oedema, and this is usually well tolerated. Vasoactive drugs should be tailored to the haemodynamic profile with inotropes considered if there is evidence of impaired contractility with a low cardiac output state, and vasopressors preferred if there is evidence of pathological vasodilatation.

POST CARDIO-PULMONARY RESUSCITATION CARE - A SYSTEMS BASED REVIEW

K Mead, G Glover

There may be adverse effects from these drugs including an increase in myocardial oxygen demand, dysrhythmias or over vasoconstriction, so they should be used cautiously and titrated to modest physiological goals. In terms of blood pressure targets, the evidence suggests that hypotension should be treated with the aim of restoring a systolic blood pressure (SBP) of > 100mmHg (12) and cardiovascular optimisation should target a urine output of 0.5-1ml/kg/hr-1 and normal or falling serum lactate levels.

Consider the Aetiology of the Cardiac Arrest

Following the immediate assessment of ABC and correction of rapidly life threatening abnormalities, it is important to consider the aetiology of the cardiac arrest. The history of the presenting complaint from bystanders and the ambulance crew is key, as well as taking the patients' past medical history, drug history and pre-existing risk factors into consideration e.g. high blood pressure, diabetes, known coronary disease, recreational drug ingestion, QT prolonging medications, or a family history of sudden death.

Acute coronary syndrome (ACS) is a common cause for OHCA, with an acute coronary lesion identified in 59-71% of patients who did not have an identifiable non-cardiac cause (13). In patients with new left bundle branch block (LBBB) or ST elevation on their post ROSC ECG this is thought to be even higher, with 80% having an acute coronary lesion (14). For patients with ST elevation / LBBB, early invasive management with angiography and percutaneous coronary intervention (PCI) is appropriate, immediately after their initial resuscitation period, regardless of their level of consciousness.

The use of emergent angiography and PCI in patients who do not have any ST elevation or new LBBB is more controversial. It has been shown that in patients with an absence of these specific ECG changes, ACS might still be present, especially when they are deemed to have a high cardiac risk. A recent systemic review has shown that 32% of patients who did not have ST elevation on their post ROSC ECG had an acute occult lesion that required intervention (15). Further research is required in this area.

It is also important to consider non-cardiac causes of cardiac arrest e.g. respiratory (pulmonary embolus), neurological (intracranial bleed) or sepsis and in the absence of a primary cardiac cause, a brain and chest CT scan should be performed.

D – DISABILITY

Neuroprotection

Hypoxic brain injury following cardiac arrest is prevalent with up to two thirds of patients admitted to critical care after an OHCA dying from neurological injury (16). It is therefore very important to understand how to minimise this with specific neuroprotective measures. Following ROSC after cardiac arrest there is a period of impaired autoregulation of cerebral blood flow with cerebral hypoperfusion for up to 24 hours (1).

Cerebral perfusion has been shown to vary with cerebral perfusion pressure rather than neuronal activity (17) and therefore it is key to maintain the patient's mean arterial pressure (MAP) near their normal, pre morbid level (18), whilst venous congestion should be minimised with elevation of the head of the bed.

The monitoring and control of blood glucose levels in patients following ROSC is important and many patients will require an insulin infusion, regardless of pre-existing diabetes. Both hyperglycaemia and glycaemic variability are associated with increased mortality (19).

Drugs - Sedation and Seizures - what should we use?

Sedation should be considered routine in patients following ROSC in order to reduce cerebral oxygen consumption. In addition, this will aid ETT tolerance, controlled ventilation, patient comfort and temperature control. The choice of sedative should be considered carefully; a combination of opiates and hypnotics is common and these should be selected in terms of their mechanism and length of action.

Shorter acting drugs are preferred e.g. propofol and remifentanil, as they are associated with a shorter offset time and allow more effective sedation interruptions for prognostication (20,21). Neuromuscular blockade is occasionally required, however it can mask seizure activity in the post cardiac arrest patient. Care must be taken because sedation can accumulate, especially when metabolism is reduced by hypothermia.

Continuous electroencephalography (EEG) has been recommended to identify possible seizures although is not widely available. Seizures occur in one third of patients who remain comatose following ROSC, the most common being myoclonic (22,23). The prophylactic use of antiepileptic drugs (AEDs) is not routine, however, if seizures occur they should be treated aggressively with agents such as sodium valproate, levetiracetam or phenytoin to reduce further secondary brain injury (1).

Temperature Management

It has previously been shown that mild induced hypothermia was associated with improved neurological outcome following out of hospital cardiac arrest with a shockable rhythm. Cooling may be protective via a number of mechanisms including reductions in cerebral metabolic oxygen requirement and the inflammatory / neuro-excito-toxic cascade, leading to a decrease in cerebral oedema and intra-cranial pressure (24).

Previous recommendations were to manage the temperature at between 32-34°C, however a large study has now shown that there is no significant difference in mortality or long term neurological outcomes between cooling a patient to 33°C versus maintaining sub-febrile normothermia at 36°C (25). The temperature of 36°C also has the advantage that it exposes the patient to fewer of the potential hazards of hypothermia (see below). Because of this the phrase targeted temperature management (TTM) is preferred to that of therapeutic hypothermia.

POST CARDIO-PULMONARY RESUSCITATION CARE - A SYSTEMS BASED REVIEW

K Mead, G Glover

It is important to understand in which patients TTM should be considered. The International Liaison Committee on Resuscitation recommends TTM for adults after OHCA with an initial shockable rhythm, and it is suggested for patients with non-shockable rhythm and following IHCA with who remain unresponsive after ROSC. It is suggested that TTM 32-36°C lasts at least 24 hours (1).

How do we achieve TTM

TTM can be divided into induction, maintenance, re-warming and fever control phases. Cold IV fluid boluses have been associated with increases in re-arrest and should only be considered in hospital under controlled conditions (26). Cooling can be achieved by either internal or external methods. Surface cooling can be achieved using ice packs, wet towels, cooling pads and air circulating blankets. Internal cooling methods are endovascular heat exchangers, usually placed in the femoral vein (1) or by performing gastric, bladder or bowel lavage. Internal cooling devices may allow more precise temperature control (27).

Temperature Management Pitfalls - What to Look Out For

TTM may lead to side effects that necessitate close monitoring and management. Even mild hypothermia can cause patients to shiver, indicative of a normal physiological response. However this increases metabolic rate and oxygen consumption, as well as generating heat, and so may require management with sedation. Hypothermia decreases insulin sensitivity and is associated with hyperglycaemia that commonly requires treatment with insulin. Mild hypothermia can also result in electrolyte abnormalities and diuresis. There may be an association with an increased incidence of pneumonia (28,29), again supporting a potential benefit of prophylactic antibiotics in this population.

Prognostication

As previously outlined, death from neuronal injury is common and the majority of these deaths occur following a decision for withdrawal of life sustaining treatment (30,31). In order to avoid inappropriate withdrawal of treatment, tests used for neuro-prognostication need to have a low false positive rate, be free of bias and not allow interference by the co-administration of sedatives, neuromuscular blocking agents or TTM (32). It has therefore been suggested that a multimodal approach should be adopted, with tests carried out no earlier than 72 hours following cardiac arrest and after full elimination of any sedative agents.

These tests can be divided into four discrete categories: clinical examination – (Glasgow Coma Scale (GCS), pupillary response to light, corneal reflex, presence of seizures); neurophysiological studies (EEG, Somatosensory evoked potentials (SSEP)); biochemical markers (Neuron-specific enolase (NSE)); and imaging studies (CT / MRI brain).

Daily clinical neurological examination should be carried out to assess for any signs of improvement and, when dealing with an outcome that is uncertain, prognostication should be delayed. It has been suggested that most survivors will wake up within one week, although it has been known to take up to 25 days (1). The prognostication strategy algorithm detailed in Figure C summarises the key steps that need to be undertaken, as published in the Resuscitation Council (UK) post-resuscitation care guidelines (1).

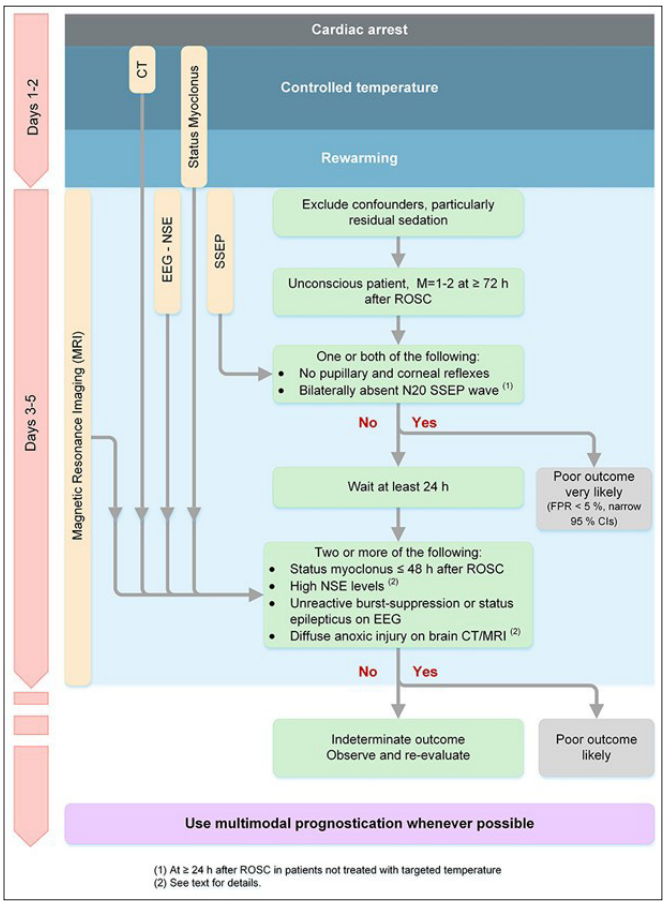


Figure C: Reproduced with the kind permission of the Resuscitation Council (UK) (1)

If a decision has been made to withdraw life sustaining treatment, the possibility of organ donation should be considered. The early involvement of a specialist nurse in organ donation (SNOD) in patients who are potential candidates is important to ensure appropriate donor family involvement and counselling, and in turn help to expedite successful organ retrieval.

POST CARDIO-PULMONARY RESUSCITATION CARE - A SYSTEMS BASED REVIEW

K Mead, G Glover

Conclusion

Post resuscitation care requires methodical patient assessment, continuous monitoring, and the meticulous application of organ support based on basic physiological principles as well as an evolving evidence base. Close liaison with other specialists including cardiologists, neurologists and radiologists as well as the ICU multi-disciplinary team are essential to provide the right care at the right time. With the provision of optimal management in post resuscitation care, the 'chain of survival' may be completed, offering the best outcome to patients and their families

MCQ's – (Best of five)

1. Regarding airway management, which of the following statements is not true?

1. C spine precautions should be maintained if trauma is suspected.
2. A supraglottic airway (LMA / iGel) is satisfactory for on going airway management in the ICU
3. ETT placement is best confirmed with waveform capnography.
4. An endotracheal tube will help reduce the risk of aspiration.
5. The presence of an ETT commonly requires the use of sedative medication

2. Which of the following statements is best, regarding the administration of O_2?

1. 100% O_2 during CPR and continue post ROSC to maximise O_2 delivery to vital organs
2. 100% O_2 during CPR and reduce once adequate SpO_2 / ABG monitoring established, targeting SaO2 88-92%, because they may have COPD and may be hypercapnic
3. 100% O_2 during CPR and reduce immediately once ROSC achieved
4. 100% O_2 during CPR and reduce once adequate SpO_2 / ABG monitoring established, targeting SaO_2 94-98%
5. Reduced O_2 during CPR and continued post ROSC in case of risk of hyperoxia

3. Which of the following is not true relating to neuro protection in post ROSC comatose patients?

1. Nurse the patient in the head up position.
2. Normoglycaemia is advised.
3. Seizure prophylaxis is not advised routinely.
4. Neuro-muscular blocking drugs prevent the patient from shivering and are recommended
5. Mean arterial pressure should be maintained close to the patient's normal

4. With relation to Targeted temperature management (TTM), in comatose patients which of the following statements is not true?

1. With every one degree Celsius reduction in temperature, the brain's cerebral metabolic rate decreases by 6%.
2. Cold IV fluid boluses should be routinely used for induction of hypothermia
3. Endovascular cooling is associated with more precise temperature control than surface cooling
4. Hypothermia decreases insulin sensitivity.
5. Hypothermia may be associated with an increased incidence of pneumonia.

5. With regards to prognostication in comatose patients following cardiac arrest, which of the following is true?

1. Most patients who die following admission to the ICU after OHCA, do so of their underlying cardiac disease
2. A low false positive rate is more important than a low false negative rate for tests used in neuro-prognostication
3. A decision on neurological prognosis can usually be made within 72 hours after cardiac arrest.
4. Daily neurological examination is of limited value compared to expensive tests
5. The co-administration of sedatives has been shown to have no effect on neuro-prognostication, provided short acting drugs are used.

Answer

Answer 1

The statement that is not true is 2 – a definitive subglottic airway is recommended in patients with reduced conscious level.

Answer 2

The statement that is best supported by the evidence and guidelines is 4, FiO_2 should be titrated with the aim of maintaining SaO_2 in the range of 94-98%.

Answer 3

The statement that is false is 4 – whilst NMBDs do stop shivering and the external manifestations of seizures, they do not prevent neuronal seizure activity and therefore may mask the identification of this problem. They should therefore be used with great caution.

Answer 4

The statement that is false is 2 – Cold IV fluids may be associated with pulmonary oedema and an increase in re-arrest and are no longer routinely recommended.

Answer 5

The only statement that is true is 2 - a test that gives a false positive for the prediction of hypoxic brain injury may lead to the premature or inappropriate withdrawal of life sustaining treatment. A false negative will usually lead to continuation of treatment and reassessment over time.

POST CARDIO-PULMONARY RESUSCITATION CARE - A SYSTEMS BASED REVIEW

K Mead, G Glover

Author

Dr Kate Mead MBChB
Acute Care Common Stem ñ Emergency Medicine Stream Specialist Trainee Year 2, Guys and St Thomasí Hospital, Westminster Bridge Road, Lambeth, London, SE1 7EH

Dr Guy Glover. MBChB, FRCA, FFICM, DICM
Consultant in Critical Care and Anaesthetics.
Guys and St Thomasí Hospital, Westminster Bridge Road, Lambeth, London, SE1 7EH
guy.glover@gstt.nhs.uk

Corresponding Author

Dr Kate Mead
kate.mead@gstt.nhs.uk

Glossary of abbreviations used in Figure A and B – otherwise not described in article itself.

CTPA – Computerised tomography pulmonary angiogram
ICD – Implantable cardiac defibrillator

References

1. Nolan J, Deakin C, Lockey A, Perkins G, Soar J. Post resuscitation care guidelines. Resuscitation Council UK. Online guideline 2015 https://www.resus.org.uk/resuscitation-guidelines/post-resuscitation-care.
2. Pilcher J, Weatherall M, Shirtcliffe P, Bellomo R, Young P, Beasley R. The effect of hyperoxia following cardiac arrest - A systematic review and meta-analysis of animal trials. Resuscitation 2012;83:417-22.
3. Wang CH, Chang WT, Huang CH, et al. The effect of hyperoxia on survival following adult cardiac arrest: a systematic review and meta-analysis of observational studies. Resuscitation 2014;85:1142-8
4. Sutherasan Y, Penuelas O, Muriel A, et al. Management and outcome of mechanically ventilated patients after cardiac arrest. Crit Care 2015;19:215.
5. Slutsky AS, Ranieri VM. Ventilator-induced lung injury. N Engl J Med 2013;369:2126-36.
6. Helmerhost HJF Roos-Blom M-J, Van Westerloo D, Abu-Hanna A, de Keizer N and de Jonge E. Associations of arterial carbon dioxide and arterial oxygen concentrations with hospital mortality after resuscitation from cardiac arrest. Critical Care; 2015: 19: 384
7. Hellenkamp K Onimischewski S, Kruppa J, et al. Early pneumonia and timing of antibiotic therapy in patients after non-traumatic out-of hospital cardiac arrest. Critical Care 2016; 20:31
8. Davies K J, Walters J H. Early antibiotics improve survival following out-of hospital cardiac arrest. Resuscitation 2013; 84:616-619
9. Gagnon DJ, Nielsen N, Fraser GL, et al. Prophylactic antibiotics are associated with a lower incidence of pneumonia in cardiac arrest survivors treated with targeted temperature management. Resuscitation 2015;92:154-159
10. Laurent I, Monchi M, Chiche JD, et al. Reversible myocardial dysfunction in survivors of out-of-hospital cardiac arrest. J Am Coll Cardiol 2002;40:2110-6.
11. Bro-Jeppesen J, Annborn M, Hassager C, et al. Hemodynamics and vasopressor support during targeted temperature management at 33 degrees C Versus 36 degrees C after out-of-hospital cardiac arrest: a post hoc study of the target temperature management trial*. Crit Care Med 2015;43:318-27.
12. Young-Min, K. Kyu Nam, Seung Pill, et al. Post-cardiac arrest care: 2015 Korean Guidelines for Cardiopulmonary Resuscitation. Clinical and Experimental Emergency Medicine. 2016 Jul: 3 (Suppl): S27-S38
13. Larsen JM, Ravkilde J. Acute coronary angiography in patients resuscitated from out-of-hospital cardiac arrest--a systematic review and meta-analysis. Resuscitation 2012;83:1427-
14 Garcia-Tejada J, Jurado-Roman A, Rodriguez J, et al. Post-resuscitation electrocardiograms, acute coronary findings and in-hospital prognosis of survivors of out-of-hospital cardiac arrest. Resuscitation 2014;85:1245-50.
15. Millin MG, Comer AC, Nable JV et al. Patients without ST elevation after return of spontaneous circulation may benefit from emergent percutaneous intervention: A systematic review and meta-analysis. Resuscitation 2016; 108: 54-60
16. Laver S, Farrow C, Turner D, Nolan J. Mode of death after admission to an intensive care unit following cardiac arrest. Intensive Care Med 2004;30:2126-8.
17. Sundgreen C, Larsen FS, Herzog TM, Knudsen GM, Boesgaard S, Aldershvile J. Autoregulation of cerebral blood flow in patients resuscitated from cardiac arrest. Stroke 2001;32:128-32.
18. Deakin CD, Nolan JP, Soar J, et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 4. Adult advanced life support. Resuscitation 2010;81:1305-52
19. Borgquist O, Wise M, Nielson et al . Dysglycaemia, glycaemic variability and outcome after cardiac arrest and temperature management at 33 °C and 36 °C. Critical Care Med.2017 Currently in press.
20. Bjelland, T Dale. O. Kaisen, et al. Propofol and Remifentanil Versus Midazolam and Fentanyl for Sedation During Therapeutic Hypothermia After Cardiac Arrest: A Randomised Trial. Intensive Care Med 38 (6), 959-967. 2012 Apr 12
21. Gillies, M. Pratt,R. Borg, J. Brooks, J. Mckenzie, C. Tibby, S. 'Does choice of sedative agent affect duration of ICU stay, mortality or neurological outcome in patients undergoing therapeutic hypothermia?' Critical Care 2009, 13:P400
22. Bouwes A, van Poppelen D, Koelman JH, et al. Acute posthypoxic myoclonus after cardiopulmonary resuscitation. BMC Neurol 2012;12:63.
23. Seder DB, Sunde K, Rubertsson S, et al. Neurologic outcomes and postresuscitation care of patients with myoclonus following cardiac arrest. Crit Care Med 2015;43:965-72.
24. Polderman K. Mechanisms of action, physiological effects, and complications of hypothermia Critical Care Med 2009 Jul;37(7 Suppl):S186-202
25. Nielsen N, Wetterslev J, Cronberg T, et al. Targeted temperature management at 33 degrees C versus 36 degrees C after cardiac arrest. N Engl J Med 2013;369:2197-206.
26. Kim F, Nichol G, Maynard C, et al. Effect of Prehospital Induction of Mild Hypothermia on Survival and Neurological Status Among Adults With Cardiac Arrest A Randomized Clinical Trial. JAMA. 2014;311(1):45-52.
27. Glover, G. Thomas, R. Vamvakas, et al. Intravascular versus surface cooling for targeted temperature management after out of hospital cardiac arrest – an analysis of the TTM trial data. Critical Care (2016) 20:381
28. Perbet S, Mongardon N, Dumas F, et al. Early-onset pneumonia after cardiac arrest: characteristics, risk factors and influence on prognosis. Am J Respir Crit Care Med 2011;184:1048-54.
29. Mongardon N, Perbet S, Lemiale V, et al. Infectious complications in out-of-hospital cardiac arrest patients in the therapeutic hypothermia era. Crit Care Med 2011;39:1359-64.
30. Laver S, Farrow C, Turner D, Nolan J. Mode of death after admission to an intensive care unit following cardiac arrest. Intensive Care Med 2004;30:2126-8.
31. Dragancea I, Rundgren M, Englund E, Friberg H, Cronberg T. The influence of induced hypothermia and delayed prognostication on the mode of death after cardiac arrest. Resuscitation 2013;84:337-42.
32. Samaniego EA, Mlynash M, Caulfield AF, Eyngorn I, Wijman CA. Sedation confounds outcome prediction in cardiac arrest survivors treated with hypothermia. Neurocrit Care 2011;15:113-9.

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

INTRA-OPERATIVE CELL SALVAGE

A Roopra, L Rahman, R Khan, A Kumar

Introduction

Blood is a finite and expensive resource, dependent on the amount of blood voluntarily provided by blood donors. In 2014-15 NHS Blood and Transplant issued 1.7 million units of red blood cells with an estimated mean cost of £122 per unit (1).

Allogenic (donor) blood transfusions have a number of well documented potential complications such as anaphylaxis, haemolytic transfusion reactions, acute lung injury, fluid overload and transmission of pathogens. In already critically ill patients, allogenic transfusions have been seen to increase the length of time requiring mechanical respiratory support as well as multi-organ dysfunction (2).

Avoiding these complications means having to avoid allogenic blood transfusions, which may be difficult due to a limited number of alternatives available. One of these alternatives, is the use of autologous blood transfusion, i.e. transfusing back one's own blood. This can be done intra-operatively using a technique called cell salvage. Infact, NICE guidance recommends use of intra-operative cell salvage in suitable patients as a way of reducing cost, making the best use of a limited resource, as well as avoiding unnecessary blood transfusions and their associated risks (1).

What is cell salvage?

Autologous blood transfusion involves collection and reinfusion of the patients own red cells. It can be broadly divided into four categories (3):

i) Preoperative autologous donation (PAD): red cells are collected from the patient before an elective procedure.

ii) Acute normovolaemic haemodilution (ANH): several red cell units are collected from the patient immediately before their surgery and their blood volume is restored with intravenous fluids. Reinfusion of red cells occurs at the end of surgery if there has been significant blood loss.

iii)Post-operative cell salvage (PCS): blood is collected from wound drains post-operatively, filtered, washed and reinfused back into the patient.

iv)Intraoperative cell salvage (ICS) (Figure 1)

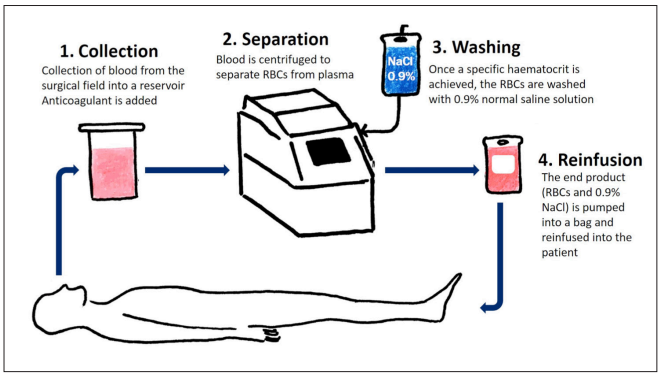


Figure 1: Processes involved in cell salvage

Who should cell salvage be used for?

Cell salvage is recommended in anyone whose intraoperative blood loss is expected to be greater than a litre or 20% of their blood volume. Often it is seen in major cardiothoracic, vascular and orthopaedic cases.

Patients with rare antibodies are good candidates for cell saver as there may be difficulties locating blood or acquiring large amounts of blood for these patients.

Similarly, patients with low haemoglobin pre-operatively or patients at a predisposition to increased bleeding may require large amounts of blood transfused and it is therefore wise to minimise the use of allogenic blood.

As healthcare workers, the autonomy of a patient must be maintained and a patient's refusal of an allogenic blood transfusion is a situation that may arise. For example, Jehovah's Witnesses regard blood as sacred and often decline transfusion of donor blood, including red cells, white cells, platelets and plasma. Cell salvage can be discussed with this cohort of patients and an informed decision can be made pre-operatively. Although individual opinion will vary, Jehovah's Witnesses are often accepting of cell salvage as long as it is set up as a continuous circuit running alongside their own circulation.

Special consideration needs to be taken in some circumstances when using cell saver. The first of these is obstetrics. Historically, there has been concern with the risk of amniotic fluid embolism which previously limited cell saver's use. However, there have been no documented cases of this phenomena and its use in obstetrics has been approved by NICE (4), Confidential Enquiry into Maternal and Child Health (CEMACH) (5) and the Joint Association of Anaesthetists of Great Britain and Ireland/Obstetric Anaesthetists Association (AAGBI/OAA) (6).

