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