In pregnancies where there is a Rh negative mother and Rh positive foetus there is risk of Rh sensitisation if the mother is exposed to foetal red cells which can result in haemolytic disease of the newborn affecting subsequent pregnancies. In these cases, all Rh negative mothers will undergo Kleihauer testing immediately post-partum and be given Anti-∂ immunoglobulin (7).

INTRA-OPERATIVE CELL SALVAGE

A Roopra, L Rahman, R Khan, A Kumar

The second of these special circumstances is the use of cell salvage in bowel surgery where there is contamination of collected blood. The UK cell salvage group recommends in these cases where there may be a clinical need to use cell salvage that there should be initial evacuation of the soiled abdominal contents, additional washing and use of broad spectrum antibiotics (7).

Who should cell salvage be avoided in?

It is recommended by the cell salvage manufacturers that its use should be avoided in patients who are known to have red blood cell disorders such as sickle cell disease and sickle cell trait.

It is also recommended that cell saver should be avoided in the use of cancer surgery due to risk of malignant cells being collected and transfused back into the patient. However, evidence suggests there is no increased risk of disease recurrence in patients that have received cell saver blood during cancer operations and as a result NICE has approved the use of cell saver for urological malignancy cases (8).

Advantages	Disadvantages
Avoids adverse effects associated with allogenic blood transfusions	Initial equipment cost and training
Provides blood for patients with rare blood antibodies	Cost of disposable items per use
Cost-effective and preserves use of limited donor blood from blood banks	Complex device with own complications
Acceptable option for some Jehovah's Witnesses	Blood may contain debris and micro-aggregates

Table 1: Advantages and disadvantages of cell salvage.

Summary

Cell salvage is becoming increasingly popular in orthopaedic, cardiothoracic, vascular and obstetric procedures where blood loss is common. In the UK 53% of all hospitals now use intraoperative cell salvage (6). It is an important alternative to donor blood transfusions which are a scarce commodity and associated with a bigger financial burden to the NHS.

Cell salvage avoids the well documented complications associated with allogenic blood transfusion as well as providing a viable alternative for patients with difficult to source blood e.g. with antibodies; or a potential option for patients that previously refused allogenic blood transfusion e.g. Jehovah Witnesses.

Whilst cell salvage should be considered for most patients, it is important to remember that not all patients are candidates for autologous transfusions, such as those with red cell disorders or the majority of those with malignancy.

However, cell salvage is a long term cost effective alternative to allogenic blood transfusions and its role in peri-operative management is growing due to its advantages.

Test yourself

Please select one option for each of these questions.

1) The cost of a unit of blood is roughly:

a. £15

b. £80

c. £120

d. £30

d. £200

2) In bowel surgery:

a. Cell saver use is not recommended

b. Cell saver should only be used in non-infective cases

c. Cell saver can be used after the bowel/abdominal contents have been surgically cleaned

d. Cell saver can be used from the start

3) When considering cell saver use with a Jehovah's Witness patient:

a. It cannot be used in patients that refuse blood transfusions

b. It can be used with all Jehovah's Witness's

c. Needs to be reviewed on a case by case basis

4) When being considered in cancer surgery:

a. Cell saver must be avoided in all cases

b. Can be used in all non-haemtological related cancer surgeries

c. Can be used in all cancer surgeries

d. Can be used in urological malignancy surgeries only

INTRA-OPERATIVE CELL SALVAGE

A Roopra, L Rahman, R Khan, A Kumar

5) There are how many different categories of autologous blood transfusion?

a. 2

b. 3

c. 4

d. 5

Answers

1) c
Estimated mean cost of 1 unit blood is £122.

2) c

3) c
As the cell saver can be set up to be running alongside the patient's circulation in a continuous circuit, some Jehovah's Witnesses accept cell saver transfusions.

4) d

5) c
The 4 categories are: Preoperative autologous donation (PAD), Acute normovolaemic haemodilution (ANH), Post-operative cell salvage (PCS), Intraoperative cell salvage (ICS).

Author

Dr Amrit Roopra
CT1 Anaesthetics
Basildon Hospital, Nethermayne,
Basildon, Essex, SS16 5NL

Dr Lamay Rahman
CT1 Anaesthetics
Basildon Hospital, Nethermayne,
Basildon, Essex, SS16 5NL

Dr Rahat Khan
Consultant Obstetrics & Gynaecology
Princess Alexandra Hospital, Hamstel Road, Harlow, CM20 1QX
rahatanwarkhan@hotmail.com

Dr Anil Kumar
Consultant Anaesthetist
Basildon Hospital
Nethermayne, Basildon
Essex, SS16 5NL
mullsnegi@yahoo.co.uk

Corresponding Author

Dr Amrit Roopra
roopra.amrit@gmail.com

Dr Lamay Rahman
lamayrahman@hotmail.com

References

1. National Institute for Health and Clinical Excellence. Costing statement: Blood transfusion. Implementing the NICE guideline on blood transfusion (NG24). November 2015, Available from: https://www.nice.org.uk/guidance/ng24/resources/costing-statement-2177158141 (accessed on January 17, 2017)
2. The Serious Hazards of Transfusion Steering Group. Serious hazards of transfusion—Annual Report 2015. Available from http://www.shotuk.org/shot-reports/ (accessed on January 12, 2017)
3. Walunj A, Babb A, Sharpe R, Autologous blood transfusion. Continuing Education in Anaesthesia, Critical Care & Pain. 2006; 6; 192-196.
4. National Institute for Health and Clinical Excellence. Intraoperative Blood Cell Salvage in Obstetrics. November 2005. Available from http://guidance.nice.org.uk/IPG144 (accessed on January 17, 2017)
5. Hall M. (2000 – 2002) Why Mothers Die – Report on confidential enquiries into maternal deaths in the United Kingdom. Chapter 4 (Haemorrhage). Confidential Enquiry into Maternal and Child Health (CEMACH); p91-92
6. Association of Anaesthetists of Great Britain and Ireland Safety Guidelines. Blood Transfusion and the Anaesthetist: Intra-operative Cell Salvage, September 2009. Available from http://www.aagbi.org/publications/guidelines/docs/cell_salvage_2009.pdf (accessed on January 17, 2017)
7. UK Cell Salvage Action Group. Intra-operative Cell Salvage Education Workbook. 2008. Available from http://www.transfusionguidelines.org.uk/transfusion-practice/uk-cell-salvage-action-group/cell-salvage-competency-workbooks (accessed on January 17, 2017)
8. National Institute for Health and Clinical Excellence Intraoperative red blood cell salvage during radical prostatectomy or radical cystectomy. April 2008. Available from https://www.nice.org.uk/guidance/ipg258/evidence/overview-309426445 (accessed on January 17, 2017)

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

PHYSIOLOGICAL CHANGES IN PREGNANCY

L Rahman, R Khan, A Kumar

Abstract

Physiological changes are normal adaptations that occur in pregnancy to help the mother meet the demands of the growing foetus, to prepare the mother for the stresses of labour and birth, and to prepare her for later on in the pregnancy. These changes are multi-system and become important in the event of complications. It is important to understand these changes, as normal physiological values alter in pregnancy and appreciating what is normal in pregnant individuals allows us not to wrongly mistreat.

Endocrine and Metabolic Changes

Many of the physiological changes associated with pregnancy are linked, both directly and indirectly, by hormonal changes. HCG (Human Chorionic Ganadotrophin) is produced from 8 to 9 days post fertilisation onwards. It maintains the levels of oestrogen and progesterone during the first trimester until the placenta takes over.

The placenta acts as an endocrine organ producing HCG, human placental lactogen (HPL), oestrogen and progesterone. HCG levels peak at 10-12 weeks and then fall over the remainder of the pregnancy whilst HPL levels begin to rise from week 8 onwards and peak around term time. (1,2)

In the pituitary gland there is increased secretion of prolactin and adrenocorticotrophin but decreased secretion of growth hormone and pituitary gonadotropins. Parathyroid hormone is increased in pregnancy resulting in increased uptake of calcium in intestine and reabsorption by the kidneys. Levels of cortisol, aldosterone, thyroxine, T3 and prostaglandins increase. (3)

The basic metabolic rate peaks at 36 weeks and is 20% more compared to the non-pregnant individual. Oxygen demand is similarly 20% more compared to the non-pregnant individual. (4)

Insulin secretion increases throughout pregnancy, peaking at week 32 and then drops back to normal levels by term. Despite increased insulin increase, insulin sensitivity reduces and so glucose intolerance becomes more marked, resulting in gestational diabetes. It is thought this is due to HPL. (3)

During the first half of pregnancy, fat is increasingly stored and becomes utilised in the second half of pregnancy. Approximately 3kg is stored in the first half of pregnancy. (4)

Cardiovascular Changes

Pregnancy sees significant changes in maternal heart rate, stroke volume and cardiac output as shown in figure 1.

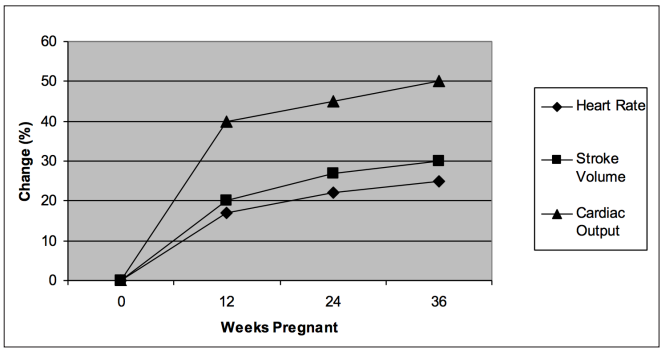


Figure 1 showing percentage increase of heart rate, stroke volume and cardiac output against weeks pregnant.

Heart rate increases by 25% at term, stroke volume increasing by 20-30% and cardiac output by 45-50%. Cardiac contractility remains the same throughout pregnancy, so these increases are achieved by left ventricular hypertrophy and dilatation. With the diaphragm being pushed up by the larger uterus in lower abdomen, there is a resulting lateral displacement of the apex of the heart and associated ECG changes of left axis deviation, flattening/inversion of T waves in lead III, Q wave in lead III, ST depression and T wave inversion in the inferior and lateral leads. (3,5)

As mentioned earlier, there is an increased progesterone and prostaglandins level. These coupled with down regulation of ∂-receptors cause a decrease in the total peripheral vascular resistance, peaking at decrease of 35% at week 20, and remain at a decrease of 30% for rest of pregnancy compared to the non-pregnant individual. The balance between increased cardiac output and decreased peripheral resistance causes the blood pressure (both systolic and diastolic) to drop slightly. The diastolic blood pressure decreases between 12-26 weeks and then return to pre-pregnancy levels by 36 weeks. If blood pressure becomes significantly elevated, then the woman should be investigated for pre-eclampsia and other causes of hypertension. (5)

A large proportion of the increased blood flow is directed towards the uretoplacental circulation. Here there is a 10 fold increase to a flow rate of 750ml/min. There is an increase in renal blood flow by approximately 80% and also increased blood flow to breasts, GI tract and skin.

PHYSIOLOGICAL CHANGES IN PREGNANCY

L Rahman, R Khan, A Kumar

Roughly 15% of pregnant women can suffer from aortocaval compression syndrome and symptoms include hypotension, pallor, nausea and vomiting. This is due to the inferior vena cava (IVC) being compressed by the uterus when the pregnant woman is lying flat. The compression reduces the amount of blood returning to the right atrium, decreasing pre-load and therefore decreasing cardiac output. To avoid this it is advised for pregnant women to be lying left rather than fully supine. (6)

Haematological Changes

Total blood volume in the mother begins to increase from week 6 onwards and peaks around weeks 32-34, with a total volume increase of 40%. The plasma volume increases by 45% due to sodium and water retention. As mentioned in the endocrine section, there is an increased oestrogen level in pregnancy and this causes an oestrogen mediated activation of the rennin-angiotensin system.

Red blood cell volume increases by 20%. The level of increase of red cell volume is comparably less than plasma volume increase, and this discrepancy in level of change causes a fall in haematocrit level. This also causes the haemoglobin levels to fall. These changes are graphically summarised in figure 2.

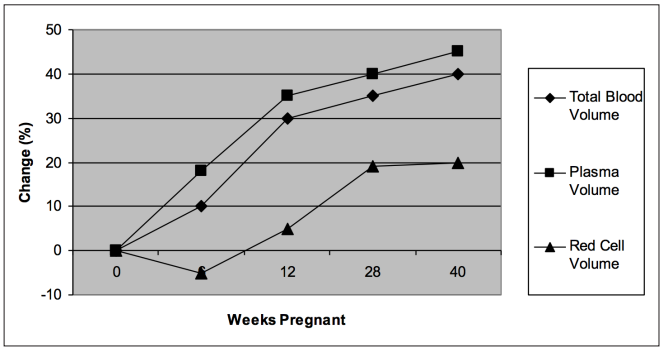


Figure 2 showing how total blood volume, plasma volume and red cell volume varies with pregnancy.

Pregnancy is also associated with change in coagulation and platelet turnover. Coagulation factors VII, VIII, IX, X and fibrinogen increase. The balance between coagulation and fibrinogen is disturbed, leading to a pro-coaguable state and therefore increased risk of pulmonary emboli and deep vein thrombosis. Platelet production increases to account for the increased demand/consumption and the overall count decreases. However, platelet function does not alter. (7)

Respiratory Changes

Elevated progesterone levels produce a noticeable effect on respiratory physiology as it increases minute ventilation by 40%. A large reason for the physiological respiratory changes is due to anatomical changes. The diaphragm is pushed upwards by up to 4cm, and the thorax increases in circumference by 5-7cm. The large airways become dilated and airway resistance decreases by 35%.

From week 20 onwards, there is noticeable difference in expiratory reserve volume (ERV) and residual volume (RV). There is a gradual decrease in these values and eventually the functional residual capacity (FRC) [the ERV + RV] is 20% less than in non-pregnant individuals.

Tidal volume (TV) rises to 28% more than a non-pregnant individual by term. Respiratory rate increases by 10%. In combination these cause a minute volume increase at term to 40-50%.

Figure 3 summarises changes in respiratory physiology graphically.

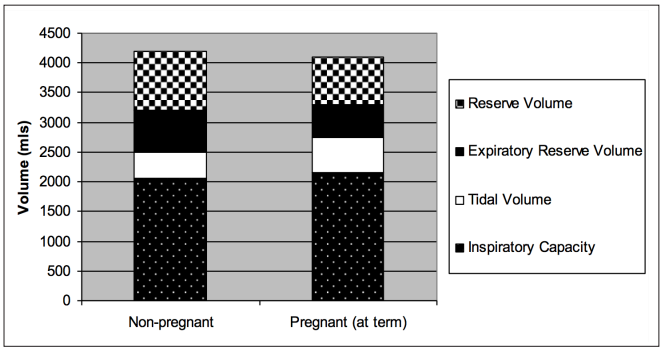


Figure 3 demonstrating changes in respiration between pregnant and non-pregnant individual.

With an increased respiratory rate and hyperventilation, the arterial carbon dioxide levels drop to 3.6-4.3 kPA and cause respiratory alkalosis. This is compensated by the kidney with decreased bicarbonate release. This results in a shift of the normal acid/base baselines as demonstrated in table 1. (8)

	Non-Pregnant Individual	Pregnant Individual
pH	7.35 – 7.45	7.40 - 7.47
pCO_2 (kPa)	4.7 - 6.0	3.6 – 4.3
pO2 (kPa)	>10.5	>12.6
Bicarbonate (mmol/l)	24-28	18-22
Base excess	+2 to -2	-2 to -3

Table 1 showing acid/base normal levels in pregnant vs non-pregnant individuals.

PHYSIOLOGICAL CHANGES IN PREGNANCY

L Rahman, R Khan, A Kumar

Gastrointestinal Changes

Nausea and vomiting is common during pregnancy, especially during the first trimester and often termed as 'morning sickness' which may be linked to HCG levels which peak during first trimester and resolves by 14-16 weeks of pregnancy.

Raised progesterone levels relax smooth muscles, and relaxed smooth muscle in the lower oesophageal sphincter leads to gastric reflux. There is reduced motility of small and large intestine due to lower level of motilin being present. There is also reduced contractility of the gall bladder due to lower levels of cholecytokinin, again caused by high progesterone levels.

Within the hepatic system there are also changes. There is mild fatty changes in the liver. Serum cholesterol and alkaline phosphate levels increase. Conversely aspartate transaminase (AST), alanine transaminase (ALT), bilrubin and gamma-glutamyl transferase (Gamma GT) all fall by roughly 20%. (6,9)

Renal changes

As mentioned earlier, there is an upto 80% increase in renal blood flow. This causes glomerular filtration rate (GFR) to increase and so an increased clearance of creatinine and urea. This consequently causes plasma levels to fall.

Mild glycosuria and/or proteinurea can occur. While the exact mechanism of this is not clear, it has been theorised that this may be due to the increase in GFR and the renal tubules not being able to reabsorb the increased protein/glucose. (6)

Multiple choice questions

Please select one option for each of the questions.

1) Within the pregnant individual cardiovascular changes are seen. Which is the correct change?

a. Cardiac output increases the most by percentage

b. Heart rate increases the most by percentage

c. Stroke volume increase the most by percentage

d. All increase by equal amounts

2) Morning sickness is due to:

a. Increased oestrogen levels

b. Increased progesterone levels

c. Relaxed lower oesophageal sphincter

d. Raised HCG levels

3) Renal blood flow in pregnancy:

a. Decreases by 20%

b. Remains unchanged

c. Increases by 40%

d. Increases by 80%

4) Arterial carbon dioxide levels in pregnancy:

a. Increase due to decreased respiratory effort

b. Does not change

c. Decreases as a compensation mechanism due to increased bicarbonate levels

d. Decreases due to increased respiratory rate and hyperventilation

5) The following ECG changes are normal in pregnancy:

a. Left axis deviation, Right bundle branch block, T wave inversion in anterior leads

b. Left axis deviation, flattening/inversion of T waves in lead III, Q wave in lead III, ST depression and T wave inversion in the inferior and lateral leads

c. Left bundle branch block

d. Left axis deviation, atrial flutter, ST depression in inferior and lateral leads

PHYSIOLOGICAL CHANGES IN PREGNANCY

L Rahman, R Khan, A Kumar

Answers

1) a.

Cardiac output increases by 45-50% whilst heart rate and stroke volume increases by 20-30%.

2) d.

Whilst the exact mechanism of morning sickness is not clear, it is thought to be related to raised HCG levels.

3) d

4) d

5) b

Author

Dr Lamay Rahman
CT1 Anaesthetics
Basildon Hospital, Nethermayne,
Basildon, Essex, SS16 5NL

Dr Rahat Khan
Consultant Obstetrics & Gynaecology
Princess Alexandra Hospital,
Hamstel Road, Harlow, CM20 1QX
rahatanwarkhan@hotmail.com

Dr Anil Kumar
Consultant Anaesthetist
Basildon Hospital, Nethermayne,
Basildon, Essex, SS16 5NL
mullsnegi@yahoo.co.uk

Corresponding Author

Dr Lamay Rahman
lamayrahman@hotmail.com

References

1) Schumacher, A, Heinze, K, Witte, J, Poloski, E, Linzke, V. Human Chorionic Gonadotropin as a Central Regulator of Pregnancy Immune Tolerance. The Journal Of Immunology. 2013; 190(6): 2650-2658.
2) Kumar P, Magon N. Hormones in Pregnancy. Nigerian Medical Journal. 2012; 53(4): 179 – 183
3 Soma-Pillay P, Nelson-Piercy C, Tolppanen H, Mebazaa A. Physiological changes in pregnancy. Cardiovascular Journal of Africa. 2016; 27(2):89-94
4) Lof, M, Olausson, H, Bostrom, K, janerot-sjöberg, B, Sohlstrom, A. Changes in basal metabolic rate during pregnancy in relation to changes in body weight and composition, cardiac output, insulin- like growth factor I, and thyroid hormones and in relation to fetal growth. Amercan Journal of Clinical Nutrition. 2005;81(3): 678-685.
5) Sanghavi, M, Rutherford, J. Cardiovascular Physiology of Pregnancy. Circulation. 2014;130(12): 1003-1008
6) Blackburn , S. Maternal, Fetal, & Neonatal Physiology. (4th ed.). USA: Elsevier Saunders; 2014
7) Pavord S, Hunt B. The Obstetric Hematology Manual. UK: Cambridge University Press; 2010
8) McCormack, M, Wise, R, Bourjeily, G, Rosene-montella, K. Pulmonary Problems in Pregnancy. (1st ed.). US: Humana Press; 2009
9) Costantine, M. Physiologic and pharmacokinetic changes in pregnancy. Frontiers in Pharmacology. 2014;5(65): 1-5.

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

PRE-OPERATIVE INVESTIGATIONS: A GUIDE FOR FOUNDATION DOCTORS

UM McHugh, M Pachucki, SPK Linter

Abstract

This article presents the current evidence and guidelines for pre-operative investigation of patients scheduled for surgery. The tests required are determined by the clinical status of the patient and the co-morbidites they have, as well as the complexity of the proposed surgical procedure. The role of the foundation doctor in enabling this to occur in an efficient manner is discussed.

Introduction

The number of patients in the United Kingdom requiring surgery is steadily increasing, and consequently the need to ensure patients are pre-operatively investigated in a timely and cost-effective manner is also rising. In 2015/16 there were 10.12 million operations completed by the NHS. (1) A 2012/2013 survey undertaken by the Royal College of Anaesthetists (RCoA) and the Association of Anaesthetists of Great Britain and Ireland (AAGBI) revealed that more than 3.5 million patients are cared for by an anaesthetist each year and of these 2.8 million receive general anaesthesia. (2)

The aims of pre-operative medical assessment are to:

- *Ensure patients presenting for surgery have had their clinical condition optimised within the limits of the clinical context in order to reduce the morbidity associated with surgery*
- *Allow for determination of post-operative destination and discharge planning*
- *Minimise the cost of the peri-operative course*
- *Increase efficiency in the use of beds and theatre time*

The Purpose of Pre-operative Investigations

All patients should be reviewed by an anaesthetist before undergoing a procedure that requires their services. (3) Anaesthetists use specific pre-operative investigations to guide peri-operative management. It is the role of the anaesthetist to determine a patient's suitability for surgery and to ascertain the baseline clinical status of the patient. In addition, they must consider the options for anaesthesia and identify the most appropriate plan, in conjunction with the surgeon and the patient. "Routine" pre-operative testing is not recommended and over the past decade there has been a strong move away from this practice. (4)

The Role of the Foundation Doctor

Many trusts now have a dedicated pre-operative assessment clinic where patients attend in advance of elective surgery, however in areas where this is not available and in cases of emergency surgery the role of the medical and surgical teams is vital. As a foundation doctor involved in the care of pre-operative patients, it is important to know which investigations are appropriate to order for each patient, thereby ensuring that they do not undergo unnecessary investigations, which can be time-consuming, unpleasant, costly and confer no additional benefit to the patient. (5)

A thorough history and physical examination are invaluable in the pre-operative work-up, as it has been demonstrated that 60-70 percent of laboratory tests are not essential if the clinical findings are carefully considered. (6,7,8) It is important for the surgical team to recognise which patients require further testing, medical review and early anaesthesia review. (3)

Guidance

The National Institute for Health and Care Excellence (NICE) has issued a comprehensive guideline on this topic. (9) In this article we shall discuss patient risk stratification, surgery type stratification and the pre-operative tests which should be considered. It is intended as a discussion on the current recommendations and not an exhaustive analysis of all pre-operative investigations.

Patient Risk Stratification

Scoring systems are used to risk stratify patients based on their physiological status. Risk stratification identifies patients who may be more likely to have peri-operative complications.

American Society of Anaesthesiologists

The scoring system most commonly used by anaesthetists is the American Society of Anaesthesiologists (ASA) Physical Status Classification System. (10,11,12) This is used to determine which peri-operative investigations should be performed, as patients with more co-morbidities are more likely to have underlying pathology, undiagnosed conditions or complications of known conditions.

ASA PS Classification	Definition
ASA I	A normal healthy patient
ASA II	A patient with mild systemic disease
ASA III	A patient with severe systemic disease
ASA IV	A patient with severe systemic disease that is a constant threat to life
ASA V	A moribund patient who is not expected to survive without the operation
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes

Patients presenting for emergency surgery have an E added to their ASA classification.

PRE-OPERATIVE INVESTIGATIONS: A GUIDE FOR FOUNDATION DOCTORS

UM McHugh, M Pachucki, SPK Linter

Duke Activity Status Index

Functional capacity, as determined by exercise tolerance, is an important predictor of perioperative risk. The physiological response to surgery increases oxygen demand, which must be met by an increase in oxygen delivery and this is akin to the ability to perform physical activity. The Duke Activity Status Index (DASI) is a questionnaire used to quantify exercise tolerance by identifying the level of physical activity a patient is able to perform.

The index is reported in metabolic equivalents (METs) whereby one MET is the oxygen consumption of an adult at rest (3.5 ml kg−1 min−1). Patients who are unable to achieve 4 METs of physical activity are at higher risk for poor outcomes after surgery. It is important to remember that patients often over-report their level of activity. (13)

Metabolic Equivalents (METs)	Activities
1-4	Walking around the house Eating Dressing
4-10	Climbing a flight of stairs Walking uphill Running a short distance Golf
>10	Swimming Tennis Football

Surgery Risk Stratification

Surgery is classified into minor, intermediate or major, based on the level of risk posed by the operation and the predicted morbidity and mortality.

Minor – *Superficial procedures, such as removal of skin lesions.*

Intermediate – *More invasive procedures, such as varicose vein surgery, hernia repair or tonsillectomy.*

Major/Complex – *Significantly invasive procedures, such as spinal surgery, joint replacements, abdominal surgery, cardiac surgery or thoracic surgery.*

Investigations

The required investigations should be determined after eliciting a history and performing a thorough clinical examination, thereby deriving the patient's ASA classification and considering this in conjunction with the surgical risk stratification. (14)

Blood Tests

Full blood count

A full blood count is not required for healthy patients undergoing minor surgery. In patients with co-morbidities which may pre-dispose to anaemia it may be beneficial to assess their baseline haemoglobin level. In patients at risk of thrombocytopenia, measuring platelets is useful for surgical and anaesthesia planning. For patients undergoing higher risk surgeries where there may be a high risk of blood loss, a baseline full blood count is recommended.

Renal profile

A renal profile is not required for healthy patients undergoing minor surgery. It should be considered in all patients who are deemed to be at risk of an acute kidney injury in the peri-operative period. Additionally, it is recommended for all patients undergoing major surgery.

Coagulation profile

A coagulation profile is not routinely required for ASA I or ASA II patients undergoing any type of surgery. It should be considered in patients with liver impairment. Furthermore, it is recommended that patients who are receiving anticoagulant medications have a coagulation profile tested as this will assist with planning of peri-operative therapy. It is important to note that direct oral anticoagulants cannot be assessed by routine tests and local guidelines should be followed in relation to these drugs.

Electrocardiogram

Healthy patients undergoing minor surgery do not routinely require an ECG. All patients with cardiovascular signs and symptoms should have an ECG.

For patients without cardiovascular signs and symptoms, the European guidelines recommend that it is useful to use the Revised Cardiac Risk Index (RCRI) to determine the level of cardiac investigation required before non-cardiac surgery.

Revised Cardiac Risk Index criteria
- Ischaemic heart disease
- Congestive heart failure
- Cerebrovascular disease
- Diabetes mellitus requiring insulin therapy
- Renal impairment with a creatinine level >177µmol.L^{-1}
- High risk surgery (suprainguinal vascular, intrathoracic surgery, or intra-abdominal)

For those undergoing minor surgery, if one or more RCRI criteria are present an ECG may be considered. For those undergoing intermediate or major surgery, if one or more RCRI criteria are present they should have an ECG. For those undergoing intermediate or major surgery with no risk factors, but are greater than 65 years of age, an ECG may be considered. (15,16)

PRE-OPERATIVE INVESTIGATIONS: A GUIDE FOR FOUNDATION DOCTORS

UM McHugh, M Pachucki, SPK Linter

Echocardiogram

Echocardiography, particularly trans-thoracic, is the most readily-available modality for assessing ventricular function. Routine pre-operative resting echocardiography is recommended in patients with known or suspected valvular heart disease who are scheduled for intermediate or major surgery. It may be considered in all patients scheduled for major surgery.

Chest X-ray

There is no robust evidence that routine pre-operative chest imaging is beneficial or effective. It should be performed only in patients with new or unstable cardiopulmonary signs or symptoms, and patients at increased risk of post-operative pulmonary complications, but only if the results will alter peri-operative management. (17)

Cardiopulmonary Exercise Testing

Cardiopulmonary exercise testing is a reliable and objective way of measuring functional capacity and is now widely available. Aside from many cardiovascular and respiratory parameters, it also measures work rate and metabolic gas exchange parameters including oxygen consumption, carbon dioxide production, respiratory exchange ratio and anaerobic threshold.

This enables assessment of the extent to which oxygen delivery can be increased to meet the tissues needs. It acts as a non-invasive simulation of the requirements of major surgery and is a useful tool in assessing both suitability for surgery and most appropriate post-operative destination. (18)

Lung Function Tests

Lung function tests are used to further investigate respiratory pathology. For pre-operative patients they should only be requested in consultation with a respiratory physician, thoracic surgeon or anaesthetist.

Pregnancy Testing

All women of childbearing age must be asked about their pregnancy status. There is an increased risk of spontaneous miscarriage, premature birth, low birth weight infants, intrauterine growth retardation and infant death associated with anaesthesia and surgery during pregnancy. (19,20) Consequently it is recommended that only emergency procedures are carried out during pregnancy.

If there is any doubt regarding the pregnancy status, a pregnancy test should be carried out with the woman's consent. (9)

Other Investigations

Sickle Cell Screen - *Should not be routinely performed. Ask about family history and then consider.*

HbA1C - *Should not be routinely tested. All patients with diabetes should have a HbA1C checked within 3 months of the date of surgery.*

Arterial Blood Gas - *Should not be routinely tested. Consider in patients with known respiratory pathology or in whom developing respiratory pathology is suspected.*

Summary of Investigations

Adapted from NICE guidelines NG45 (2016). (9)

Surgery / Test	ASA I			ASA II			ASA III/IV		
	Minor	Intermediate	Major	Minor	Intermediate	Major	Minor	Intermediate	Major
FBC	Not routinely	Not routinely	Yes	Not routinely	Not routinely	Yes	Not routinely	Consider	Yes
Renal Profile	Not routinely	Not routinely	Consider	Not routinely	Consider	Yes	Consider	Yes	Yes
Coagulation Profile	Not routinely	Not routinely	Not routinely	Not routinely	Not routinely	Not routinely	Not routinely	Consider	Consider
ECG	Not routinely	Not routinely	Consider	Not routinely	Consider	Yes	Consider	Yes	Yes
Lung Function/ ABG	Not routinely	Not routinely	Not routinely	Not routinely	Not routinely	Not routinely	Not routinely	Consider	Consider

How much do tests cost?

As a foundation doctor it is useful to be aware of the cost implications of your decisions as resources should be used appropriately. The prices of the most commonly ordered pre-operative tests are outlined below. (21)

Name of test	Total cost per patient (£) including equipment and staff
Full blood count	6.00
Renal function test	6.00
Coagulation screen	29.42
Electrocardiography	8.66
Chest X-ray	29.60
Pulmonary function tests	66.00
Pregnancy test	3.52

In addition, it is important to consider the further costs which may be incurred by routine testing. This may include further investigations, further medical and healthcare staff involvement, or a delay in treatment and a prolonged hospital stay.

PRE-OPERATIVE INVESTIGATIONS: A GUIDE FOR FOUNDATION DOCTORS

UM McHugh, M Pachucki, SPK Linter

Guidelines

Each local trust or hospital should develop a clear guideline for all staff to follow. This has been shown to decrease the number of tests carried out on pre-operative patients. In addition, the use of a guideline has demonstrated cost savings. (22) However, it will not guarantee accuracy of testing in all patients and ongoing education and an enhanced understanding are also required. (23)

Further Investigations

Which patients need a medical review?

Any patient who presents with an uncontrolled medical co-morbidity or with new worrying signs and symptoms which have not been investigated should be seen by the relevant medical speciality.

Which patients need early referral to the anaesthetist?

Any patient deemed to be high risk (ASA III or greater) should be referred for early anaesthetic assessment. If possible, this review should take place in a pre-assessment clinic. If an unplanned admission, the anaesthetic review should take place on the ward, as far in advance of the surgery as possible.

Specific issues which should prompt referral include:

- *Metabolic equivalent level <4*
- *Exercise tolerance restricted by chest pain*
- *Angina occurring >1/month*
- *Arrhythmia*
- *Heart failure*
- *Frequent asthma attacks*
- *Insulin-dependent diabetes*
- *Unspecified renal disease*
- *Unspecified liver disease*
- *Previous problems with anaesthesia*
- *Family history of problems with anaesthesia (24)*

Conclusion

Ordering of pre-operative tests should not be "routine", but should be a considered decision based on each individual patient and the surgery they are scheduled for. Ordering the correct tests can ensure that patients safely receive the appropriate surgery in a timely fashion without exposure to unnecessary risk. If there is a clinical concern regarding a patient, it is best to seek anaesthesia input early in the clinical course.

Case Discussion

A 72 year old gentleman attends the vascular outpatient clinic before elective abdominal aortic aneurysm (AAA) repair. The AAA was picked up on a screening abdominal ultrasound. The patient has been under surveillance for seven years, but the AAA has increased in size and now requires intervention.

His medical history includes type 2 diabetes, gout, hypertension and ischaemic heart disease with a stent inserted 10 years ago. He is also a life-long smoker and drinks 4 drinks per day, 5 days per week. His medications include metformin, simvastatin, aspirin, and bisoprolol.

Further questioning reveals that he experiences intermittent palpitations and breathlessness on dressing. He has not been to see his GP for the last 4 months as he was visiting his family in Spain but he has noticed increased swelling of his ankles.

Examination reveals an irregular heart rhythm on palpation of the radial pulse (110 bpm) and an ejection systolic murmur. On auscultation there are bibasal crepitations detected. On palpation of the abdomen there is a pulsatile mass.

How would you stratify this patient and the surgery?

- *This gentleman is ASA III.*
- *This surgical procedure falls in the major category.*

What investigations would you order for this patient pre-operatively?

- *Full blood count: should be tested in any patient (ASA 1-4) presenting for major or complex surgery as well as those with suspected anaemia.*
- *Renal profile: should be tested in ASA 2-4 patients presenting for major surgery and considered in ASA 1 patients at risk of AKI.*
- *ECG: is required in any patient with a history of palpitations; moreover, in the context of major surgery, an ECG should be considered for patients aged over 65 years if no ECG results are available from within the past 12 months.*

Would you consider any further cardiac investigations?

- *Echocardiography: This patients has a murmur as well as signs and symptoms of heart failure (breathlessness, oedema). Echocardiography is required to assess valvular apparatus as well as ejection fraction and regional wall motion abnormalities.*
- *Cardiopulmonary exercise testing: This patient is ASA III undergoing major surgery, with signs and symptoms of cardiac compromise. CPEX testing would be useful to assist in assessing how well he will tolerate the physiological demands of major surgery.*

PRE-OPERATIVE INVESTIGATIONS: A GUIDE FOR FOUNDATION DOCTORS

UM McHugh, M Pachucki, SPK Linter

Are there any other specific investigations you would request?

- *HbA1C: should be offered to patients with diabetes if they have not been tested in the last 3 months.*
- *Haemostasis/Clotting: should be considered as this gentleman has a significant alcohol intake and may have chronic liver disease.*

Single Best Answer Questions (Best of Five)

Q1. Choose the most appropriate investigations for a 34 year old woman presenting for excision of a breast lump who is generally well and takes no regular medication.

A. No investigations
B. FBC
C. ECG
D. FBC, ECG
E. FBC, coagulation

Q2. Choose the most appropriate investigations for an 86 year old man with no medical history, presenting for Transurethral Resection of Prostate (TURP) for treatment of benign prostatic hyperplasia.

A. FBC, ECHO
B. FBC, UE
C. FBC, UE, ECG
D. FBC, UE, coagulation
E. FBC, UE, coagulation, echocardiography

Q3. Which of the following patients should have pre-operative echocardiography?

A. 64 year old woman with aortic valve replacement two years previously presenting for total knee replacement and reporting increasing breathlessness on climbing the stairs.
B. 58 year old man with hypertension and diabetes presenting for anterior resection.
C. 72 year old man with paroxysmal atrial fibrillation presenting for excision of BCC from the forehead.
D. 48 year old woman with hyperthyroidism presenting for knee arthroscopy.
E. 84 year old woman presenting for emergency repair of fractured neck of femur sustained while walking on the golf course.

Q4. Which of these is the most pressing indication for a coagulation profile in a patient presenting for intermediate surgery?

A. The surgical consultant likes all patients on the list to have one.
B. The patient is ASA II.
C. The patient is on Aspirin.
D. The patient is on Warfarin.
E. The patient is having bloods taken anyway.

Q5. Choose the most appropriate investigations for a 68 year old lady presenting for total abdominal hysterectomy. She has a history of hypertension, atrial fibrillation and type 2 diabetes. She is taking Ramipril, Warfarin and Metformin. She walks 3km each day without symptoms.

A. FBC, UE,
B. FBC, UE, coagulation
C. FBC, UE, coagulation, ECG, HbA1C
D. FBC, UE, coagulation, ECG, echocardiography
E. FBC, UE, coagulation, ECG, echocardiography, HbA1C

Answers

A1. A

In an ASA 1 patient for minor intermediate surgery no investigations are required.

A2. C

This patient is 86 years old and at risk of AKI and ischaemic heart disease.

A3. A

This patient is having major surgery and the clinical history suggests there may be increasing functional impairment.

A4. D

Patients receiving Warfarin should have a coagulation screen.

A5. C

This patient is having major surgery and so should have FBC and UE. A coagulation profile should be taken as she is on Warfarin. HbA1C is recommended as she has diabetes. Her functional capacity is good and so echocardiography is not necessary.

PRE-OPERATIVE INVESTIGATIONS: A GUIDE FOR FOUNDATION DOCTORS

UM McHugh, M Pachucki, SPK Linter

Author

Dr Ursula M McHugh
Clinical Fellow in Cardiac Anaesthesia
Bristol Heart Institute
BS2 8HW

Dr Marcin Pachucki
ST7 Anaesthesia and ICM
Bristol Royal Infirmary
BS28HW
marcinpachucki@gmail.com

Dr Stephen PK Linter DA, FRCA
Consultant in Anaesthesia and Intensive Care Medicine
Bristol Heart Institute
BS28HW
stephen.linter@uhbristol.nhs.uk

Corresponding Author

Dr Ursula M McHugh
mchughu@tcd.ie

References

1. www.nhsconfed.org/resources/key-statistics-on-the-nhs
2. Pandit JJ, Andrade J, Bogod DG, et al. 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: protocol, methods, and analysis of data. Br J Anaesth 2014; 113: 540–8.
3. Pre-operative Assessment: The Role of the Anaesthetist. Published by the Association of Anaesthetists of Great Britain and Ireland (AAGBI). November 2001.
4. Czoski-Murray C, Lloyd Jones M, McCabe C, et al. What is the value of routinely testing full blood count, electrolytes and urea, and pulmonary function tests before elective surgery in patients with no apparent clinical indication and in subgroups of patients with common comorbidities: a systematic review of the clinical and cost-effective literature. NIHR Health Technology Assessment programme: Executive Summaries 2012. Available from: https://www.ncbi.nlm.nih.gov/books/
5. Johansson T, Fritsch G, Flamm M, et al. Effectiveness of non-cardiac preoperative testing in non-cardiac elective surgery: a systematic review. Br J Anaesth 2013; 110 (6):926-939.
6. Kaplan EB, Sheiner LB, Boeckmann AJ, et al. The usefulness of preoperative laboratory screening. J Am Med Assoc 1985; 253: 3576–81.
7. Macario A, Roizen MF, Thisted RA, Kim S, Orkin FK, Phelps C. Reassessment of preoperative laboratory testing has changed the test-ordering patterns of physicians. Surg Gynecol Obstet 1992; 175: 539–47.
8. Velanovich V. The value of routine preoperative laboratory testing in predicting postoperative complications: a multivariate analysis. Surgery 1991; 109: 236–43
9. Preoperative tests (update). Routine preoperative tests for elective surgery. NICE guideline NG45. April 2016.
10. American Society of Anaesthesiologist. New Classification of Physical Status. Anesthesiology. 1963; 24:111
11. https://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system
12. Fitz-Henry J. The ASA classification and peri-operative risk. Annals of The Royal College of Surgeons of England. 2011; 93(3):185-187.
13. Pearse RM, Holt PJ, Grocott MP. Managing perioperative risk in patients undergoing elective non-cardiac surgery. Br Med J 2011; 343: 734–9
14. Roizen M. More preoperative assessment by physician and less by laboratory tests. NEJM 2000; 342:204-205.
15. Kristensen SD, Knuuti J, Saraste A, et al. 2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management. Eur Heart J 2014 Sep 14; 35(35):2383-431.
16. Guarracino F1, Baldassarri R, Priebe HJ. Revised ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management. Implications for preoperative clinical evaluation. Minerva Anestesiol 2015 Feb; 81(2):226-33.
17. Qaseem A, Snow V, Fitterman N, et al. Risk assessment for and strategies to reduce perioperative pulmonary complications for patients undergoing noncardiothoracic surgery. Ann Intern Med 2006; 144(8):575–580.
18. Neil Agnew. Preoperative cardiopulmonary exercise testing. Contin Educ Anaesth Crit Care Pain 2010; 10 (2): 33-37.
19. Duncan PG et al. Fetal risk of anesthesia and surgery during pregnancy. Anesthesiology 1986; 64: 790-4.
20. Mazze RI and Kallen B. Reproductive outcome after anesthesia and operation during pregnancy: A registry study of 5405 cases. Am J Obstet Gynecol 1989; 161(5): 1178-85.
21. Preoperative tests (update). Routine preoperative tests for elective surgery. NICE guideline NG45. Appendix M: Economic considerations for Delphi. April 2016.
22. Nicholls J, Gaskin PS, Ward J, et al. Guidelines for preoperative investigations for elective surgery at Queen Elizabeth Hospital: effects on practices, outcomes, and costs. J Clin Anesth 2016 Dec; 35:176-189.
23. Kirkham KR, Wijeysundera DN, Pendrith C, et al. Preoperative testing before low-risk surgical procedures. Canadian Medical Association Journal 2015 Aug 11; 187(11):E349-58.
24. Hilditch WG, Asbury AJ, Crawford JM. Pre-operative screening: Criteria for referring to anaesthetists. Anaesthesia 2003 Feb;58(2):117-24.

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

SEVERE OBSTRUCTIVE SLEEP APNOEA COMPLICATING AN ALREADY DIFFICULT AIRWAY

T Rudnick, S Acharya

Abstract

Obstructive sleep apnoea (OSA) is a considerable cause for difficult airway, morbidity and mortality in surgical patients undergoing anaesthesia. OSA affects 5-10% of the adult population, with estimates of twice that in patients scheduled for surgery (1). With obesity the commonest cause for OSA in adulthood, it is very easy to overlook the existence of OSA in the non-obese patient (2).

Aside from increased body mass index (BMI), there are multiple concurrent predisposing risk factors for OSA, including increasing age, male gender, the use of sedatives, smoking and excess alcohol intake, neck circumference >40cm, neuromuscular disease and with relevance to this case, craniofacial abnormalities, such as those seen in Downs syndrome, retro/micrognathia and achondroplasia (1) (3). This article is aimed to give a brief account of obstructive sleep apnoea, as well as some important elements regarding recognition, anaesthesia, and implications in management.

Case Discussion

The case describes a 53-year-old female patient attending our tertiary maxillofacial centre for a procedure to correct her retrognathia. Retrognathia is an abnormal posterior positioning of the mandible, relative to the facial skeleton and soft tissues (2) (figure 1).

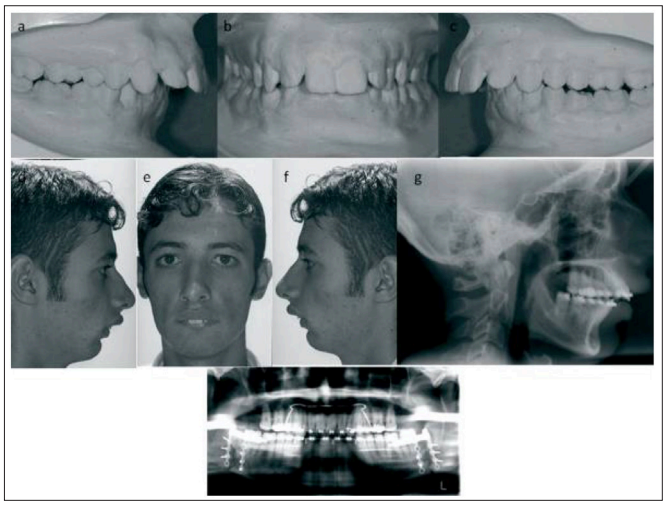


Figure 1: Multiple images illustrating a patient with retrognathia.

Other than the cosmetic consequences of her retrognathia, our patients' main complication was the severe OSA which had developed secondary to her craniofacial abnormality. Her OSA has required Continuous positive airway pressure (CPAP) ventilation overnight for the past 4-5 years, as well as trials of multiple mandibular advancement devices, all of which had been poorly tolerated. Consequently, the decision was made to attempt major surgery to definitively correct the anatomical abnormality that had been causing her problems.

The plan was to split her upper and lower jaws, manipulating them into a more normal anatomical alignment, a procedure named a 'bi-maxillary osteotomy and genioplasty'. Both for anaesthesia and surgery this lady was a very complicated and high risk patient. The combination of a difficult airway, resulting from her anatomy, osteoarthritis of her temporal-mandibular joint, and the obstructive sleep apnoea, required a meticulous and safe anaesthetic and airway plan well in advance. On the day, she was initially anaesthetised with the addition of Optiflow nasal cannula, to maintain oxygenation throughout the intubation process. Once asleep and the oral airway secured, an elective surgical tracheostomy was performed.

Extensive neck and facial swelling following bi-maxillary osteotomy is a well-known complication, but this would not usually require a tracheostomy. However, due to the severity of this patients OSA, and the uncertainty whether she would need a period of ventilatory support or long term tracheostomy post operatively, an elective tracheostomy was planned by consultant anaesthetist, maxillary-facial surgeon and respiratory physician.

Although the surgery would hopefully correct her retrognathia, there was no guarantee that the surgery would correct her OSA. There are case reports available illustrating morbidity and even mortality following airway oedema/obstruction upon extubation in bi-maxillary osteotomy patients (4). The issues mentioned above, along with the inevitable need for opioid analgesia in the post-operative period, made an elective tracheostomy the safest option for this particularly high risk patient.

The patients' tracheostomy was removed within a few days of the procedure following a satisfactory set of lung function tests and sleep studies with the fenestrated tracheotomy tube being capped. Her measured post-operative apnoea/hypoapnoea index (AHI) was 4.4 (<5 being normal), compared to 30 pre-operatively. Furthermore, her overnight mean and median oxygen saturations where 96%, suggesting that the procedure had been successful in treating her OSA.

SEVERE OBSTRUCTIVE SLEEP APNOEA COMPLICATING AN ALREADY DIFFICULT AIRWAY

T Rudnick, S Acharya

Obstructive Sleep Apnoea

Obstructive sleep apnoea is a syndrome characterized by periodic, partial or complete obstruction of the upper airway during sleep (5). Apnoea is defined as complete cessation of airflow for more than 10 seconds, and hypopnoea as 50% reduction in airflow for more than 10 seconds. This repetitive upper airway obstruction often results in oxygen desaturation and arousal from sleep. 'OSA syndrome' refers to the clinical entity of OSA resulting in excessive daytime sleepiness and other symptoms such as poor concentration, fatigue and morning headaches.

Epidemiological studies have illustrated a high prevalence of OSA worldwide. In middle age, it is thought approximately 4% of men and 2% of women suffer from OSA. With these figures very much underestimated, OSA is thought to be undiagnosed in approximately 80% of patients (6), meaning the recognition of the condition is all the more important for anaesthetic practitioners. The prevalence will increase further as the population becomes older, or with higher rates of obesity. OSA is found in 40% of obese females and 50% of obese males.

Pathophysiology

OSA occurs when the negative airway pressure that develops during inspiration is greater than the muscular distending pressure, thereby causing airway collapse (5). During sleep and when under the influence of anaesthesia there is decreased tone of the pharyngeal dilator muscles (musculus genioglossus and musculus geniohyoideus).

The aforementioned risk factors for OSA, including obesity, and craniofacial abnormalities can narrow the pharyngeal/laryngeal inlet. The narrower upper airways in these patients can cause a more negative pressure to develop for the same inspiratory flow (7), and it is this phenomenon which is thought to lead to the symptoms of OSA. Nasal continuous positive airway pressure (CPAP) can counteract this by keeping the pressure in the upper airways positive, thus acting as a 'splint' to maintain airway patency.

During these periods of hypopnoea and apnoea, the reduction in arterial pO_2 and increase in arterial pCO_2, cause partial arousal from sleep and a brief period of hyperventilation to compensate. Sleep then deepens and the cycle begins again.

Due to the patients' poor sleeping patterns, OSA can manifest as excessive sleepiness during the day. OSA is also associated with hypertension, pulmonary artery hypertension, coronary heart disease, and cardiac arrhythmias (8)(9).

Effects on anaesthesia

OSA markedly increases the risk of morbidity and mortality in patients undergoing anaesthesia, or sedation for surgery. Anaesthetists are key figures in the early recognition of undiagnosed OSA, because of their role in preoperative screening.

There have been many clinical screening tests for OSA trialled, including the Berlin questionnaire, the ASA (American Society of Anaesthesiologists) checklist, Flemons criteria and the Epworth Sleepiness Scale, however there is no consensus as to which is best. As a result the STOP-BANG model (10) (figure 2) is a quick screening tool used in the pre-operative assessment of all patients. Early recognition and early planning can considerably reduce a patients' risk of morbidity.

1. **S**noring Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?	Yes/No
2. **T**ired Do you often feel tired, fatigued, or sleepy during daytime?	Yes/No
3. **O**bserved apnea Has anyone observed you stop breathing during your sleep?	Yes/No
4. Blood **p**ressure Do you have or are you treated for high blood pressure?	Yes/No
5. **B**MI more than 35 kg/m^2?	Yes/No
6. **A**ge Age over 50 yr old?	Yes/No
7. **N**eck circumference Neck circumference greater than 40 cm?	Yes/No
8. **G**ender Gender male?	Yes/No
High risk of OSA: answering yes to three or more items **Low risk of OSA:** answering yes to fewer than three items	

Figure 2: Most commonly used screen tool for OSA (STOPBANG Questionnaire).

In terms of airway management, obese patients, those with larger neck circumference or those with craniofacial/airway abnormalities, can create problems for the anaesthetist. Structural abnormalities of the face and obesity can both lead to difficult bag mask ventilation. The increased chest and abdominal weight in obese patients, reduces their functional residual capacity, as well as making the manual ventilation of the patient more difficult. This may lead to rapid oxygen desaturation despite good pre-oxygenation.

SEVERE OBSTRUCTIVE SLEEP APNOEA COMPLICATING AN ALREADY DIFFICULT AIRWAY

T Rudnick, S Acharya

Meticulous positioning of the patient into the "sniffing" position should be undertaken before induction to maximise the chances of first pass intubation. There are also more novel techniques such as 'Optiflow', which allow continued oxygenation during periods of apnoea, particularly when trying to pass an endotracheal tube. 'Optiflow' is a form of high flow oxygen delivery device which can provide oxygen at driving pressures up to 70L/min which is well above the average patients peak inspiratory pressure.

It has also been shown to provide a low level of positive airway pressure in patients upon which it has been used (11). The 'Optiflow' device can be extremely useful in patients such as this whom you suspect a potentially difficult airway, or those with the potential to rapidly desaturate during apnoeic periods.

Local or regional anaesthesia should be preferred wherever possible due to the implications that other more common analgesic drugs have on the patency of the airway (5). Opioids and other sedative agents both reduce the patency of airway, and can also cause respiratory depression, potentially complicating the patients recovery post operatively (12).

The emergence from anaesthesia of these patients is just as challenging as induction. The risk of airway obstruction following extubation is increased in OSA patients (13). As a result patients with OSA, regardless of cause, should be extubated conscious, communicative, and breathing spontaneously with adequate tidal volumes and oxygenation, to prevent the risk of airway complication upon tracheal extubation.

Management of OSA

Once those patients 'at risk' of OSA have been highlighted, they must be appropriately investigated, most accurately via a sleep study known as polysomnography. This technique qualifies the number of respiratory events (periods of hypopnea, or apnoea) occurring during sleep (14).

The studies also monitor ECG, EEG, oronasal airflow and pulse oximetry during sleep. Figure 3 shows a typical sleep study of a patient with OSA. The apnoea/hypopnoea index (AHI) is calculated from the number of apnoea and hypopnoea periods lasting 10 s or longer per hour of sleep. The severity of OSA is categorized from an AHI of 5, 15, and 30 designating mild, moderate, and severe OSA, respectively.

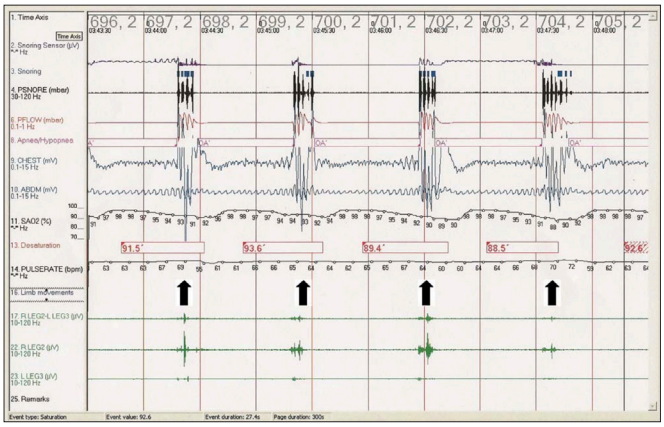


Figure 3: Typical example of an OSA patients polysomnography result.

If obesity is present, weight loss is a critical step in the treatment of obstructive sleep apnoea (15). Medical treatment plans can include both mandibular advancement devices, and CPAP with pressures set between 5 and 20mmHg. Studies have consistently reported a significant decrease in AHI and improved patient-reported quality of life during CPAP therapy. Long-term use of CPAP has also been shown to decrease the frequency of cardiac arrhythmias and improve cardiac function.

In terms of the mandibular advancement devices, studies have shown that they can be equally effective as CPAP in the treatment of OSA (16), however as seen with the patient illustrated in this article, they can be as poorly tolerated as CPAP masks. Consequently, there is an array of surgical procedures available for the treatment of OSA including uvulopalatoplasty, submucosal diathermy and septoplasty, as well as the more major procedures including the osteotomy which this patient underwent.

Test Yourself

1) Which of the following has been shown to be the most accurate screening tool for OSA?

a) Berlin Questionnaire

b) STOPBANG questionnaire

c) Flemons criteria

d) Epworth sleepiness scale

e) None of the above

SEVERE OBSTRUCTIVE SLEEP APNOEA COMPLICATING AN ALREADY DIFFICULT AIRWAY

T Rudnick, S Acharya

2) Which of these statements is correct regarding the epidemiology of OSA?

a) OSA affects more females than males

b) The prevalence of OSA is underestimated

c) Neck circumference >25cm is a quoted risk factor

d) The younger you are the higher risk you are to developing OSA

3) Which of the following drugs should we try to avoid post operatively in OSA patients?

a) Ondansatron

b) Paracetamol

c) Midazolam

d) NSAIDs

4) If appropriate, which would be the most ideal post-operative analgesia plan for OSA patients?

a) Morphine PCA

b) Post op analgesia including paracetamol, codeine, and oromorph

c) As little analgesia as possible as it will all effect OSA

d) Local and regional anaesthesia techniques and the avoidance of opioid therapy

5) Regarding CPAP in general, which of the following statements is most accurate?

a) It refers to bi-level positive airway pressure, a form of non-invasive ventilation that delivers a level of inspiratory pressure to aid the patient during inspiration, and an expiratory pressure to splint open alveoli

b) CPAP is a great tool to clear CO2 in patients with COPD exacerbations

c) CPAP can only be delivered to OSA patients in a hospital setting

d) CPAP Is not always well tolerated

Test yourself answers and teaching points

1) The answer is E, none of the above.

All of the mentioned screening tests are used. The STOPBANG screening tool is probably the most commonly used tool in the UK, however there has been no definitive data suggesting one is better than the other in terms of screening accuracy.

2) The answer is B.

The prevalence of OSA is very much underestimated. OSA effects more men than women, a neck circumference >40cm rather than 25cm is a quoted risk factor, and increasing age is a risk factor.

3) The answer is C, midazolam.

Midazolam is a commonly used sedative agent by anaesthetists, however alongside opioids, it is one of the more common drugs that can dampen respiratory effort and/or obstruct the patients' airway with its sedative effects.

4) The answer is D, local anaesthetic techniques and the avoidance of opioid therapy is ideal for OSA patients.

Opioids have the potential to reduce the patients respiratory rate, and their potential sedative effects can exacerbate the patients OSA.

5) The answer is D, CPAP much like some of the mandibular advancement devices are not always well tolerated.

In terms of the other answers, both A and B in fact refer to BiPAP rather than CPAP. CPAP is very commonly delivered to patients at home, which renders C, false.

SEVERE OBSTRUCTIVE SLEEP APNOEA COMPLICATING AN ALREADY DIFFICULT AIRWAY

T Rudnick, S Acharya

Author

Dr Thomas Rudnick
Anaesthetic Core Trainee
Aintree University Hospital
Longmoor Lane, Liverpool, L9 7AL

Dr Shambhu Acharya
Anaesthetic Consultant
Aintree University Hospital
Longmoor Lane, Liverpool, L9 7AL
spacharya1958@yahoo.co.uk

Corresponding Author

Dr Thomas Rudnick
thomas.rudnick@nhs.net

References

1. Young T, Peppard PE, Gottlieb DJ. Epidemiology of obstructive sleep apnea: A population health perspective. Vol. 165, American Journal of Respiratory and Critical Care Medicine. 2002. p. 1217–39.
2. Imes NK, Orr WC, Smith RO, Rogers RM. Retrognathia and sleep apnea. A life-threatening condition masquerading as narcolepsy [Internet]. Vol. 237, Jama. 1977. p. 1596–7. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=medc&AN=576659 http://sfx.scholarsportal.info/uhn?sid=OVID:medline&id=pmid:576659&id=doi:&issn=0098-7484&isbn=&volume=237&issue=15&spage=1596&pages=1596-7&date=1977&title=JAMA&atitle=Ret
3. Peppard PE, Austin D, Brown RL. Association of alcohol consumption and sleep disordered breathing in men and women. J Clin Sleep Med [Internet]. 2007;3(3):265–70. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17561593%5Cnhttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC2564771
4. Dark a, Armstrong T. Severe postoperative laryngeal oedema causing total airway obstruction immediately on extubation. Br J Anaesth. 1999;82(4):644–6.
5. Rudra a, Chatterjee S, Das T, Sengupta S, Maitra G, Kumar P. Obstructive sleep apnoea and anaesthesia. Indian J Crit Care Med [Internet]. 2008;12(3):116–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21191303
6. Young T, Evans L, Finn L, Palta M. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. Sleep [Internet]. 1997;20(9):705–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9406321
7. Kuna ST, Sant'Ambrogio G. Pathophysiology of upper airway closure during sleep. JAMA. 1991;266(10):1384–9.
8. McNicholas WT, Bonsigore MR, Bonsignore MR. Sleep apnoea as an independent risk factor for cardiovascular disease: current evidence, basic mechanisms and research priorities. Eur Respir J [Internet]. 2007;29(1):156–78. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17197482
9. Lévy P, Ryan S, Oldenburg O, Parati G. Sleep apnoea and the heart. Vol. 22, European Respiratory Review. 2013. p. 333–52.
10. Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, Islam S, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. Anesthesiology [Internet]. 2008;108(5):812–21. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18431116%5Cnhttp://www.ncbi.nlm.nih.gov/pubmed/18431116?ordinalpos=123&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum
11. Parke R, McGuinness S, Eccleston M. Nasal high-flow therapy delivers low level positive airway pressure. Br J Anaesth. 2009;103(6):886–90.
12. Benumof JL. Obstructive sleep apnea in the adult obese patient: Implications for airway management. Vol. 20, Anesthesiology Clinics of North America. 2002. p. 789–811.
13. Rennotte MT, Baele P, Aubert G, Rodenstein DO. Nasal continuous positive airway pressure in the perioperative management of patients with obstructive sleep apnea submitted to surgery. Chest. 1995;107(2):367–74.
14. American Academy of Sleep Medicine Task Force. Sleep-related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. The Report of an American Academy of Sleep Medicine Task Force. Sleep [Internet]. 1999;22(5):667–89. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10450601
15. Johansson K, Neovius M, Lagerros YT, Harlid R, Rössner S, Granath F, et al. Effect of a very low energy diet on moderate and severe obstructive sleep apnoea in obese men: a randomised controlled trial. BMJ [Internet]. 2009;339(2):b4609. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19959590%5Cnhttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC2788899
16. White DP, Shafazand S. Mandibular advancement device vs CPAP in the treatment of obstructive sleep apnea: Are they equally effective in short term health outcomes? Vol. 9, Journal of Clinical Sleep Medicine. 2013. p. 971–2.

Disclaimers

Conflict of interest

The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement

The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement

All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights

When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

SEVERE TRAUMATIC BRAIN INJURY & ORGAN DONATION AFTER NEUROLOGICAL DEATH

KW Tan, D Fraser, V Cunningham

Abstract

The management of traumatic brain injury may be challenging due to the heterogeneity of presentation and pathology. We present a case report in which the management and investigation of severe head trauma in the out-of-hospital setting and emergency department is described.

We focus on the population of severe traumatic brain injury which is associated with a fatal outcome. Critical care management of these patients is carried out in close communication with the neurosurgeons, family and friends, nursing staff. It is closely aligned with the need for the multidisciplinary team to delivery high quality end of life care (1) encompassing physical, psychosocial, emotional and spiritual care to the patient and their relatives.

A discussion of the diagnosis of death by cardio-respiratory and neurological criteria follows, along with the practical aspects of brain stem death testing, circumstances regarding the reporting of deaths to the coroner/procurator fiscal, and the preparation for organ donation as part of end of life care.

Case Report

A 19yr old male was admitted to the neurosurgical intensive care unit (neuro ICU) after being found at the bottom of a flight of concrete steps. His identity was unknown and his fall was unwitnessed. On arrival of the paramedics, he had an apparent isolated head injury, with bleeding from a large occipital wound. He had a Glasgow Coma Scale of 3 (E1M1V1). His left pupil was 6mm and unreactive, and his right pupil 3mm and reactive. He was snoring loudly. An oropharyngeal airway was inserted, 15L oxygen via trauma mask applied, and IV fluids commenced.

He was transferred with full spinal precautions to the nearest emergency department as a standby call, and was intubated and ventilated on arrival before being transferred to CT scan for trauma series imaging. A computed tomography (CT) scan of his head showed diffuse parenchymal and intraventricular haemorrhage and likely diffuse axonal injury. C-spine, chest, abdomen and pelvis imaging revealed no significant abnormalities. He was referred to the on call neurosurgeon who felt that there were no immediate surgical options, but recommended mannitol for raised intracranial pressure (ICP) and ongoing care in neuro ICU for neuroprotection and ICP monitoring.

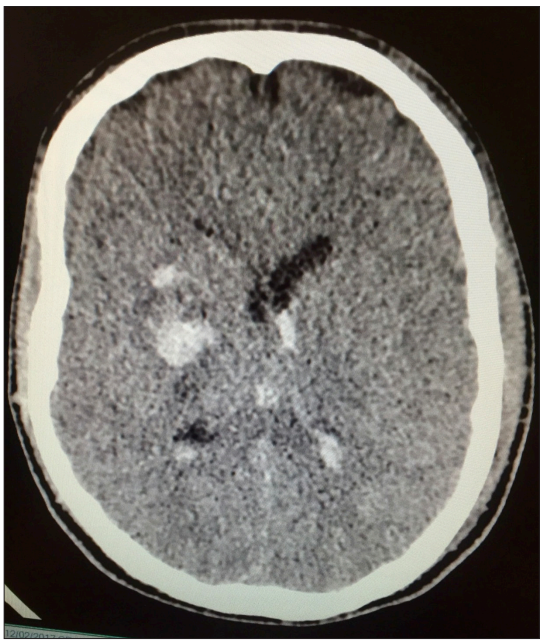


Figure 1: CT scan of patient showing extensive intracranial haemorrhage. Blood is present in the ventricular system, basal cisterns and parenchymal tissue, reflecting diffuse axonal injury. Loss of grey-white matter differentiation suggests global brain hypoxia.

An ICP bolt was placed in neuro ICU, showing a high ICP of 28-30 cm H_2O despite both deep multi-drug sedation, and controlled moderate hyperventilation to an arterial $PaCO_2$ of 4.1kPa. Despite optimal management as described in the Traumatic Brain Injury Guidelines (2), he continued to deteriorate. Over the following 24 hours, his ICP rose to 44cm H_2O, his right pupil also became 6mm and unreactive, and he remained GCS3. There was no evidence of coughing during suctioning of his ET tube and no evidence of spontaneous breaths on the ventilator. It was presumed that he had 'coned' and become brainstem dead. His sedation was permanently discontinued to allow full assessment.

Police had meanwhile confirmed the patient's identity, and his next of kin were contacted. They arrived overnight and were fully updated on his grave and irreversible condition, and of our subsequent plan to perform brain stem death (BSD) tests in the morning. The organ donor register was checked; the patient had agreed to organ donation with no restrictions while applying for his driving licence two years previously. The on call Specialist Nurse in Organ Donation (SN-OD) was notified of his potential status as an organ donor pending completion of BSD tests.

SEVERE TRAUMATIC BRAIN INJURY & ORGAN DONATION AFTER NEUROLOGICAL DEATH

KW Tan, D Fraser, V Cunningham

Overnight he became unstable, requiring fluid and noradrenaline via a central line to support his blood pressure. He began producing large volumes of dilute urine, and his sodium on the arterial blood gas rose to 151 mmol/L. Serum and urine osmolalities confirmed diabetes insipidus. He was treated with DDAVP (desmopressin), a vasopressin analogue, and his urine volumes and serum sodium returned to normal. It was agreed that the patient should not be offered cardiopulmonary resuscitation in the event of cardiac arrest (DNACPR), but that all supportive measures should be offered.

Two sets of brain stem death tests were performed the following day. Condolences were offered to the family, and in a sensitive manner, his decision to become an organ donor was discussed. Although they had not discussed organ donation with him while he was alive, they were supportive of our efforts to facilitate his wishes. The SN-OD spent time with the family explaining the organ donation process and completing formal consent paperwork. The Procurator Fiscal was contacted due to the unwitnessed nature of his accident, and gave permission for organ donation to proceed.

The patient was prepared for organ donation after brain death (DBD). Bloods were taken for tissue typing, as well as routine tests including amylase and GGT. An electrocardiogram (ECG) and chest x-ray were requested and reported. The on call Cardiac Scout performed a transoesophageal echocardiogram to assess heart structure and function. A single 1g bolus of IV methylprednisolone was given to reduce the harmful systemic inflammation that occurs following brain death. Vasopressin and actrapid infusions were commenced and titrated.

After all investigations had been completed and suitable recipient centres identified for his organs, a transplant team was mobilised and theatre prepared. The patient was transferred to theatre where the retrieval proceeded uneventfully. In accordance with the instructions of the Procurator Fiscal, all lines, drips and tubes remained in situ at the end of the harvest. Medical staff did not issue a death certificate to the family, leaving this responsibility to the Procurator Fiscal once suspicious circumstances surrounding the patient's initial injury had been ruled out.

Discussion

Diagnosing death after cardiorespiratory arrest

Death can be defined in many ways, but an international consensus opinion on the medical concept of death involves the irreversible loss of consciousness, coupled with the irreversible loss of the capacity to breathe (3).

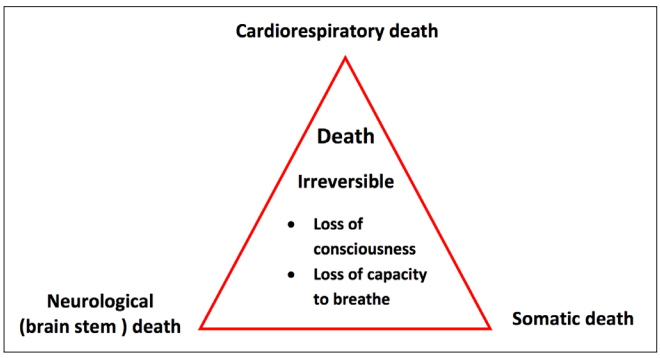


Figure 2: Criteria for diagnosing death (4).

The diagnosis and confirmation of death after cardiorespiratory arrest is a responsibility most foundation year doctors have undertaken.

This entails

- *Observation of the lack of a central pulse or heart sounds on auscultation over a period of five minutes. Any return of function during this period should be followed by a further five minutes of observation.*

- *Testing of pupillary and corneal reflexes and the motor response to supra-orbital pressure is carried out after this period.*

- *The time of death is recorded as the time of test completion (3).*

Arterial blood pressure monitoring, electrocardiography or echocardiography in the hospital setting can be used to supplement observation.

Criteria for neurological death

Foundation doctors may be less familiar with the diagnosis of neurological, or brain stem death. Patients who are in a coma and have suffered irreversible brain stem damage may be kept alive by mechanical ventilation and cardiovascular support. Withdrawal of support inevitably leads to circulatory death after a varying length of time.

Neurological death, where brain stem control of respiratory function and integrative function is lost, must therefore be distinguished from coma or a persistent vegetative state where cranial nerve reflexes and ventilation may remain. It implies that the patient has neither sensation nor awareness, and is in keeping with the concept of the irreversible loss of consciousness and capacity to breathe. Spinal reflexes leading to limb movement may however be present when a stimulus is applied, and should not be taken as an indicator of purposeful movement.

SEVERE TRAUMATIC BRAIN INJURY & ORGAN DONATION AFTER NEUROLOGICAL DEATH

KW Tan, D Fraser, V Cunningham

The diagnosis of neurological death requires certain criteria to be fulfilled (5).

- Aetiology of brain injury

This may be due to clear causes such as intracranial haemorrhage, but in cases of uncertainty e.g. central nervous system infection or drug overdose, all treatable conditions must first be excluded. A period of observation greater than 24 hours prior to brain stem death testing is advocated in anoxic brain injury and after rewarming from hypothermia.

- Excluding reversible causes of unconsciousness

This includes metabolic, endocrine, infections, temperature or drug related causes of an impaired conscious level. Drug effects may take significant amounts of time to wear off especially in the presence of hepatic or renal dysfunction. Any abnormalities should be corrected prior to consideration of brain stem death testing.

- Absence of brain stem reflexes

Once the above pre-conditions are met, the practical assessment of brain stem death can be carried out. This involves the testing of cranial nerve reflexes and the apnoea test, which illustrates the irreversible loss of the capacity to breathe.

These criteria have been applied for over 40 years and are based on scientific principles, robust observational studies and international agreement, leading to confidence in diagnosing death if adhered to meticulously (6).

Brain stem death testing

Once preconditions have been satisfied, brain stem death testing can be carried out. Tests must be performed by two medical practitioners registered with the General Medical Council for more than five years, and who are competent in the assessment of patients with irreversible brain stem damage and the conduct and interpretation of brain stem death testing (7). Tests should be performed on two occasions. The usual practice is of role reversal, with the doctor who performs the first set of tests observing the second set. The second set of tests can be carried out immediately following the first set.

The patient is considered alive until the completion of both sets of tests, however, the time of death is recorded as the time of completion of the first set of tests.

Confirmation of death by neurological criteria is advocated if this is likely to be the case, regardless of the possibility of organ donation. This gives family members certainty of diagnosis and allows futile treatment to cease.

APPENDIX 1

PROCEDURE FOR THE DIAGNOSIS AND CONFIRMATION OF CESSATION OF BRAIN-STEM FUNCTION BY NEUROLOGICAL TESTING OF BRAIN-STEM REFLEXES

Diagnosis is to be made by two doctors who have been registered for more than five years and are competent in the procedure. At least one should be a consultant. Testing should be undertaken by the doctors together and must always be performed completely and successfully on two occasions in total.

Patient Name: **Unit No:**

Pre-conditions

Are you satisfied that the patient suffers from a condition that has led to irreversible brain damage?

Specify the condition:

Dr A: **Dr B:**

Time of onset of unresponsive coma:

Dr A: **Dr B:**

Are you satisfied that potentially reversible causes for the patient's condition have been adequately excluded, in particular:

	DR A:	DR B:
DEPRESSANT DRUGS		
NEUROMUSCULAR BLOCKING DRUGS		
HYPOTHERMIA		
METABOLIC OR ENDOCRINE DISTURBANCES		

TESTS FOR ABSENCE OF BRAIN-STEM FUNCTION	1ST SET OF TESTS	2ND SET OF TESTS	1ST SET OF TESTS	2ND SET OF TESTS
DO THE PUPILS REACT TO LIGHT?				
ARE THERE CORNEAL REFLEXES?				
IS THERE EYE MOVEMENT ON CALORIC TESTING?				
ARE THERE MOTOR RESPONSES IN THE CRANIAL NERVE DISTRIBUTION IN RESPONSE TO STIMULATION OF FACE, LIMBS OR TRUNK?				
IS THE GAG REFLEX PRESENT?				
IS THERE A COUGH REFLEX?				
HAVE THE RECOMMENDATIONS CONCERNING TESTING FOR APNOEA BEEN FOLLOWED?				
WERE THERE ANY RESPIRATORY MOVEMENTS SEEN?				

Date and time of first set of tests:

Date and time of second set of tests:

Dr A Signature: **Dr B Signature:**

Status: **Status:**

A CODE OF PRACTICE FOR THE DIAGNOSIS AND CONFIRMATION OF DEATH

Figure 3: Documentation for brain stem death testing.

Challenges

The General Medical Council (GMC) has issued guidance on treatment and care towards the end of life (8), which may be predicted or unexpected, as was the case for our patient. This is an emotive and highly stressful time for families who have received bad news and are faced with the shock and fear of losing a loved one. Communication about poor prognosis or treatment decisions must therefore be carried out with utmost care and sensitivity, in a timely and appropriate setting.

A comatose patient does not have capacity to make decisions, but their feelings, beliefs, values and prior wishes should be taken into consideration, as well as those of their family members. Medical records or advanced directives should be consulted, as well as ascertaining if someone holds power of attorney regarding healthcare decisions. Treatment decisions made by the multidisciplinary healthcare team should always be for the benefit of the patient, and this may mean cessation or withdrawal of life-prolonging treatment that does not benefit the patient.

SEVERE TRAUMATIC BRAIN INJURY & ORGAN DONATION AFTER NEUROLOGICAL DEATH

KW Tan, D Fraser, V Cunningham

Guidance states that 'if a patient is close to death and their views cannot be determined, you should be prepared to explore with those close to them whether they had expressed any views about organ or tissue donation, if donation is likely to be a possibility' (8). Donation should not be discussed until the family have accepted the clinical outcome.

Referral to the Specialist Nurse for Organ Donation (SN-OD) should be done when the decision to conduct brain stem death testing or to withdraw active treatment in the anticipation of circulatory death is made (9). Early referral facilitates decision making and communication between the parent team, transplant team and the family, improving processes and outcomes. Decisions regarding the suitability of a candidate for organ donation are made by the transplant coordinator or team rather than the team caring for the patient.

Knowing the aetiology of his coma and having excluded reversible causes, it would be appropriate to discuss the likely outcome with his family, including in the discussion the topic of organ donation and referral to the transplant coordinators if the patient is on the Organ Donor Register (www.nhsbt.org.uk or www.organdonationscotland.org) or if this is compatible with the patient's and family's wishes. The discussion should include an explanation of the need for and process of brain stem death testing, which families may wish to be present for, as the recorded time of death is the time of conclusion of the first set of tests. If they are present, they should be prepared for the possibility of spinal reflexes during testing.

Legal requirements for reporting of deaths to the coroner or procurator fiscal (Scotland only) should be fulfilled, and be discussed with the family at the same time10. Advice on when to report a death is available at https://www.gov.uk/after-a-death/when-a-death-is-reported-to-a-coroner and http://www.crownoffice.gov.uk/images/Documents/Deaths/Reporting%20Deaths%20to%20the%20Procurator%20Fiscal%202015.pdf. They may allow donation to proceed if this does not interfere with their investigation into the cause of death.

Organ donation

Organ donation should be considered as part of end-of-life care planning (11). The Human Tissue Act 2004 and the Human Tissue (Scotland) Act 2006 provide the legal framework for deceased organ donation. The number of deceased donors per year is at the highest level to date (1,364 in 2015-16) with 4,021 patients whose lives were saved or improved (12). However, 1,347 patients either died while waiting for a transplant or were removed from the waiting list due to ill health during this time. The overall rate of referral of potential donors and of consent/authorisation has risen, and may rise further if presumed consent or opt-out strategies are more widely adopted as in the Human Transplantation (Wales) Act 2013.

In relation to the clinical case, discussion about organ donation after brainstem death (DBD) should include practicalities such as (11):

- *The timing of brainstem death testing and the withdrawal of active treatment.*

- *The process and time frame of organ retrieval, which can be associated with a lengthy wait in order to retrieval teams to assemble and an emergency theatre to be made available.*

- *Potential interventions required to maintain physiological stability prior to retrieval.*
- *Post-retrieval arrangements.*

Facilitating organ donation may mean that interventions are necessary to stabilize the patient, such as providing circulatory and endocrine support in addition to mechanical ventilation. This could be argued as remaining in the patient's best interests, if organ donation is consistent with their wishes, values and beliefs, even if it does not constitute active treatment. However, any intervention should be carried out in a way that minimizes distress to relatives and friends. The UK Donation Ethics Committee has produced an ethical framework for donation after brain stem death, which should be consulted and may help in areas of controversy (13).

Interventions to optimize donor organ condition can be grouped into the following areas (14):

- *Appropriate monitoring including invasive blood pressure monitoring and transthoracic echocardiography*

- *Cardiovascular status: Restoration of adequate circulating volume and vasopressin as a first line vasopressor if required.*

- *Respiratory parameters: Lung recruitment manoeuvres and protective ventilation, along with an up to date chest xray.*

- *Endocrine: Diagnose and treat diabetes insipidus, and administer liothyronine (T3) and methylprednisolone (15mg/kg, maximum 1g) in consultation with the transplant team. Glycaemic control, with insulin infusions if required, is essential.*

- *Overall critical care: Temperature control, correcting electrolyte abnormalities, suctioning and enteral feeding should all be considered.*

SEVERE TRAUMATIC BRAIN INJURY & ORGAN DONATION AFTER NEUROLOGICAL DEATH

KW Tan, D Fraser, V Cunningham

Donation after circulatory death (DCD) or non-heart beating organ donation is increasing. DCD occurs when patients do not fulfil the criteria for BSD testing, and organ retrieval takes place after death is diagnosed by cardio-respiratory criteria (15). This has arisen after advances in road safety, neurocritical care and the treatment of traumatic brain injury lead to fewer suitable candidates for DBD. Success rates are also improving with the increase in awareness of DCD and the development of strategies to optimize organs that are obtained after cardio-respiratory death.

Summary

- The diagnosis of death involves determining the irreversible loss of consciousness and the capacity to breathe.

- Neurological, or brain stem death, requires preconditions to be satisfied before brain stem death testing can be performed to confirm death.

- Discussion of organ donation should be instituted early when this is a possibility, in conjunction with SN-ODs and the multidisplinary team, as part of end of life care.

- Organ donation can be heart beating (DBD) or non-heart beating (DCD). The ethical and legal frameworks of organ donation are well established, and substantial guidance is available.

Multiple Choice Questions (Best of 5)

1) Cardiorespiratory Death is diagnosed by fixed dilated pupils and

(a) Absence of breath sounds and absence of central pulse for 3 mins
(b) Absence of heart sounds and absence of central pulse for 3 mins
(c) Absence of breath sounds and absence of central pulse for 5 mins
(d) Absence of heart sounds and absence of central pulse for 5 mins
(e) Absence of an ECG trace on the monitor

2) Neurological Death is diagnosed by

(a) Exclusion of all other factors contributing to deep coma
(b) Absence of breathing
(c) Absence of cough or gag reflex
(d) No pupillary response to light or blink to corneal stimulation
(e) All of the above

3) Brainstem Death Tests:

(a) Must be performed when the patient's core temperature is above 34C
(b) Can be performed 2 hours after stopping sedation
(c) Can be undertaken by the On Call Consultant and Medical FY2
(d) Requires the consent of the patient's relatives
(e) Are always necessary before organ donation

4) The correct Time of Death in a DBD (Donation after Brain Death) patient is;

(a) Time that the patient 'cones'
(b) Time of completion of first set of Brainstem Death Tests
(c) Time of completion of second set of Brainstem Death Tests
(d) Time of switching off ventilator in theatre during organ harvest
(e) Time of completion of organ harvest procedure

5) Regarding the Human Tissue and Transplantation Acts; the following statement is false

(a) In Wales the organ donation process will occur after circulatory or neurological death unless the patient has previously "opted out"
(b) In England and Scotland a person's joining of the organ donor register is considered legal consent
(c) If the patient is on the organ donor register, their relatives wishes don't count
(d) Competent adults and children over the age of 12 can give consent for their organs to be donated
(e) A patient's wish to be and organ donor is automatically given priority over other posthumous wishes (ie donating body to science)

Answers

1) C – Circulatory death is diagnosed when examination demonstrates absence of central pulse (ie femoral, carotid) plus absence of heart sounds for five minutes.

Following this, there should be no response to a supraorbital painful stimulus, and pupils should be dilated and unreactive to light, both directly and consensually. Monitoring devices such as arterial lines and the ECG monitor can be used as supporting methods but must never be used as a primary mode of diagnosis of death, as these is a risk of technical fault or disconnection which may give false information.

2) E – Neurological death is essentially death of the brainstem, demonstrated by loss of vital brainstem functions.

It involves the presence of deep coma, with apnoea and loss of cranial nerve reflexes. In the eyes, fixed unreactive pupils (cranial nerves (CN) 2, 3), and an absent corneal reflex (CN 5, 7). In the ears, absent vestibulocochlear reflex in response to instillation of ice cold water (CN 3, 8). No cough or gag should be elicited on pharyngeal stimulation or endobronchial suction (CN 9, 10). There should be no motor response to supraorbital pain (CN 5, 7). On disconnection of the ventilator, despite rising $PaCO_2$, there should be no respiratory effort (medulla and chemoreceptors).

SEVERE TRAUMATIC BRAIN INJURY & ORGAN DONATION AFTER NEUROLOGICAL DEATH

KW Tan, D Fraser, V Cunningham

3) A – BSD tests can be undertaken when there is deep coma, with evidence of loss of critical brainstem functions, in the presence of pathology causing irreversible severe brain damage.

This may be intracranial (bleeds, head injury), or extracranial (cardiac arrest) with the end result being profound cerebral hypoxia. Other causes of coma, particularly hypothermia, must be excluded. Sedation and muscle relaxants should have completely worn off.

Tests must be undertaken by two doctors, both with 5 years full GMC registration, and one must be a consultant. It is good practice to notify the relatives of the intent to perform BSD testing but this does not require specific consent. BSD tests are only necessary when considering DBD (donation after brain death); however, donation can also proceed after withdrawal of active care and subsequent circulatory death in a process known as DCD (donation after circulatory death).

4) B – The legal time of death is the time of completion of the first set of BSD tests.

5) C – England, Scotland and Northern Ireland have adopted an 'opt-in' policy on organ donation for competent adults and children over the age of 12.

By opting in via donor card, driving licence or will, advance legal consent has been given. This consent is considered valid even when relatives disagree with it, and the law says that relatives cannot 'undo' or overrule this consent. In reality however, it is unlikely that most clinicians would proceed with organ donation if a family felt strongly against it, as this has massive implications for the grieving process. It is a situation that must be treated with the utmost sensitivity and respect.

Author

Ker Wei Tan
ST7 Anaesthetics
Queen Elizabeth University Hospital
1345 Govan Road, Glasgow, G51 4TF

Donna Fraser
Specialty and Associate Specialist (SAS) doctor
Institute of Neurological Sciences
1345 Govan Road, Glasgow, G51 4TF
drdonnafraser@gmail.com

Valerie Cunningham
Consultant Anaesthetist
Institute of Neurological Sciences
1345 Govan Road, Glasgow, G51 4TF
cunninghamrsvj@btinternet.co

Corresponding Author

Ker Wei Tan
kerweitan@nhs.net

References

1. The Foundation Programme (2016). FP Curriculum 2017. http://www.foundationprogramme.nhs.uk/curriculum/Syllabus
2. Brain Trauma Foundation (September 2016). Guidelines for the management of severe traumatic brain injury. 4th edition, https://braintrauma.org/uploads/03/12/Guidelines_for_Management_of_Severe_TBI_4th_Edition.pdf
3. Academy of Medical Royal Colleges (2008). A code of practice for the diagnosis and confirmation of death. http://aomrc.org.uk/wp-content/uploads/2016/04/Code_Practice_Confirmation_Diagnosis_Death_1008-4.pdf
4. Oram J, Murphy P. Diagnosis of Death. Continuing education in anaesthesia, critical care and pain 2011, 11(3): 77-81.
5. Conference of Medical Royal Colleges and their Faculties in the United Kingdom. Diagnosis of brain death. British Medical Journal 1976, 2(11): 1187-8.
6. Gardiner D, Shemie S, Manara A, Opdam H. International perspective on the diagnosis of death. British Journal of Anaesthesia 2012, 108(S1): i14-i28.
7. Gardiner D, Manara A. Form for the Diagnosis of Death using Neurological Criteria. Faculty of Intensive Care Medicine (November 2014). https://www.ficm.ac.uk/sites/default/files/Form%20for%20the%20Diagnosis%20of%20Death%20using%20Neurological%20Criteria%20-%20Full%20Version%20(2014).pdf
8. General Medical Council (May 2010). Treatment and care towards the end of life: good practice in decision making. http://www.gmc-uk.org/Treatment_and_care_towards_the_end_of_life___English_1015.pdf_48902105.pdf
9. NHS Blood and Transplant (September 2012). Timely identification and referral of potential organ donors – a strategy for implementation of best practice. http://www.odt.nhs.uk/pdf/timely-identification-and-referral-potential-donors.pdf
10. Intensive Care Society. Guidelines for adult organ and tissue donation. http://www.ics.ac.uk/ICS/guidelines-and-standards.aspx
11. National Institute for Health and Clinical Excellence (December 2011). Organ donation for transplantation: improving donor identification and consent rates for deceased organ donation. http://guidance.nice.org.uk/CG135
12. NHS Blood and Transplant. Organ donation and transplantation – Activity report 2015-2016. http://www.odt.nhs.uk/pdf/activity-report/activity_report_2015_16.pdf
13. UK Donation Ethics Committee (April 2016). An ethical framework for donation after confirmation of death using neurological criteria (DBD). http://www.aomrc.org.uk/publications/reports-guidance/ethical-framework-donation-confirmation-death-using-neurological-criteria-dbd/
14. NHS Blood and Transplant. Donor optimisation guideline for management of the brain-stem dead donor. http://www.odt.nhs.uk/pdf/donor_optimisation_guideline.pdf
15. NHS Blood and Transplant. Donation after circulatory death. http://www.odt.nhs.uk/donation/deceased-donation/donation-after-circulatory-death/

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

THE OBESE SURGICAL PATIENT FOR NON-BARIATRIC SURGERY

SA Howell, MV Copp

Abstract

Obesity is an increasing problem within modern healthcare. It causes a financial burden on health services as a whole, and on multi disciplinary teams caring for individual patients in the perioperative period. In this review we will consider the definition of obesity and the physiological and anatomical challenges it presents the anaesthetist during non-bariatric surgery. In particular, respiratory changes impair ventilation and predispose to hypoxia, cardiovascular changes predispose to increased myocardial workload, ischaemic heart disease and arrhythmias.

Altered airway anatomy increases the risk of encountering a difficult airway. Increased body fat leads to difficulties in correctly dosing drugs with the potential for under and overdosing. However, we will discuss how, with careful pre, intra and postoperative care these risks can be mitigated. Finally, we will provide a case example to illustrate these principles.

Introduction

The World Health Organization (WHO) defines obesity as a body mass index (BMI) of greater than 30 kg/m2 (table 1). From 1993 to 2014 the prevalence of obesity among adults rose from 14.9% to 25.6% (1). It is predicted that by 2050 obesity will affect 60% of men, 50% of women and 25% of children. This is expected to cost the NHS an extra £45.5 billion per year (2). It causes a number of challenges for the anaesthetist in the perioperative period, which we will explore in the context of non-bariatric (non weight loss) surgery.

BMI (kg/m2)†	Classification
<18.5	Underweight
18.5-24.9	Normal range
≥25.0	Overweight
30-34.9	Obese class 1
35-39.9	Obese class 2
≥40.0	Obese class 3 (formerly 'morbid obesity')

†Body Mass Index

Table 1: WHO classification of obesity.

Pathophysiology

As a multisystem disorder, obesity presents a host of anatomical and physiological challenges in the perioperative period. This is particularly true of the 'apple shaped' patient with central obesity.

Respiratory system

Obesity results in an increased oxygen demand as a result of highly metabolically active fat and the mechanical effect of increased weight, whilst simultaneously rendering ventilation less efficient.

Functional residual capacity (FRC), which provides a reservoir of oxygen during apnoea, is reduced as a result of fat deposition within the chest wall and abdomen (Figure 1). There is increased atelectasis, and ventilation-perfusion mismatching. These changes are exacerbated with the onset of anaesthesia itself, with head down positioning and pneumoperitoneum. This results in an increased risk and faster onset of hypoxia, and higher airway pressures during positive pressure ventilation.

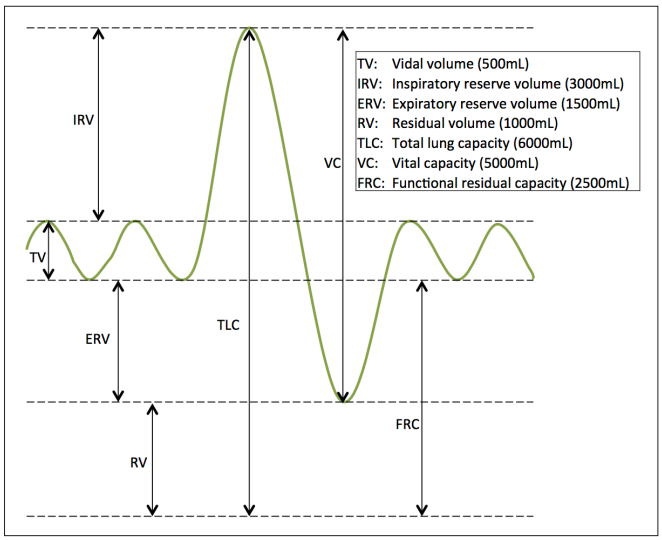


Figure 1: Spirometry trace demonstrating functional residual capacity.

Obstructive sleep apnoea (OSA) occurs when repeated apnoeic episodes are caused by pharyngeal collapse during sleep. Severe OSA may affect up to 20% of patients with a BMI > 35 kg/m^2. It is associated with an increased risk of respiratory and cardiac complications perioperatively, particularly as a result of increased sensitivity to the respiratory depressant effects of opioid medications (3). These risks are significantly reduced in those treated with overnight continuous positive airway pressure (CPAP)(4).

Cardiovascular system

Obesity is associated with hypercholesterolaemia, hypertension and ischaemic heart disease. Cardiac workload is increased in order to supply the greater oxygen requirements. Fatty infiltration of cardiac conduction pathways predisposes to arrhythmias, particularly atrial fibrillation (5).

THE OBESE SURGICAL PATIENT FOR NON-BARIATRIC SURGERY

SA Howell, MV Copp

Other systems

Obesity may lead to insulin resistance and type 2 diabetes mellitus, with associated increase in the risk of micro and macrovascular complications. Risk of venous thromboembolism is also increased. There is a greater risk of hiatus hernia and gastro-oesophageal reflux disease, which puts patients at risk of regurgitation and aspiration during periods of anaesthesia where the airway is unprotected.

Pharmacology

Complexity when adjusting drug doses in the obese patient introduces the potential to under or overdose. Logically, it might be thought that lipophilic drugs could be dosed based on the patients total body weight, as they are likely to distribute throughout the fat compartment. However, this ignores the effect of varying degrees of lipid solubility and redistribution rates.

The 5th National Audit Project (NAP5) found that obese patients were at greater risk of accidental awareness during anaesthesia (6), demonstrating the risk of under dosing anaesthetic agents. Conversely, excess dosing of anaesthetic drugs is likely to cause cardiovascular instability, prolong wake-up, and in the postoperative phase cause respiratory depression, delay mobilization and exacerbate nausea and vomiting.

In practice it is suggested that hydrophilic drugs are dosed based on the 'lean body weight'; the calculated weight of the patient excluding fat. These calculations are complex, but plateau at 100kg in men and 70kg in women (7).

Lipophilic drugs in contrast should be dosed depending on 'adjusted body weight', which adds 40% of the excess weight to the lean body weight (8).

Preoperative care

In the preoperative phase height and weight should be measured and BMI calculated. In the obese patient, particular attention should be paid to identifying co-morbid diseases, and ensuring their management is optimal. This extends beyond those conditions for which the patient already has a diagnosis, to screening for diabetes and OSA for example. A simple screening tool for OSA is the STOP-BANG questionnaire (Figure 2)(9).

Snoring	Do you snore loudly (loud enough to be heard through closed doors?)
Tired	Do you often feel tired, or sleepy during daytime?
Observed	Has anyone observed you stop breathing during your sleep?
Blood Pressure	Do you have or are you being treated for high blood pressure?
BMI	BMI more than 35kg/m^2?
Age	Age over 50 years old?
Neck	Neck circumference >40cm?
Gender	Male?

A score > 5 indicates a high probability of moderate/severe OSA

Figure 2: The STOP-BANG questionnaire, a screening tool for obstructive sleep apnoea

A thorough examination of the airway should be performed, as obesity is associated with an increased risk of difficult bag-mask ventilation and of difficult or failed intubation. This should include assessment of mouth opening, Mallampati score (figure 3)(10), ability to protrude the jaw, neck extension and dentition. In addition, neck circumference over 60cm is a particularly sensitive predictor of difficult laryngoscopy (11).

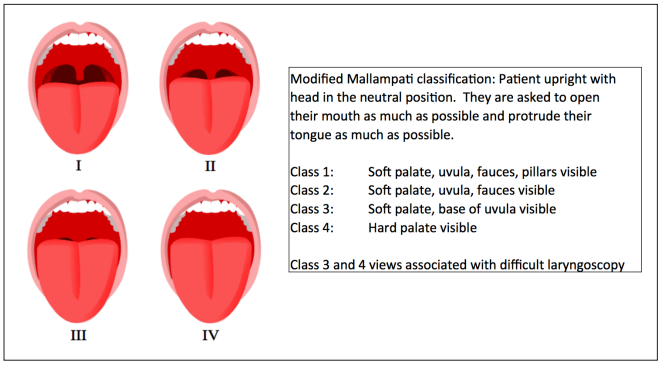


Figure 3: Diagram showing the modified Mallampati classification. (image covered by creative commons license)

Anaesthetic technique

Good communication between the multi-disciplinary team is required to ensure that appropriate levels of staff, equipment, expertise and time are available. Consideration should be given at all steps in the patient's journey to the influence of high BMI, including appropriate hospital clothing, beds, chairs and monitoring.

Where possible, general anaesthesia should be avoided altogether by using local or regional techniques in which nerves providing sensory supply to the surgical site are surrounded by local anaesthetic. An example would be blockade of the brachial plexus for upper limb surgery.

Preoperative analgesia and antacid medication should be considered, and if possible the patient should position themselves on the operating table to reduce the need for manual handling. The 'ramped' rather than the classic 'sniffing the morning air' position should be adopted. Aligning the tragus of the ear with the chest in this manner improves respiratory function and view at laryngoscopy (12). This can be achieved easily with the Oxford HELP pillow (Figure 4).

THE OBESE SURGICAL PATIENT FOR NON-BARIATRIC SURGERY

SA Howell, MV Copp

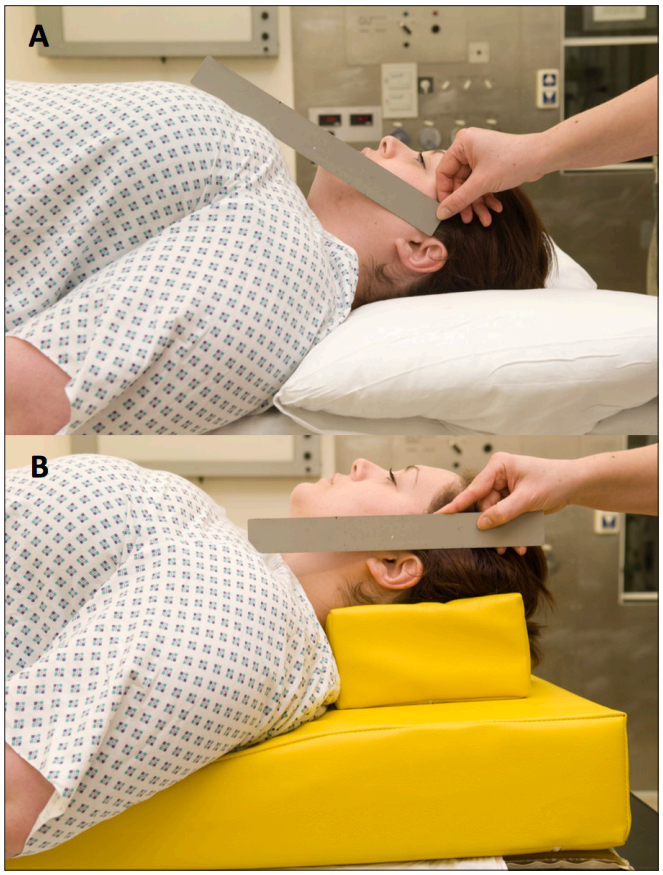


Figure 4: Diagram demonstrating patient positioning without (A) and with (B) the Oxford HELP pillow. Images courtesy of Alma Medical 2017.

Effective pre-oxygenation maximizes the time during which the patient's arterial oxygen saturations will be maintained during apnoea. Due to the physiological changes discussed above this can be considerably shorter than in other patients. A plan should be in place before induction in line with Difficult Airway Society guidelines in the event that bag-mask ventilation or laryngoscopy is difficult (13), bearing in mind that rescue techniques also have a greater chance of failure (14). The aim of induction should be to use short acting and easily reversible drugs to achieve rapid control of the airway. Monitoring may be challenging, and blood pressure cuffs may need to be positioned on the patients forearm.

Due to the risk of hypoventilation and regurgitation, endotracheal intubation and mechanical ventilation is the most common means of maintaining the airway. This is particularly true of intra abdominal surgery, and surgery in the head down position. Anaesthesia should be maintained with short acting volatile agents such as desflurane, or an infusion of propofol. Where available this can be titrated with a depth of anaesthesia monitor. All efforts should be made to reduce the amount of opioid required, including use of local anaesthetic, paracetamol and non-steroidal anti-inflammatory drugs.

Emergence from anaesthesia is another common time to encounter airway difficulties, and therefore patients should be extubated awake and following the return of airway reflexes. They should be positioned sat up to optimise respiratory mechanics. Neuromuscular blocking drugs used to facilitate intubation or surgery should be fully reversed.

Traditionally, reversal of non-depolarising neuromuscular blockade has relied on cholinesterase inhibitors such as neostigmine. These reduce the breakdown of acetylcholine at the motor end plate and allow competitive inhibition of neuromuscular blockade. However, there is increasing recognition of the role of sugammadex in the reversal of the aminosteroid drugs rocuronium and vecuronium, particularly in the obese patient. Sugammadex works by encapsulating these drugs and has demonstrated rapid, predictable restoration of muscle function and an enhanced quality of recovery.

Postoperative care

Appropriate monitoring should continue into the postoperative period, with supplemental oxygen provided as required to maintain oxygen saturations. In patients established on CPAP for OSA this should be reinstituted. Multimodal analgesia should continue and there should be an emphasis on early mobilisation and appropriate prophylaxis of venous thromboembolism.

Applied clinical case

This report is based on a true clinical case of a patient with morbidly obesity requiring elective surgery for endometrial carcinoma.

A laparoscopic approach was chosen to enhance patient recovery with optimal pain control and early mobilisation. Therefore in addition to the challenge of anaesthesia in the morbidly obese patient, the surgery would require a pneumoperitoneum and positioning in the Trendelenburg (head down) position for at least an hour.

The patient was a 56-year-old female with an actual weight of 172kg. Her BMI was 53kg/m^2. Her airway assessment revealed a Mallampati score of 2 and a good range of cervical spine movement. Her STOP-BANG scored was 3. She was a non-insulin dependent, type 2 diabetic.

Aims

- **Successfully intubate the trachea with optimal positioning achieved using the Oxford HELP pillow**
- **Optimal organ perfusion with a cardiovascularly stable anaesthetic**
- **Maintain muscle relaxation throughout surgery to provide ideal surgical conditions**
- **Avoid long acting and lipophilic drugs where possible which could impair recovery from anaesthesia**
- **A controlled emergence from anaesthesia, with complete return of airway reflexes, neuromuscular and respiratory function**
- **A rapid recovery to street fitness with early mobilisation, no post-operative nausea and vomiting and good analgesia**

THE OBESE SURGICAL PATIENT FOR NON-BARIATRIC SURGERY

SA Howell, MV Copp

Anaesthetic technique

• Premedication: 30mg lansoprazole, 1g paracetamol. To reduce gastric pH and content and provide preemptive analgesia
• Patient anaesthetised in the operating theatre having positioned herself on the operating table in the ramped position using the Oxford HELP pillow
• All airway equipment checked and ready for a potential difficult intubation. Videolaryngoscope immediately available.
• Patient preoxygenated for 3 minutes
• Intravenous induction of anaesthesia: fentanyl 150µg (opioid analgesic), propofol 200 mg (anaesthetic induction agent), rocuronium 100mg (non-depolarising neuromuscular blocker)
• Bag and mask ventilation was easy following insertion of an oropharyngeal airway
• Laryngoscopy revealed a Cormack-Lehane Grade 1 view (a full view of the glottis) and tracheal intubation was achieved with a size 8 endotracheal tube
• Anaesthesia was maintained with O2, air and desflurane
• A remifentanil infusion (ultra-short acting opioid) was run at 0.1-0.3µg/kg/min
• Morphine (opiate analgesic) 15mg, 30 minutes prior to the estimated end of surgery
• 20mg rocuronium top up doses as required
• Reversal of neuromuscular blockade with sugammadex 350mg (2mg/kg)

Surgery lasted 150 minutes. 60 seconds after administration of sugammadex the patient open her eyes and started spontaneous respiration with good tidal volumes and pattern of breathing. 3 minutes after reversal the patient had been extubated and was fully awake. 5 minutes after extubation, the patient was able to transfer herself across onto her bed with minimal assistance. She was alert and had minimal discomfort. The patient was discharged home 36 hours after surgery.

Conclusion

In conclusion, as its prevalence continues to increase, obesity is expected to cause growing financial pressures on health services. Obesity provides a number of physiological, anatomical and pharmacological challenges for the anaesthetist, which require careful consideration. However, with thorough preoperative assessment and planning, intraoperative care and appropriate postoperative management these risks can be mitigated and successful outcomes achieved.

Questions

1. Which of the following is most likely to predispose to hypoxia in the obese patient in the perioperative period?

a. Aspiration
b. Increased work of breathing
c. Decreased inspired concentration of oxygen
d. Decreased functional residual capacity
e. An obstructive lung defect

2. With regards to obstructive sleep apnoea

a. Bi-level positive airway pressure (BiPAP) is the treatment modality of choice
b. Is caused by centrally driven apnoea
c. Is associated with an increased risk of respiratory and cardiac complications in the perioperative period
d. It can be diagnosed using the STOP-BANG questionnaire
e. CPAP is of symptomatic benefit only and does not influence respiratory or cardiac complications in the perioperative period

3. The following is the strongest predictor of difficult laryngoscopy in the obese patient

a. Neck circumference of 65cm
b. Mallampati class 2
c. Presence of a beard
d. Male gender
e. Poor dentition

4. Regarding neuromuscular drugs

a. They should be avoided in obese patients
b. A cholinesterase drug such as neostigmine should be administered to reverse their effects at the end of surgery
c. Sugammadex acts by hydrolysing aminosteroid neuromuscular blockers
d. Sugammadex acts by encapsulating aminosteroid neuromuscular blockers
e. Suxamethonium should be used in preference to the non-depolarising neuromuscular blockers

5. Regarding body mass index. Which of the following is true?

a. It is measured in kg/m^3
b. It is measured in m^2/kg
c. It cannot exceed a value of 50
d. A value >25 is considered obese in the context of comorbid disease
e. It is measured in kg/m^2

THE OBESE SURGICAL PATIENT FOR NON-BARIATRIC SURGERY

SA Howell, MV Copp

Answers

1. Answer is d

Functional residual capacity is the sum of the residual volume and the expiratory reserve volume. It is the volume of gas remaining in the lung after a normal tidal volume expiration. It provides a reservoir of oxygen, and its volume is reduced in obesity contributing to an increased risk of hypoxia. Although there is a greater risk of aspiration this is not the most likely to lead to hypoxia as it is relatively uncommon. A restrictive lung defect is more commonly seen.

2. Answer is c

Obstructive sleep apnoea is associated with an increased risk of adverse events in the perioperative period and therefore should be screened for in the perioperative period using a STOP-BANG questionnaire or similar. However, diagnosis requires overnight polysomnography. Established CPAP significantly reduces the risk of perioperative complications. BiPAP is occasionally indicated but is not the first line treatment. It is caused by pharyngeal collapse.

3. Answer is a

Neck circumference of greater than 60cm is a particularly sensitive predictor of a difficult airway. Mallampati class 2 is not predictive of a difficult airway. Presence of a beard does not impair view at laryngoscopy although it may make bag-mask ventilation more challenging. Poor dentition presents a hazard at laryngoscopy but should not impair the view achieved.

4. Answer is d

Sugammadex acts by encapsulating aminosteroid neuromuscular blockers. It produces predictable reversal of neuromuscular blockade in these drugs. Neuromuscular drugs are often needed in obese patients to facilitate intubation. Suxamethonium can be used to achieve rapid paralysis, however, fasciculations may increase oxygen demand and hasten desaturation, and rocuronium can achieve muscle relaxation in a similar time period – this is an area of current debate in anaesthesia, especially with the advent of sugammadex as a reversal agent.

5. Answer is e

Body mass index is measured in kg/m^2. A value > 30kg/m^2 is considered obese. Jon Brower Minnoch (1941-83), the heaviest person in medical history, may have had a BMI as high as 129!

Author

Dr Samuel A Howell
ST5 Anaesthetic trainee, Cheltenham General Hospital
Sandford Road, Cheltenham, GL53 7AN

Dr Michael V Copp
Consultant Anaesthetist
Department of anaesthesia, Cheltenham General Hospital
Sandford Road, Cheltenham, GL53 7AN
michael.copp@glos.nhs.uk

Corresponding Author

Dr Samuel A Howell
samuelahowell@gmail.com

References

1. Public Health England. Measurement of Obesity. http://www.noo.org.uk/noo_about_obesity/measurement (accessed 09/01/2017)
2. Kopelman P, Jebb SA, Butland B. Executive summary: foresight ''Tackling Obesities: Future Choices'' project. Obesity Reviews 2007; 8(Suppl. 1):vi–ix.
3. Mutter TC, Chateau D, Moffatt M, et al. A matched cohort study of post-operative outcomes in obstructive sleep apnea. Anesthesiology 2014; 121:707–18
4. Weingarten T, Flores A. Obstructive sleep apnoea and perioperative complications in bariatric patients. British Journal of Anaesthesia 2010; 106:273–3
5. Wanahita N, Messerli FH, Bangalore S, Gami AS, Somers VK, Steinberg JS. Atrial fibrillation and obesity – results of a meta-analysis. American Heart Journal 2008; 155:310–5
6. Pandit JJ, Andrade J, Bogod DG et al. The 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: protocol, methods and analysis of data. Anaesthesia 2014; 69:1078-88
7. Ingrande J, Lemmens HJM. Dose adjustment of anaesthetics in the morbidly obese. British Journal of Anaesthesia 2010; 105(Suppl. 1):16–23
8. Association of Anaesthetists of Great Britain and Ireland. Perioperative management of the obese surgical patient 2015. Anaesthesia; 70:859-876
9. Chung F, Subramanyam R, Liao P, Sasaki E, Shapiro C, Sun Y. High STOP-BANG score indicates a high probability of obstructive sleep apnoea. British Journal of Anaesthesia 2012; 108:768–75
10. Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. Anaesthesia 1987; 42(5):487–90
11. Brodsky JB, Lemmens HJM, Brock-Utne JG, Vierra M, Saidman LJ. Morbid obesity and tracheal intubation. Anesthesia and Analgesia 2002; 94:732–6
12. Collins JS, Lemmens HJ, Brodsky JB, Brock-Utne JG, Levitan RM. Laryngoscopy and morbid obesity: a comparison of the "sniff" and "ramped" positions. Obes Surg 2004; 14(9):1171-5
13. DAS guidelines for management of unanticipated difficult intubation in adults 2015. https://www.das.uk.com/guidelines/das_intubation_guidelines (accessed 09/01/2017)
14. Cook TM, Woodall N, Frerk C, on behalf of the Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: Anaesthesia. British Journal of Anaesthesia 2011;

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

THE RISK OF CONTAMINATION OF RE-USABLE SPRAY BOTTLES WHEN USED WITH DISPOS-ABLE ATOMIZER NOZZLES

A Polson, D Bondin, P Morar

Abstract

Bacterial contamination of multi-use atomizer has been proven in a number of studies. The aim of this study was to look at the infection control implications of the current disposable nozzles used in our trust and to demonstrate the safety and cost effectiveness of using such devices.

An experiment was performed using disposable nozzles and topical anaesthetic and spraying the later into various volumes of blue dye at various distances to evaluate whether any back flow occurred contaminating the reservoir of medication.

The results showed no visual signs of transmission of the blue dye back into the reservoir. Together with the literature, the study conferred minimal risk of cross contamination to patients when using the positive pressure atomiser. This study highlights the importance of continuously questioning our current practices to reduce the risk of harm to our patients.

Introduction

Otorhinolaryngeal examinations such as nasal endoscopy, requires the use of topical vasoconstrictive and anaesthetic sprays. Many of these sprays are used on multiple patients by changing the disposable nozzle. Using such nozzles does raise the question of whether such a practice imposes a risk to patients via cross contamination. The definitive way to eliminate any contamination would be to use once-only medication, however, this is a costly alternative.

There are two types of delivery devices which are used to administer such agents: Venturi atomizers and positive pressure atomizers. In Venturi atomizers, high flow air creates a negative pressure causing fluid to move out of the reservoir (1). Once the air flow stops, there is a backflow of fluid back into the reservoir at the end of the cycle due to a momentary vacuum effect. Positive displacement atomizer has a one-way valve that ensures unidirectional flow (2).

Many papers have looked at the Venturi atomizers and its risk of cross contamination to patients (3). Studies have shown results to support the theory of back flow causing contamination and growth of bacteria in samples. There is very limited research done looking at the positive displacement atomizer (disposable) and the risk of possible back flow into the medication reservoir.

This paper aims to look at the risk of back flow through the disposable nozzles into the medication device when used. The disposable atomizer nozzles used in this study, work under the principles of positive pressure.

Figure 1: Equipment utilised

Method

This study was conducted using multiple standardised trust atomizers. Xylocaine sprays were used with the disposable atomiser nozzle. Xylocaine was chosen as it is one of the most common topical local anaesthetic agents utilised in ENT and anaesthetic practices containing lidocaine, ethanol, magrogel, levomenthol, essence of bananna, saccharin and purified water. Various volumes of blue dye (the blue dye was used to emulate mucosal surfaces such as nasal mucosa) were measured: 1ml, 2mls, 3mls, 4mls, 5mls and placed in separate gallipots.

Different volumes of blue dye were used to see if increased volume of fluid would have any effect on risk of contamination. Blue dye was chosen as it would be easily identifiable should any liquid trace back into the anaesthetic/antibiotic bottle.

Using Xylocaine spray and an atomizer nozzle, multiple sprays were first sprayed from a 2cm distance, followed by 1cm distance and then directly touching the various volumes of blue dye within their respective gallipots. The different distances were used, as in practice, the nozzle may not be in direct contact/touching mucosal surfaces. The nozzle was placed at a 45 and 90 degree angle each time.

THE RISK OF CONTAMINATION OF RE-USABLE SPRAY BOTTLES WHEN USED WITH DISPOS-ABLE ATOMIZER NOZZLES

A Polson, D Bondin, P Morar

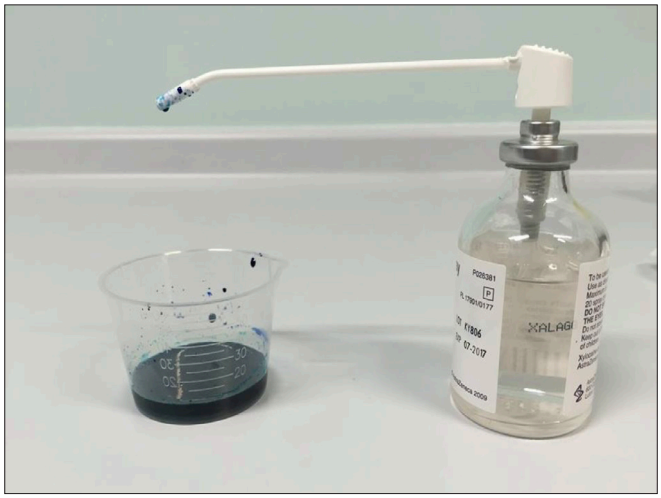


Figure 2: Blue Dye and Spray

Results

The results were encouraging as no evidence of blue dye was seen within the xylocaine bottle when spraying at any angle, from any distance or within any volume of blue dye.

Discussion

Coakley et al (1993) (4) concluded that devices which used the Venturi principle have the 'suck back' phenomena and they concluded that disposable Venturi atomizers carry a risk of contamination.

The results of this study is supported by a study done by Wolfe et al (2002) (5) looking at internal contamination of medication reservoir, comparing Venturi principle atomizer and positive displacement devices. The results showed that there was no sign of contamination on using the positive displacement nozzles.

Other studies have also been conducted looking at cleaning of nasal atomizer (7), and the use of isopropyl alcohol pad was said to make a drastic difference in the risk of contamination when compared to sterile tip cover.

However, the study by Wolfe et al (2002) (5) concluded that despite cleaning Venturi nozzles after use, there is still a risk of contamination and bacteria was found in the reservoir. The findings of these studies do support that a Venturi device may be the cause for cross contamination however none of the studies ruled out other causes for the contamination.

Contamination can occur if various simple procedures are not followed. Hand washing and wearing sterile gloves by medical staff when performing procedures are often simple ways to avoid cross contamination. In studies where swabs were taken from the nozzles, there was no swab taken prior to the use of the nozzle. The nozzle itself may have been contaminated prior to the usage if touched with unclean glove or hand.

In the current era of cost saving within the National Health Service (NHS), the expense of using such products has to be considered. When evaluating the cost of once only medication versus using disposable nozzles and multiuse medication the following costs were found.

Figure 3: Nozzle

Cost (approximately):

- *Disposable Nozzle - 39p per nozzle*
- *Re-usable Xylocaine oral spray (50mls) - £7.86 per bottle.*
- *Once only Lidocaine nasal spray (2.5mls) - £11.25*

It can be noted from the price of disposable nozzle to the price of once only nasal sprays that it is not feasible to change spray bottles after each patient. However, this study shows that this is not necessary as disposable nozzles are safe to use without the risk of contamination via back flow in to the bottle.

THE RISK OF CONTAMINATION OF RE-USABLE SPRAY BOTTLES WHEN USED WITH DISPOS-ABLE ATOMIZER NOZZLES

A Polson, D Bondin, P Morar

Conclusion

Our study is further evidence in supporting that there is minimal contamination risk when using disposable atomiser nozzles as there was no evidence of back flow observed when blue dye was used. Their use in practice is therefore safe and also more cost effective than single use items.

This study also highlights the importance in always assessing current practices and ensuring that they are safe for patients. We recommend that other institutions consider adopting positive pressure atomiser nozzles instead of Venturi atomisers to reduce contamination risks and also for their cost benefits.

Author

Dr Ashak Polson
Foundation Year 2 Doctor,
Royal Blackburn Hospital

Miss Daniela Bondin
ENT ST7, Royal Blackburn Hospital
North West Deanery, UK

Mr Pradeep Morar
Consultant in Otorhinolaryngology,
Royal Blackburn Hospital

Corresponding Author

Miss Daniela Bondin
danielabondin@hotmail.com

References

1. Wolfe TR. Are you inadvertently cross-contaminating patients in your practice?.Ears Nose & Throat Journal Research Series. 2011.
2. Aydin E, Hizal E, Akkuzu B et al. Risk of contamination of nasal sprays in otolaryngologic prac-tice. BMC Ear Nose Throat Disord. 2007 Mar 13;7:2.
3. Bossart PJ, Wolfe T. Venturi atomisers as potential sources of patient cross-infection Ameri-can Journal of Infection Control: 2003 31 (7) 441-444.
4. Coakley JF, Arthurs GJ, Wilsher TK. 1993 The need for and development of a single disposable nasal spray. J Laryngol Otol. 1993 Jan;107(1):20-3.
5. Wolfe TR, Hillman TA, Bossart PJ. The comparative risks of bacterial contamination between a venture atomizer and a positive displacement atomizer. Am J Rhinol 2002 16:181-186
6. Kieff D, Fink D. Decontamination of nasal atomizer tips: Alcohol versus guards. Otolaryngol Head Neck Surg. 2011 Sep;145(3):411-3

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

ULTRASONOGRAPHY FOR JUNIOR DOCTORS

TR Barrow, R Kong

Introduction

Ultrasonography is a cheap, safe and effective imaging modality with a multitude of both diagnostic and procedural applications. The recent advent of more compact ultrasound (US) machines has meant that the technology is becoming increasingly more accessible with the potential for future US devices to be linked to smartphone technology (1).

It has been argued that the use of portable US may become as integral a piece of equipment in the Doctor's arsenal as Rene Laennec's stethoscope (2,3). Undergraduate programmes integrating US training into their course are limited; although some universities in the UK are beginning to pioneer early exposure to US technology.

Similarly, most foundation trusts fail to offer US training to junior doctors. When surveyed trainees universally agreed that this would be a welcome addition to their education. In this article I will discuss the efficacy of bedside or "point-of-care" US and present the argument for its introduction to the junior doctor's curriculum and undergraduate education as a valuable adjunct to physical examination.

US machines work by producing ultrasonic waves, outside the range of human hearing. Tissues of differing densities reflect these sound waves, which in turn are detected by the transducer probe and an image is generated. Images produced by an US machine provide a two-dimensional cross section of the anatomy being scanned. Directional flow (Doppler) can be superimposed or three-dimensional images can be generated, however that is beyond the scope of this article. Shades of grey indicate the density of tissues being visualized. Fluid or high-density tissue is anechoic and therefore appears black, whereas air or soft tissues appear white (figure 1).

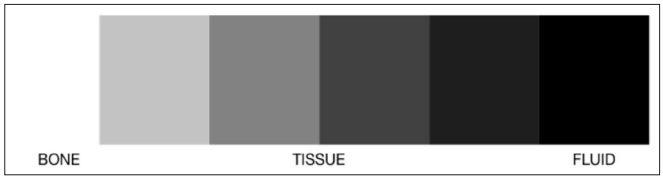


Figure 1. An illustration demonstrating the colour produced by tissues of differing densities.

US waves emitted at varying frequencies provide different image qualities. Low frequency (1-5 megahertz [mHz]) ultrasound probes are used to image deeper structures such as organs or effusions; as the waves penetrate deeper with a lower image resolution. In contrast high frequency (10-15 mHz) waves provide high-resolution images of superficial structure such as arteries and veins (4).

Clinical vignette

A 73 year old gentleman has undergone a coronary artery bypass graft (CABG) following progressive onset shortness of breath secondary to coronary artery disease. Two days post-operatively the patient is recovering on the Cardiac Intensive Care Unit. In order to maintain his arterial oxygen saturations, he requires high-flow nasal oxygen with some intermittent CPAP.

On examination the patient has reduced chest expansion, absent basal breath sounds and a dull percussion note on the left. A post-operative weight revealed that the patient had gained 3kg. A chest X-ray was performed and demonstrated opacification in the left lower zone, likely to be attributable to a left sided pleural effusion (figure 2).

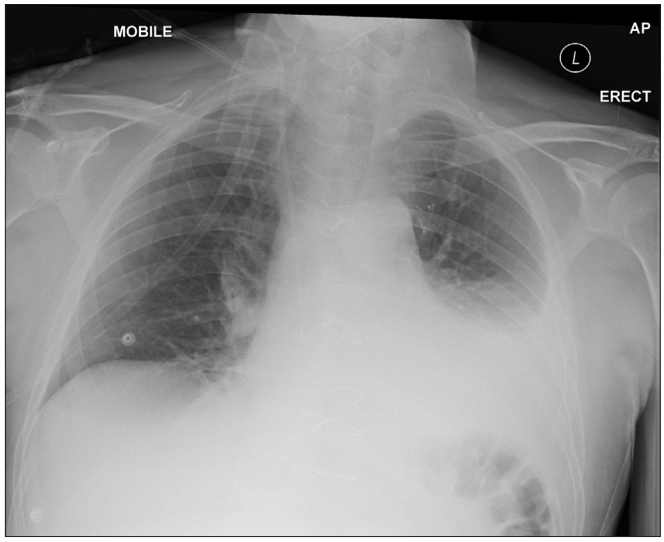


Figure 2: A chest radiograph taken 2 days after CABG showing opacity in the left lower zone. This could be due to a pleural effusion. Sternal wires and a central line are also visible.

Chest radiographs are unreliable for quantifying the size of an effusion and hence making management decisions based purely on radiological findings can be problematic (5). In this case both the anaesthetist and cardiothoracic surgeon agreed to perform a bedside US, which revealed a moderate sized effusion measuring a maximum of approximately 5cm between the visceral and parietal pleura (figure 3).

ULTRASONOGRAPHY FOR JUNIOR DOCTORS

TR Barrow, R Kong

This allowed for an objective quantification of the effusion size in real-time and facilitated the final decision to manage the effusion conservatively rather than inserting a chest drain. If an intercostal drain had been necessary, this could have been performed at the time using US guidance. This case demonstrates the clinical utility of point-of-care US which was instrumental in the management decision for this patient and would have been available should surgical intervention have been required. After a short course of diuretics, the patient was weaned off his oxygen requirements and discharged home without any further concern.

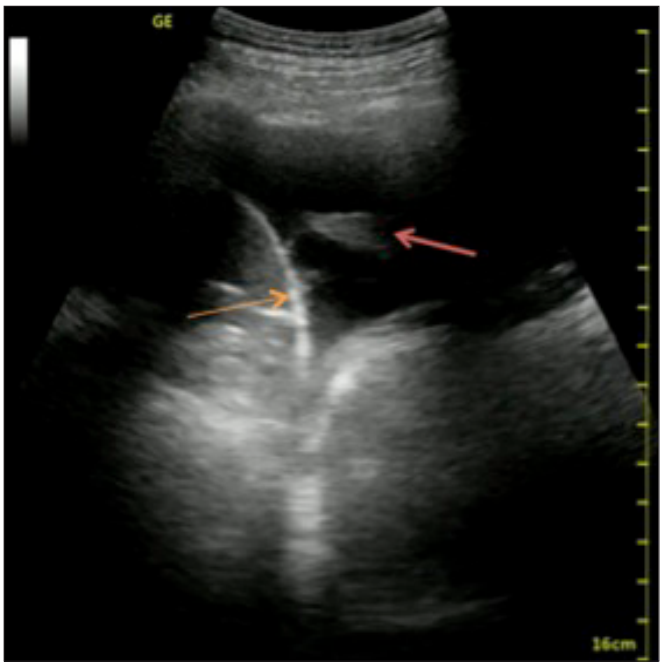


Figure 3. An ultrasound scan of the pleural effusion performed with the probe at the patient's back (superior aspect of the image.) For reference the right of the image is cephalic and the left caudal. The diaphragm is demarcated with an orange arrow and the collapsed lung tissue a red arrow. The lung tissue is surrounded by anechoic fluid.

US and the Junior Doctor

Several North American, European and at least one UK medical school have introduced US education to their undergraduate teaching (6, 7, 8). Studies have demonstrated that trained medical students performing diagnostic US have a higher diagnostic sensitivity than experienced physicians performing a physical examination (9). It is therefore just a matter time before teaching US skills becomes a standard component of UK undergraduate curriculum.

Postgraduate training in point-of-care US is promoted by a few specialties – mainly critical care, anaesthesia and trauma, through courses such as FAST, FATE, FICE and CUSIC (10). The use of US for effective patient care, arguably, does not have to rely solely on the traditional experts in radiology or cardiology.

Currently, most foundation doctors are not formally taught how to perform or interpret US imaging. In order to gather data on the relevance of US training to junior doctors, a short survey was sent to foundation trainees at Brighton & Sussex University Hospitals (Table 1).

Point-of-care US use observed by Junior Doctors (n=49)

Response	Number (%)
Assist venesection	41
Facilitate arterial blood gas sampling	9
Facilitate arterial cannulation	11
Facilitate venous cannulation	76
Diagnose or assess pleural effusion	37
Diagnose or assess deep vein thrombosis	20
Scan the urinary bladder	85
Other	22

Table 1: Table illustrating the point-of-care US observed by 49 Foundation Doctors at Brighton & Sussex University Hospitals.

Respondents were from both foundation years 1 and 2 and represented a breadth of medical, surgical and community specialties. Of 49 respondents 46 had observed the use of US in their clinical environment. The most common indications being to assist peripheral venous access or to scan the urinary bladder for retention.

When asked whether they had performed US scanning themselves, only 32% of respondents were able to. Of those who had performed US imaging within their foundation training, there were a wide variety of skills demonstrated by junior doctors: assessing effusions, venous cannulation, urinary bladder scan, chest drain insertion and ascitic taps. Finally 100% of respondents said they would find US training useful to their foundation practice and would definitely attend a course if one were to be provided by the foundation school.

Indications for the use of US

Outside of the radiology department where radiologists perform US-guided procedures and investigations, US is also used as a point-of-care technology in a number of clinical areas. Indications for US can be categorized into diagnostic and procedural. Below is a table illustrating some of the common uses (Table 2).

ULTRASONOGRAPHY FOR JUNIOR DOCTORS

TR Barrow, R Kong

Point-of-care application of US technology	
Diagnostic	**Procedural**
Pulmonary effusion	Vascular access – venous and arterial
Pulmonary oedema	Thoracocentesis
Pneumothorax	Intercostal drain placement
ARDS	Paracentesis
Pericardial effusion	Arthrocentesis
Infective endocarditis	Pericardiocentesis
Deep vein thrombosis	Peripheral and regional nerve blockade
Abdominal aortic aneurysm	Transthoracic echocardiography
Urinary retention	Transoesophageal echocardiography
	Bladder scan

Table 2: Table demonstrating some of the diagnostic and procedural applications of point-of-care US.

As an imaging modality US is effective, immediate and non-ionizing. The portability of US means that unstable and critically ill patients do not require transportation to the radiology or echo department for imaging. Clinicians are able to make a rapid diagnostic assessment at the patient's bedside and monitor the response to an intervention in real-time. As demonstrated by the case study above the clinical utility of US in making a qualitative assessment of a pleural effusion is superior to radiographic imaging or physical examination.

The most sensitive clinical finding of an effusion on respiratory examination is a dull percussion note, however this only detects effusions of approximately 300mls (5). Similarly, blunting of the costophrenic angles requires approximately 200mls of fluid to be detectable on a chest X-ray (5). For the detection of pleural effusions, ultrasound has an 83% concordance with CT findings (11). Diagnostic US of the lungs is simple to interpret and quick to perform, being both sensitive and specific for detecting consolidation, pneumothorax, pleural effusion and pulmonary oedema.

US proves to be superior to chest radiographs and arguably comparable to CT (12, 13). If junior doctors were enabled to perform basic US scans it would help in making more effective interpretations of their clinical findings. Ultimately this would enhance patient care and free up the time of senior clinicians or radiographers. Limitations of US imaging are few and often restricted to the skill of the clinician.

Patient factors such as obesity and sub-optimal positioning can impact upon image quality, while certain pathologies such as peripheral oedema or surgical emphysema can make interpretation problematic. In addition, various artifacts can affect image quality, for instance ultrasonic waves cannot penetrate bone, frequently probe orientation has to be optimized to minimize Artefact (13).

Ultrasound guided procedures are safer and more successful where image guidance is advised. British Thoracic Society guidelines recommend that thoracocentesis and intercostal drain insertion be performed with US guidance (14). Similarly the National Institute for Health and Care Excellence (NICE) recommendations for central venous catheterization advocates the use of US as a safer and more reliable technique associated with fewer complications than the traditional anatomical landmark approach (15). US guided peripheral vascular access can be used where access is challenging (figure 4).

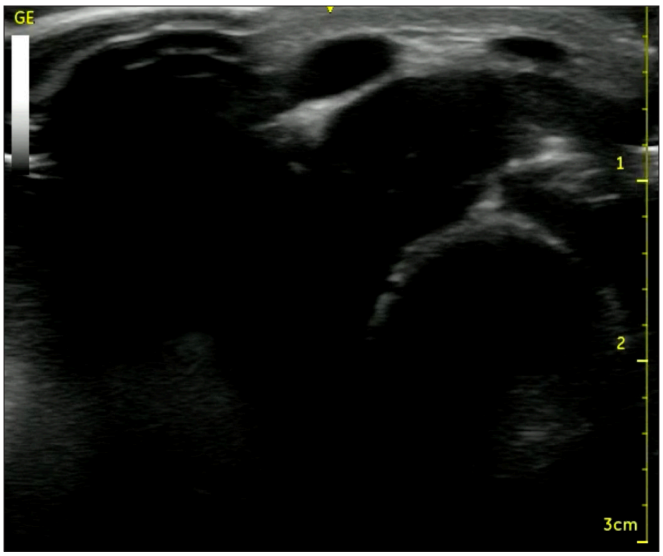


Figure 4: An US of the forearm demonstrating peripheral venous imaging. This can be used to aid venesection or cannulation. The yellow arrow indicates the centre of the US probe lying over the cephalic vein, allowing the user to direct their needle in the correct orientation.

Some patient characteristics are typically associated with difficult peripheral venous access, e.g. postoperative oedema, obesity, multiple previous cannulations and chronic intravenous drug abuse (16). While central venous catheterisation and thoracocentesis are beyond the responsibilities of most foundation doctors, difficulty with peripheral vascular access is commonly encountered in all hospital settings. Resources are readily available demonstrating how to perform basic US guided procedures (NEJM 17, 18, 19).

Conclusion

Point-of-care US imaging is simple and effective, demonstrating a sensitivity for commonly encountered pathologies comparable to CT. There are several advantages to bedside US imaging with few limitations. These skills are easily learned and basic ultrasonography should be taught to both junior doctors and undergraduate students, enabling them to be more effective clinicians and broaden their skillset early in their training.

ULTRASONOGRAPHY FOR JUNIOR DOCTORS

TR Barrow, R Kong

Multiple Choice Questions

1. What is the minimum volume of pleural effusion detectable on a postero-anterior chest radiograph?

a. 100mls
b. 200mls
c. 300mls
d. 400mls
e. 500mls

2. What are the useful properties of low frequency ultrasound imaging over high frequency?

a. Better resolution, deeper image penetration
b. Better resolution, superficial image penetration
c. Poorer resolution, superficial image penetration
d. Poorer resolution, deeper image penetration
e. No difference in resolution or image penetration

Answers

1. B

Studies have demonstrated that on a postero-anterior chest radiograph, a meniscus becomes detectable when approximately 200mls of fluid has accumulated. On a lateral chest x-ray a meniscus can be identified with approximately 50mls of fluid. (5)

2. D

High frequency beams are attenuated more than low frequency. Attenuation is the cumulative result of reflection, refraction, scattering and absorption by tissues with differing properties. As a result lower frequency probes are preferred for imaging deeper structures. A compromise has to be found between resolution and penetration. (4)

Author

Dr Tom Robert Barrow
Corresponding author
Anaesthetic Foundation Year 1
Royal Sussex County Hospital
Eastern Road, Brighton, BN2 5BE

Dr Robert Kong
Contributing author & supervisor
Consultant in Cardiac Anaesthesia & Intensive Care
Royal Sussex County Hospital
Eastern Road, Brighton, BN2 5BE
robert.kong@bsuh.nhs.uk

Corresponding Author

Dr Tom Robert Barrow
tom.barrow@bsuh.nhs.uk

References

1. Ahn S, Kang J, Kim P, Lee G, Jeong E, Jung W, et al. Smartphone-based Portable Ultrasound Imaging System: Prototype Implementation and Evaluation. IEEE Ultrason Symp Proc. 2015;1:1–4.
2. Alpert JS, Mladenovic J, Hellmann DB. Should a hand-carried ultrasound machine become standard equipment for every internist? Am J Med. 2009;122:1-
3. Fakoya, du Plessis M, Gbenimacho I. Ultrasound and stethoscope as tools in medical education and practice: considerations for the archives. Adv Med Educ Pract. 2016;7:381–7.
4. Aldrich JE. Basic physics of ultrasound imaging. Crit Care Med. 2007;35(5):S131–7.
5. Soni NJ, Franco R, Velez MI, Schnobrich D, Dancel R, Restrepo MI, et al. Ultrasound in the diagnosis and management of pleural effusions. Vol. 10, Journal of Hospital Medicine. 2015;10:811–6.
6. King's College Hospital. King's first to use Ultrasound in medical education: https://www.kch.nhs.uk/news/media/press-releases/view/18979. Accessed: 25th March 2017
7. Mulvagh SL, Bhagra A, Nelson BP, Narula J. Handheld ultrasound devices and the training conundrum: how to get to "seeing is believing". J Am Soc Echocardiogr. 2014;27(3):310-3.
8. Heiberg J, Hansen LS, Wemmelund K, Sørensen AH, Ilkjaer C, Cloete E, et al. Point-of-Care Clinical Ultrasound for Medical Students. Ultrasound International Open. 2015;1(2):E58-E66.
9. Solomon SD, Saldana F. Point-of-Care Ultrasound in Medical Education — Stop Listening and Look. New England Journal of Medicine. 2014;370(12):1083-1085.
10. Ultrasound Courses Available: http://www.sonoguide.com/FAST.html, http://www.fate-protocol.com, http://www.ics.ac.uk
11. Lichtenstein D1, Goldstein I, Mourgeon E, Cluzel P, Grenier P, Rouby JJ. Comparative Diagnostic Performances of Auscultation, Chest Radiography, and Lung Ultrasonography in Acute Respiratory Distress Syndrome. Anesthesiology. 2004;100(1):9-15.
12. Prina E, Torres A, Carvalho CRR. Lung ultrasound in the evaluation of pleural effusion. Jornal Brasileiro de Pneumologia. 2014;40(1):1-5.
13. Ashton-Cleary DT. Is thoracic ultrasound a viable alternative to conventional imaging in the critical care setting? British Journal of Anaesthesia. 2013;111 (2):152-160.
14. Du Rand I, Maskell N. British Thoracic Society pleural disease guideline 2010. Thorax. 2010;65:ii1-ii3.
15. NICE: Guidance on the use of ultrasound locating devices for placing central venous catheters: https://www.nice.org.uk/guidance/TA49/chapter/5-Recommendations-for-further-research. Accessed: 25th March 2017
16. Vezzani A, Manca T, Vercelli A, Braghieri A, Magnacavallo A. Ultrasonography as a guide during vascular access procedures and in the diagnosis of complications. Journal of Ultrasound. 2013;16(4):161-170.
17. Joing S, Strote S, Caroon L, Wall C, Hess J, Roline C, et al. Ultrasound-Guided Peripheral IV Placement. New England Journal of Medicine. 2012;366(25):e38.
18. Ortega R, Song M, Hansen CJ, Barash P. Ultrasound-Guided Internal Jugular Vein Cannulation. New England Journal of Medicine. 2010;362(16):e57.
19. Ailon J, Mourad O, Chien V, Saun T, Dev SP. Ultrasound-Guided Insertion of a Radial Arterial Catheter. New England Journal of Medicine. 2014;371(15):e21.

Disclaimers

Conflict of interest
The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"**(https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement
The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement
All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights
When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

UNCOMMON COMPLICATIONS OF DURAL PUNCTURE & EPIDURAL PUNCTURE THAT CAN PRESENT TO JUNIOR DOCTORS ON THE WARDS

R Harrison, M Hitchcock

Abstract

Spinal anaesthesia and epidural analgesia are common and considered safe but can lead to serious complications (1). Junior doctors on the ward are often the first port of call for reviewing patients with the early signs of these conditions and they may well have limited experience in this area.

Many of these serious complications can be difficult to pick up early; meningitis can masquerade as a post dural puncture headache initially presenting with headache, neck pain and malaise although the present of fever can be a determining feature (2,6). Back pain can be commonplace but those presenting with fever or subtle neurological signs may point towards an epidural abscess or vertebral canal haematoma (2,12,13). Management of these conditions requires early recognition, prompt investigations and implementation of timely treatment (8,12,13,17).

Understanding these conditions can also help juniors to prevent these complications when they start to perform these procedures themselves. Use of a small diameter pencil point needle for spinal anaesthesia and lumbar punctures can help reduce headache and appropriate use of microbial barriers including the use of masks, hats, sterile gloves and gowns can limit serious infective complications (3, 25). Carefully consideration of a patient's medical conditions including platelet count, clotting function and medications can help avoid vertebral canal haematoma (12,13).

Introduction

Spinal anaesthesia and epidural catheter placement is performed for a wide variety of situations in theatre and maternity units in order to provide adequate anaesthesia and/or analgesia. Although they are generally considered to be safe procedures, they do have a wide range of side effects and complications some of which are rare but potentially serious (1).

Side Effect/Complication	Estimated Incidence
Urinary Retention	5-70%
Back Pain	38%
Post Dural Puncture Headache	36%*
Hypotension	33%
Bradycardia	13%
Local Anaesthetic Toxicity	0.1%
Meningitis	1 in 35,000
Epidural Abscess	1 in 110,000
Vertebral Canal Haematoma	1 in 150,000
Chronic Adhesive Arachnoiditis	Very Rare**

* this figure is taken from a study using 22G Quincke cutting spinal needle
** less than 1000 cases in last 50 years

Table 1: Complications in Neuraxial Blockade (2,3,4,5)

Junior doctors are often the first to see these complications present as they can develop long after the anaesthetic team has transferred care to the ward team (2,6). Common complications such as urinary retention and distributive hypotension can become quite familiar to patient's medical teams but juniors are unlikely to have had much experience in anaesthesia and may not be familiar with more severe complications (see table 1).

Rare complications such as meningitis and spinal cord compression require early recognition, investigation and treatment in order to minimise morbidity and mortality. It is crucial, therefore, that all junior doctors are educated on how these complications present so that they can be identified and treated as early as possible.

Post Dural Puncture Headache

PDPH is one of the most common complications of neuraxial blocks and lumbar punctures (2,3). This depends on a number of factors, most importantly, the needle size and design. The incidence can be as high as a third of patients who have had a dural puncture with a spinal needle and this is even higher in those who have had an inadvertent dural puncture whilst having an epidural catheter inserted (1,3). Other risk factors for PDPH include: female sex, young age, pregnancy and previous history of PDPH. PDPH typically presents 12 hours or more after the procedure.

Symptoms have been well described as a severe frontal and/or occipital throbbing headache with associated nausea and vomiting (2,3). This commonly occurs in the first 48 hours post puncture and very rarely develops after 5 days post puncture (8). Most typically the headache is postural in nature, aggravated by standing and excessive head movement. It can be associated with neck stiffness and photophobia as well as tinnitus, vertigo and occasionally diplopia. Taking a good history and examining these patients is crucial to diagnosing PDPH and more importantly, in considering (or excluding) the rarer complications.

Although paresthesia involving the trigeminal nerve has been reported, any suggestion of motor palsy or other focal signs should prompt the doctor to consider other causes (3). Subdural haematoma and cerebral haematoma both have been reported as rare sequelae of PDPH and present alongside the features of PDPH with focal neurology and reduced consciousness. Meningitis shares many of the symptoms of PDPH and should be considered as a differential, especially in the present of fever and altered conscious level (7).

UNCOMMON COMPLICATIONS OF DURAL PUNCTURE & EPIDURAL PUNCTURE THAT CAN PRESENT TO JUNIOR DOCTORS ON THE WARDS

R Harrison, M Hitchcock

The cause of PDPH is not fully understood. One theory is that the dural puncture causes a hole allowing a CSF leak, leading to loss of CSF from the subarachnoid space at a greater rate than production of CSF from the choroid plexus (2,3). This leads to a reduction in subarachnoid space volume particularly when in a standing position and subsequent 'sagging' of intra-cranial structures seen on MRI studies. This strain on these structures is thought to either directly cause the headache or lead to compensatory veno-dilatation within the cranium (in order to balance the loss of pressure exerted by the CSF), which then causes the headache (2,3).

The vast majority of PDPH will spontaneously resolve without intervention and 72% of patients will see resolution within 7 days (3). If symptoms are severe and affecting the patient's ability to function normally despite simple regular analgesia then the gold standard treatment is a blood patch. There is very limited and variable evidence for drugs, which act by causing cerebral vasoconstriction including the use of caffeine (300-600mg BD) and sumatriptan (a 5-HT1D agonist) (3).

A blood patch is an invasive procedure where the epidural space is accessed aseptically in order to inject 15-30ml of autologous blood into the space surrounding the dural puncture (3). This is thought to work by increasing the pressure in the subarachnoid space and also by causing a clot to form over the dural puncture site in order to stop leakage of CSF. There is a 70-98% success rate if the blood patch is performed over 24 hours after the dural puncture (3). Contra-indications are similar to those for any dural/extradural puncture (see table 2) except that this procedure has an increased risk of microbial seeding in the CSF from the autologous blood and so any signs of infection on blood tests and on assessment of the patient is a contra-indication to the procedure. Likewise any active cancer would also carry the potential risk of seeding of malignant cells.

Patient Refusal
Coagulopathy (pathological or drug induced)**
Local Skin Infection at site of injection
Raised Intra-cranial pressure
Untreated Systemic Infection

*note additional contra-indications exist when performing spinal anaesthesia and epidural analgesia/anaesthesia

**specific rules and considerations are present for different coagulopathies, antiplatelet and anti-coagulant drugs but are beyond the scope of this article

Table 2: Contra-indications to Dural/Epidural Puncture *(3,8)

Local Anaesthetic Systemic Toxicity

Local Anaesthetic Systemic Toxicity (LAST) usually refers to a toxic dose of local anaesthetic in the systemic circulation and in neuraxial blockade has an estimated incidence between 1-140/128,000 (9,10). This can occur either by giving an excessive dose of local anaesthetic at the correct site or by inadvertent delivery of local anaesthetic directly into the bloodstream (9).

The former can present early with a total spinal or high epidural block, and then later with signs of LAST (2,9). The latter can occur due to needle or catheter placement error and will typically present to the anaesthetist directly after he has performed the procedure. Local anaesthetic toxicity presenting on the wards with neuraxial blocks will be typically seen with running epidurals and will be caused by either inadvertent connection of the epidural local anaesthetic infusion pump to a venous or arterial cannula or by migration of the epidural catheter into an epidural vein (9,11).

Signs of LAST can be divided into neurological and cardiovascular signs (9). Neurological signs often precede cardiovascular signs but not always. Early neurological signs include: peri-oral tingling, tinnitus, slurring of speech, agitation and tremor (9,12). These symptoms can then progress to seizure activity and then later, central nervous system depression. Picking up the earlier, more subtle signs will allow quicker intervention and possible prevention of cardiovascular collapse.

Cardiovascular signs occur in three stages although in severe sudden toxicity the initial stages may be skipped. The first stage involves hypertension and tachycardia. The intermediate stage causes myocardial depression, bradycardia and hypotension. The final stages lead to severe vasodilatation, arrhythmias including conduction abnormalities which all lead to severe hypotension or a full cardiac arrest with ventricular tachycardia or asystole (9,12).

This is a medical emergency and management involves the immediate cessation of any local anaesthetic infusion and a call for urgent help, ideally including the on call anaesthetic team (9,12). An immediate "ABCD" assessment should be performed, 100% Oxygen should be applied and if the patient presents in cardiac arrest then a cardiac arrest call should be made as normal and managed just like a normal cardiac arrest situation.

UNCOMMON COMPLICATIONS OF DURAL PUNCTURE & EPIDURAL PUNCTURE THAT CAN PRESENT TO JUNIOR DOCTORS ON THE WARDS

R Harrison, M Hitchcock

Similarly seizures, hypotension and arrhythmias should be managed in accordance with Advanced Life Support (ALS) protocols noting that hypotension will be caused by a combination of distributive and cardiogenic shock. Local anaesthetic anti-arrhythmia agents are obviously contra-indicated in these circumstances.

The only variance in management outside of ALS protocols would be the administration of 20% Lipid Emulsion as stated in the AAGBI guidelines if there is evidence of severe LAST. In a cardiac-arrest situation lipid emulsion treatment is mandatory and it may take over an hour before return of spontaneous circulation (9,12).

Spinal Cord Injury

Spinal Cord Injury is rare and carries an approximate incidence of 1 in 40,000 (10). Causes of spinal cord injury include: spinal cord blunt trauma, vertebral canal haematoma and epidural abscess both leading to spinal cord compression (10). One of the first presenting features of these conditions can be back pain, which is normally the most common and benign side effect associated with the direct needle trauma to innervated local tissues (2).

Vertebral Cord Haematoma and Epidural Abscess should both be suspected if patients develop signs of spinal cord compression including sensory changes and initially flaccid paralysis in keeping with cord level of the lesion (13,14). Bowel and Bladder dysfunction may occur and back pain with cord radiation down the associated dermatomes is a common feature (2).

Time of onset varies between the two conditions. Iatrogenic epidural or spinal Haematoma tend to occur closer to the dural or epidural puncture (14). This means that a haematoma can present whilst the epidural infusion is ongoing which can mask early symptoms. Typical signs include sudden onset sharp back and leg pain with development of neurologic signs of spinal cord compression, however, those using an epidural will already have altered sensation and urinary retention (14).

However, acute back pain only actually presents in 38% of cases (14). It is important, therefore, to regularly monitor patients for motor function. Any significant weakness should result in stopping the epidural infusion and re-assessing. If there is no resolution of weakness then this should alert you to possible spinal cord compression and the anaesthetic team should be contacted urgently. Risk factors for developing a vertebral canal haematoma include: female gender, increased age, difficult needle placement with increased trauma and when the neuraxial block or catheter removal is performed close to LMWH administration (14).

Epidural abscesses typically form many days after the initial neuraxial block and can even form months after the procedure (13). Onset of symptoms can be insidious with fevers starting before the onset of back pain. There may be tenderness to palpation of the spine and there may be signs of neck stiffness. They may well also present with sepsis. Symptoms of cord compression tend to present later and are associated with a prolonged neurological recovery or even permanent damage.

In both cases neurology recovery is dependent on quick diagnosis. An MRI Spine is the gold standard investigation (13,14). Good neurological outcome is dependent on urgent surgical intervention in the vast majority of cases and should be within 8-12 hours from onset of symptoms. Antimicrobial treatment for 4-6 weeks for epidural abscesses tailored to the specific causative organism is crucial for resolution of sepsis and infection (13).

Post Dural Puncture Meningitis

Post Dural Puncture Meningitis (PDPM) is also very rare but is a potentially fatal complication. Incidences vary widely between 1 in 35,000 and 1 in 235,800 (6,10). This is compared with an overall calculated incidence of meningococcal meningitis in the UK in 2004 of 1 in 25,000 (15).

Early presentation of PDPM can be subtle and can include: headache, photophobia, fatigue and neck stiffness all of which, as discussed before, can be attributable to the more common and relatively benign post dural puncture headache (2,6). Those who then go on to develop the fever and/or reduced conscious level should raise the likelihood of PDPM and lead to immediate treatment (16). Negative results for clinical signs of meningitis including Kernig's sign and Brudzinski's sign are neither sensitive nor specific (17).

Broad spectrum antibiotics that have good blood brain barrier penetration (such as third generation cephalosporins) should be not be delayed for any reason as studies have shown that mortality rate can increase by up to 13% for every hour that antibiotic administration is delayed (16). Blood cultures are also important in isolating the causative organism but should not significantly delay treatment. Likewise a lumbar puncture can be helpful in diagnosis and should be carried out once raised intra-cranial pressure can be excluded but this should never delay antibiotic treatment (16).

The lumbar puncture results, which suggest a bacterial infection include: a significantly lowered glucose level, a high lactate and high protein levels, although these are not completely sensitive (17). Organisms are not always identified on microscopy and culture especially if antibiotics are started before the sample is obtained (17).

UNCOMMON COMPLICATIONS OF DURAL PUNCTURE & EPIDURAL PUNCTURE THAT CAN PRESENT TO JUNIOR DOCTORS ON THE WARDS

R Harrison, M Hitchcock

PDPM can be caused by microbial infection of the meninges or by aseptic inflammation of meninges (2). Septic PDPM is caused either by introduction of microbes to the CSF via the spinal needle through ineffectual aseptic technique or by seeding of microbes in a septic patient to the CSF through the traumatic puncture site (2,18). Due to the mode at which dural puncture potentially circumvents the normal protective barriers for entry of pathogens to the CSF, onset of septic PDPM can be rapid. Experimental studies have shown that there is a 2-3 hour delay between bacterial introduction to the CSF and the onset of disease (6).

Aseptic causes of meningitis relating to anaesthetic have also been documented and can result from a reaction to number of drugs including: non-steroidal anti-inflammatories (especially ibuprofen), a wide range of antibiotics (including penicillins, metronidazole, cephalosporins, sulfonamides and ciprofloxacin) as well as spinal anesthetics (21). Specifically relating to neuraxial blockade; there have been a number of case reports that have suggested bupivacaine intrathecally has been a likely cause of meningitis (19-24).

The cause of drug-induced aseptic meningitis (DIAM) is not clear but is thought to be related to either type 3 or 4 hypersensitivity reaction within the meninges or from an inflammatory response to particularly drugs given intrathecally (18- 19). The presence of pre-existing autoimmune disease appears to be a risk factor for DIAM. DIAM presents like any form of meningitis but without associated sepsis. It is a diagnosis of exclusion and so management will be similar to any other form of meningitis at least until all appropriate investigations have returned.

Lumbar puncture results typically demonstrate neutrophilic pleocytosis with a variable glucose and normal lactate levels and variable protein content. Lymphocytosis and eosinophilic cytosis can also occur and CSF staining and cultures are always negative (19-24). Patients commonly start to have resolution of symptoms after 48 hours of treatment. It seems logical to consider stopping drugs such as ibuprofen that are particularly associated with DIAM in these patients (19). Corticosteroids have been used in some case reports but we have no means of telling whether this improves speed of recovery or not (19-24).

Preventing Complications

As junior doctors, you may have rotations that allow you to work with the Anaesthetic department and may well be involved in placing spinal anaesthetic and epidural catheters. More likely, you may be required to perform a lumbar puncture on the medical wards or on day units. For this reason, knowing how best to prevent these complications can lead to better outcomes for patients.

Needle Type	Incidence
Tuoy 16G	70%
Quincke (cutting needle) 22G*	36%
Sprotte (pencil point) 24G	0-9.6%
Whitacre (pencil point) 25G	0-14%

*Typically used for adults having a diagnostic lumbar puncture by physicians

Table 3: Incidence of PDPH after Dural Puncture (3)

PDPH very rarely leads to longterm morbidity but can be very distressing and debilitating for patients who have to endure it. It can lead to longer hospital stays and in the specific case of PDPHs resulting from epidurals performed in labour, can lead to difficulty establishing breast feeding, low mood and difficulties with maternal-baby bonding (3).

As previously mentioned, needle size and shape have an impact on incidence of PDPH in dural puncture (see table 3). Both the greater the needle diameter and the use of a cutting needle instead of a pencil point needle increase the incidence of headache (see diagram 1). It is for this reason that reducing the diameter of your needle and using a pencil point needle for lumbar punctures and spinal anaesthetic is highly recommended (3).

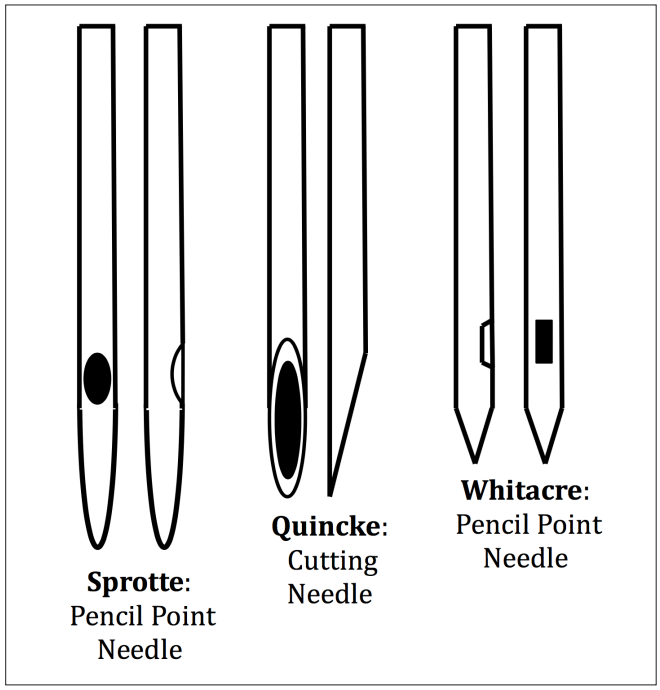


Diagram 1: Illustrations of different types of Spinal Needle (3)

UNCOMMON COMPLICATIONS OF DURAL PUNCTURE & EPIDURAL PUNCTURE THAT CAN PRESENT TO JUNIOR DOCTORS ON THE WARDS

R Harrison, M Hitchcock

A review of 179 case reports of patients treated for PDPM showed the majority had a bacterial cause. Of those cultured, a majority of 82 were of viridians type streptococcus, bacteria that normally colonize the mouth and upper respiratory tract (6). Of those species the most common was Streptococcus salivarius, suggesting a cause of bacterial PDPM could be contamination of spinal equipment with saliva.

This highlights the importance of good aseptic technique in preventing PDPM including the use of sterile clothing including gown, gloves, hat and importantly a good surgical mask. This is further reinforced in the UK by safety guidance from the AAGBI (25). Although there has been no clear evidence that performing neuraxial blocks in patients with severe sepsis increases the risk of epidural abscess or infective meningitis, it is widely considered safe practice to avoid neuraxial blocks in these patients (26).

Vertebral canal haematoma is strongly linked with problems with the patient's clotting either caused by patient pathology or iatrogenically by medications that we give them (14). Dural puncture or epidural catheter placement should only be performed after discussion with a senior physician or anaesthetist if they have a pre-existing clotting or platelet abnormality. The a common risk factor for previous vertebral canal haematomas has been shown to be use of Lower Molecular Weight Heparin (LMWH) too soon before and after dural or epidural puncture (14).

It is recommended that LMWH prophylaxis should be given no later than 12 hours before the procedure and treatment doses should be withheld for 24 hours (27). Likewise, there should be a period of 6 hours from spinal anaesthetic or removal of an epidural catheter before giving LMWH. Other anti-platelet and anti-coagulant medication can cause a higher risk of vertebral canal haematomas and there are specific rules regarding each one, which is unfortunately beyond the scope of this article.

Conclusion

Severe complications from neuraxial blockade are rare but when it occurs is associated with high morbidity. Management involves early diagnosis and prompt treatment but presentations can be vague. Junior doctors are often the first to witness the early stages of these conditions and are crucial to instigating initial management and getting help promptly. As these conditions require quick management in order to minimise risk of morbidity and mortality it is important that junior staff have an understanding of these conditions so that they can not only improving outcomes in these patients but potentially prevent them from occurring in the first place.

Questions

1.) Which needle is associated with the least likelihood of causing a post dural puncture headache if used to administer a spinal anaesthetic or perform a lumbar puncture?

a) 16G Tuoy needle

b) 22G Quincke needle

c) 25G Quincke needle

d) 22G Sprotte needle

e) 25G Whitacre needle

2.) A 26 year old woman presents six days post a normal vaginal delivery with general malaise and lower back pain. She went into spontaneous labour at Term + 4 days. She requested an epidural 24 hours into labour, which was difficult to perform but was effective once placed. Post delivery she regained normal sensation and had no residual weakness within 4 hours. Six days post delivery she presents to the assessment unit feeling generally unwell. She complains of lethargy for the last day and has myalgia. She has had a bit of lower back discomfort where she had her epidural catheter which has become progressively worse. She also complains of a headache and an aching neck and over the last 2 hours feeling her balance is off and is finding it difficult to walk.

Observations show she has a fever of 38.6ÐC, HR 98, BP 120/78, RR 20 and a GCS of 15/15. Her chest is clear and her abdomen is soft and non-tender. She has bony tenderness over her L2/L3/L4 vertebrae with normal range of movement in her neck.. She has no focal neurology.

What is the most important initial investigation for this patient?

1. CT Head

2. Lumbar Puncture

3. MRI Spine

4. CT Spine

5. Urine Culture

UNCOMMON COMPLICATIONS OF DURAL PUNCTURE & EPIDURAL PUNCTURE THAT CAN PRESENT TO JUNIOR DOCTORS ON THE WARDS

R Harrison, M Hitchcock

3.) When performing a lumbar puncture, what equipment is most appropriate to use?

a.) Sterile Gown, Sterile Gloves and 0.5% Chlorhexidine spray

b.) Sterile Gown, Sterile Gloves, Hat, Face Mask and 0.5% Chlorhexidine spray

c.) Sterile Gown, Sterile Gloves, Hat, Mask and 2% Chlorhexidine spray

d.) Sterile Gown, Sterile Gloves and 2% Chlorhexidine spray

e.) Sterile Gown, Sterile Gloves, Hat and 2% Chlorhexidine spray

4.) A 31 year old primigravida had an epidural placed to help with analgesia for labour. During the procedure the anaesthetist inadvertently caused a dural puncture. The epidural was successfully re-sited. She went on to have a normal vaginal delivery 3 hours later. 6 hours later she develops a very severe headache that is relieved by lying flat. She doesn't have a temperature and denies any symptoms of nausea. She does complain of neck pain but has no stiffness on examination. She is very distressed by the symptoms and wants it to stop.

What is the next appropriate step?

a.) Blood patch

b.) Lumbar puncture

c.) IV Ceftriaxone

d.) Regular paracetamol and ibuprofen

e.) CT Head

5.) A Consultant asks you to perform a lumbar puncture on a 65 year old lady who presented with a "thunder-clap" headache that was 10/10 on the pain score and sudden onset over her occipital region. She had no other symptoms and has no focal neurology on examination. She has had a CT Head, which is completely normal. She has also had a set of routine bloods performed. You review her notes before performing the procedure. Which of the following would be a reason to not perform the lumbar puncture immediately?

a.) On warfarin but last dose 4 days ago. INR of 1.4.

b.) Had Ibuprofen 800mg 1 hour ago

c.) Had Aspirin 75mg 8 hours ago

d.) Had Enoxaparin 40mg 14 hours ago

e.) Had Enoxaparin 120mg 22 hours ago

Answers

1. Answer Summary

Incidence of Post Dural Puncture Headache (PDPH) varies greatly depending on the type of spinal needle that is used. Small diameter needles have less chance of generating a large enough Cerebro-spinal fluid (CSF) leak and so less chance of PDPH. Equally the use of a "pencil point" needle as opposed to a "cutting needle" is equally thought to be less traumatic to the dura.

The 16G Tuoy needle has the largest diameter of the needles and is fact a needle used to place epidurals and is designed to try and prevent dura perforation. If it causes a dura puncture it is associated with the greatest risk of PDPH with an incidence of 70%. The Quincke needle is a cutting spinal needle and the 22G version is associated with a 36% incidence of PDPH.

The Sprotte needle and Whitacre needle are both "pencil point" spinal needles but the 25G Whitacre needle is the correct answer as it has the lowest diameter and has PDPH incidence of between 0-14% in studies.

References

Turnbull DK, Shepherd DB. PostÐdural puncture headache: pathogenesis, prevention and treatment. British journal of anaesthesia. 2003 Nov 1;91(5):718-29.

2. Answer Summary

This lady is presenting with classic early signs of epidural abscess post epidural. She is systemically unwell with fevers. The development of back pain along with fever indicates that we need to rule out an epidural abscess as a cause even though no focal neurology is present. Meningitis is a possibility with her headache and neck pain but as she does not have any change in her conscious level and has no neck stiffness on examination as well as lower back pain, this makes this diagnosis less likely. The gold standard imaging for diagnosis of an epidural abscess is an MRI Spine.

References

Grewal S, Hocking G, Wildsmith JA. Epidural abscesses. British Journal of Anaesthesia. 2006 Mar 1;96(3):292-302.

Viallon A, Botelho-Nevers E, Zeni F. Clinical decision rules for acute bacterial meningitis: current insights. Open Access Emergency Medicine: OAEM. 2016;8:7.

UNCOMMON COMPLICATIONS OF DURAL PUNCTURE & EPIDURAL PUNCTURE THAT CAN PRESENT TO JUNIOR DOCTORS ON THE WARDS

R Harrison, M Hitchcock

3. Answer Summary

The Association of Anaesthetists of Great Britain and Ireland (AAGBI) have recommended the use of sterile gowns, gloves along with a mask and hat when performing dural puncture or placing an epidural. This is in order to prevent contamination of needle and thereby reducing infective complications like epidural abscess formation and septic meningitis. It is has been demonstrated that previous bacterial meningitis post dural puncture has been most commonly associated with streptococcus viridians species – implying a possible contamination by saliva – this highlights the importance of using a mask for these procedures.

AAGBI also recommend the use of 0.5% chlorhexidine with alcohol in preference to 2% chlorhexidine with alcohol or any other skin prep. The evidence shows that chlorhexidine is superior to other products for eliminating potential bacterial contaminants. Whilst some studies have shown 2% to be more effective at this, there have been case studies where chlorhexidine may have in-advertently contaminated a spinal needle resulting in chemical arachnoiditis and paraplegia. For this reason they suggest limiting the concentration to 0.5% and ensuring the solution has not come into contact with any spinal injection equipment and that it has completely dried on the skin before attempting the procedure.

References

Tighe S, Moriarty A, Koerner R. Safety guideline: skin antisepsis for central neuraxial block. http://www.aagbi.org/sites/default/files/skin_antisepsis_v3_for_members%2011APRIL14.pdf

Baer ET. Post-dural puncture bacterial meningitis. The Journal of the American Society of Anesthesiologists. 2006 Aug 1;105(2):381-93.

4. Answer Summary

This lady has developed a post dural puncture headache (PDPH) 9 hours after a dural tap. There are no features of meningitis, which would warrant performing a CT head and Lumbar Puncture. Although there is good evidence for performing a blood patch to treat a PDPH, evidence suggests that it is only effective after 12 hours from the dural puncture. Therefore the most appropriate management plan is start regular analgesia to help manage her acute pain.

References

Turnbull DK, Shepherd DB. PostÐdural puncture headache: pathogenesis, prevention and treatment. British journal of anaesthesia. 2003 Nov 1;91(5):718-29.

5. Answer Summary

Evidence has shown an association between giving Lower Molecular Weight Heparin (LMWH) too close to epidural or dural puncture and an increased risk of vertebral canal haematoma. Guidance has been written as a consequence and it is recommended that dural or epidural puncture should only be performed after at least a 12 hour gap between the patients last prophylactic LMWH or 24 hours if they are on treatment dose LMWH

Aspirin and Non-steroidal Anti-Inflammatories carry a theoretical risk of increased bleeding but are considered safe prior to LP. An INR of <1.5 with patients who have stopped taking warfarin is considered to be indicative of normal clotting function and it would be safe to carry out the procedure in this case.

References

Horlocker TT. Regional anaesthesia in the patient receiving antithrombotic and antiplatelet therapy. British journal of anaesthesia. 2011 Dec 1;107(suppl 1):i96-106.

UNCOMMON COMPLICATIONS OF DURAL PUNCTURE & EPIDURAL PUNCTURE THAT CAN PRESENT TO JUNIOR DOCTORS ON THE WARDS

R Harrison, M Hitchcock

Author

Dr Richard Harrison BMBS
Trust SHO, Anaesthetic Department
Dorset County Hospital Foundation Trust
Williams Avenue, Dorchester, DT1 2JY

Dr Mark Hitchcock BSc, MBBS, FRCA, FFPMRCA, LLM
Consultant Anaesthetist, Anaesthetic Department
Dorset County Hospital Foundation Trust
Williams Avenue, Dorchester, DT1 2JY
hitchcockpain@gmail.com

Corresponding Author

Dr Richard Harrison BMBS
richard.harrison1@nhs.net

References

(1) Carpenter RL, Caplan RA, Brown DL, Stephenson C, Wu R. Incidence and risk factors for side effects of spinal anesthesia. Anesthesiology. 1992 Jun;76(6):906-16.
(2) Agarwal A, Kishore K. Complications and controversies of regional anaesthesia: a review. Indian journal of anaesthesia. 2009 Sep 1;53(5):543.
(3) Turnbull DK, Shepherd DB. PostÐdural puncture headache: pathogenesis, prevention and treatment. British journal of anaesthesia. 2003 Nov 1;91(5):718-29.
(4) Rice I, Wee MY, Thomson K. Obstetric epidurals and chronic adhesive arachnoiditis. British Journal of Anaesthesia. 2004 Jan 1;92(1):109-20.
(5) Gurudatt CL. Unintentional dural puncture and postdural puncture headache-can this headache of the patient as well as the anaesthesiologist be prevented?. Indian journal of anaesthesia. 2014 Jul;58(4):385.
(6) Baer ET. Post–dural puncture bacterial meningitis. The Journal of the American Society of Anesthesiologists. 2006 Aug 1;105(2):381-93.
(7) Van de Kelft E, Bosmans J, Parizel PM, Van Vyve M, Selosse P. Intracerebral hemorrhage after lumbar myelography with iohexol: report of a case and review of the literature. Neurosurgery. 1991 Apr 1;28(4):570-4.
(8) Allman K, Wilson I, O'Donnell A, editors. Oxford handbook of anaesthesia. Oxford university press; 2016 Jan 7.
(9) Christie LE, Picard J, Weinberg GL. Local anaesthetic systemic toxicity. Bja Education. 2015 Jun 1;15(3):136-42.
(10) Cook TM, Counsell D, Wildsmith JA. Major complications of central neuraxial block: report on the Third National Audit Project of the Royal College of Anaesthetists. British journal of anaesthesia. 2009 Feb 1;102(2):179-90.
(11) Jeon J, Lee IH, Yoon HJ, Kim MG, Lee PM. Intravascular migration of a previously functioning epidural catheter. Korean journal of anesthesiology. 2013 Jun 1;64(6):556-7.
(12) Cave G, Harrop-Griffiths, Harvey M, Meek T, Picard J, Short T, Weingberg G. AAGBI Safety Guideline: Management of Local Anaesthetic Toxicity. https://www.aagbi.org/sites/default/files/la_toxicity_2010_0.pdf.
(13) Grewal S, Hocking G, Wildsmith JA. Epidural abscesses. British Journal of Anaesthesia. 2006 Mar 1;96(3):292-302.
(14) Meikle J, Bird S, Nightingale JJ, White N. Detection and management of epidural haematomas related to anaesthesia in the UK: a national survey of current practice. British journal of anaesthesia. 2008 Sep 1;101(3):400-4.
(15) Visintin C, Mugglestone MA, Fields EJ, Jacklin P, Murphy MS, Pollard AJ. Management of bacterial meningitis and meningococcal septicaemia in children and young people: summary of NICE guidance. BMJ. 2010 Jun 28;340:c3209.
(16) Viallon A, Botelho-Nevers E, Zeni F. Clinical decision rules for acute bacterial meningitis: current insights. Open Access Emergency Medicine: OAEM. 2016;8:7.
(17) Mehndiratta M, Nayak R, Garg H, Kumar M, Pandey S. Appraisal of Kernigs and Brudzinski's sign in meningitis. Annals of Indian Academy of Neurology. 2012 Oct 1;15(4):287.
(18) Burke D, Wildsmith JA. Meningitis after spinal anaesthesia. British journal of anaesthesia. 1997 Jun 1;78(6):635-6.
(19) Cascella C, Nausheen S, Cunha BA. A differential diagnosis of drug-induced aseptic meningitis. Infect Med. 2008 Jul 1;25:331-4.
(20) Javed F, Grosu HB, Minkin R. Chemical Meningitis Following Epidural Anesthesia With Bupivacaine: Case Report And Review Of Literature. CHEST Journal. 2009 Oct 1;136(4_MeetingAbstracts):36S-d.
(21) Tateno F, Sakakibara R, Kishi M, Ogawa E. Bupivacaine-induced chemical meningitis. Journal of neurology. 2010 Aug 1;257(8):1327-9.
(22) Besocke AG, Santamarina R, Romano LM, Femminini RA. Bupivacaine induced aseptic meningitis. Neurologia (Barcelona, Spain). 2007 Oct;22(8):551-2.
(23) Singh J, Kazal S, Kapoor D, Singh M. Bupivacaine induced aseptic meningitis following subarachnoid block. Anaesth Pain & Intensive Care. 2015 Jan 1;19(1):65-7.
(24) Yahya M, Kakhandki Srinivas C, Thomas T. Aseptic meningitis following spinal anaesthesia-two case reports. Journal of Evolution of Medical and Dental Sciences. 2013 Apr 29;2(17):2925-9.
(25) Tighe S, Moriarty A, Koerner R. Safety guideline: skin antisepsis for central neuraxial block. http://www.aagbi.org/sites/default/files/skin_antisepsis_v3_for_members%2011APRIL14.pdf
(26) Eissa D, Carton EG, Buggy DJ. Anaesthetic management of patients with severe sepsis. British journal of anaesthesia. 2010 Dec 1;105(6):734-43.
(27) Horlocker TT. Regional anaesthesia in the patient receiving antithrombotic and antiplatelet therapy. British journal of anaesthesia. 2011 Dec 1;107(suppl 1):i96-106.

Disclaimers

Conflict of interest

The Foundation Years Journal requires that authors disclose any potential conflict of interest that they may have. This is clearly stated in the Journal's published "Guidelines for Authors"(**https://www.123library.org/misc/FYJ_Guidelines_For_Authors.pdf).** The Journal follows the Guidelines against Conflict of Interest published in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals **(http://www.icmje.org/urm_full.pdf).**

Financial statement

The authors of this article have not been paid. The Foundation Years Journal is financed by subscriptions and advertising. The Journal does not receive money from any other sources. The decision to accept or refuse this article for publication was free from financial considerations and was solely the responsibility of the Editorial Panel and Editor-in-Chief.

Patient consent statement

All pictures and investigations shown in this article are shown with the patients' consent. We require Authors to maintain patients' anonymity and to obtain consent to report investigations and pictures involving human subjects when anonymity may be compromised. The Journal follows the Guidelines of the Uniform Requirements for Manuscripts **(http://www.icmje.org/urm_full.pdf).** The Foundation Years Journal requires in its Guidelines for Authors a statement from Authors that "the subject gave informed consent".

Animal & human rights

When reporting experiments on human subjects, the Foundation Years Journal requires authors to indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the HelsinkiDeclaration of 1975, as revised in 2008.

123Library

Subscribe to the Foundation Years Journal, **visit www.123library.org**
For more info call **0203 0313 866** or email **sales@123library.org**

Volume 11, Issue 5: **Anesthesia**

2017 Past Issues

Volume 11, Issue 4: Urology
Volume 11, Issue 3: Obstetrics & Gynaecology
Volume 11, Issue 2: Radiology & Rheumatology
Volume 11, Issue 1: Ophthalmology & Pediatrics

2016 Past Issues

Volume 10, Issue 10: Diabetes & Endocrinology + Gastroenterology
Volume 10, Issue 9: Orthopaedics
Volume 10, Issue 8: Cardiology & Maxilofacial
Volume 10, Issue 7: Respiratory
Volume 10, Issue 6: Oncology
Volume 10, Issue 5: Palliative Care & ENT
Volume 10, Issue 4: Accident & Emergency & Dermatology
Volume 10, Issue 3: Vascular Disease
Volume 10, Issue 2: Neurology
Volume 10, Issue 1: Psychiatry

2015 Past Issues

Volume 9, Issue 10: Rheumatology
Volume 9, Issue 9: Anaesthesia (Part 2)
Volume 9, Issue 8: Anaesthesia (Part 1)
Volume 9, Issue 7: General Surgery
Volume 9, Issue 6: Ophthalmology
Volume 9, Issue 5: Infectious Diseases & Nephrology
Volume 9, Issue 4: Respiratory
Volume 9, Issue 3: Haematology
Volume 9, Issue 2: Gastroenterology
Volume 9, Issue 1: Urology - Part 2

2014 Past Issues

Volume 8, Issue 10: Urology - Part 1
Volume 8, Issue 9: Obstetrics & Gynaecology - Part 2
Volume 8, Issue 8: Paediatrics - Part 2
Volume 8, Issue 7: Obstetrics & Gynaecology - Part 1
Volume 8, Issue 6: Paediatrics - Part 1
Volume 8, Issue 5: Diabetes & Endocinology
Volume 8, Issue 4: Immunology & Nephrology
Volume 8, Issue 3: Neurology - Part 2
Volume 8, Issue 2: Cardiology - Part 2
Volume 8, Issue 1: Radiology - Part 2

2013 Past Issues

Volume 7, Issue 10: Vascular Disease - Part 2
Volume 7, Issue 9: Radiology Issue - Part 1
Volume 7, Issue 8: Environmental Medicine
Volume 7, Issue 7: Neurology - Part 1
Volume 7, Issue 6: Cardiology - Part 1
Volume 7, Issue 5: Vascular Disease - Part 1
Volume 7, Issue 4: ENT - Part 2
Volume 7, Issue 3: Ophthalmology - Part 2
Volume 7, Issue 2: Accident & Emergency
Volume 7, Issue 1: ENT

2012 Past Issues

Volume 6, Issue 10: Ophthalmology
Volume 6, Issue 9: Oncology
Volume 6, Issue 8: Anaesthesia Part 2
Volume 6, Issue 7: General Surgery Part 2
Volume 6, Issue 6: Psychiatry Part 2
Volume 6, Issue 5: Anaesthesia
Volume 6, Issue 4: General Surgery
Volume 6, Issue 3: Orthopaedics, Oral & Maxillofacial
Volume 6, Issue 2: Rheumatology
Volume 6, Issue 1: Geriatrics

How We Can Help You Succeed?

To find out how 123Doc can help you dramatically increase your medical knowledge, register your interest on our website.

123Doc Education
72 Harley Street
London
W1G 7HG

Tel: +44 (0)203 0313 866
Web: www.123library.org
Email: sales@123library.org

ISSN

1753-6995

Designed by Tim Lawrenson Creative.
Please visit www.pure-tlc.com.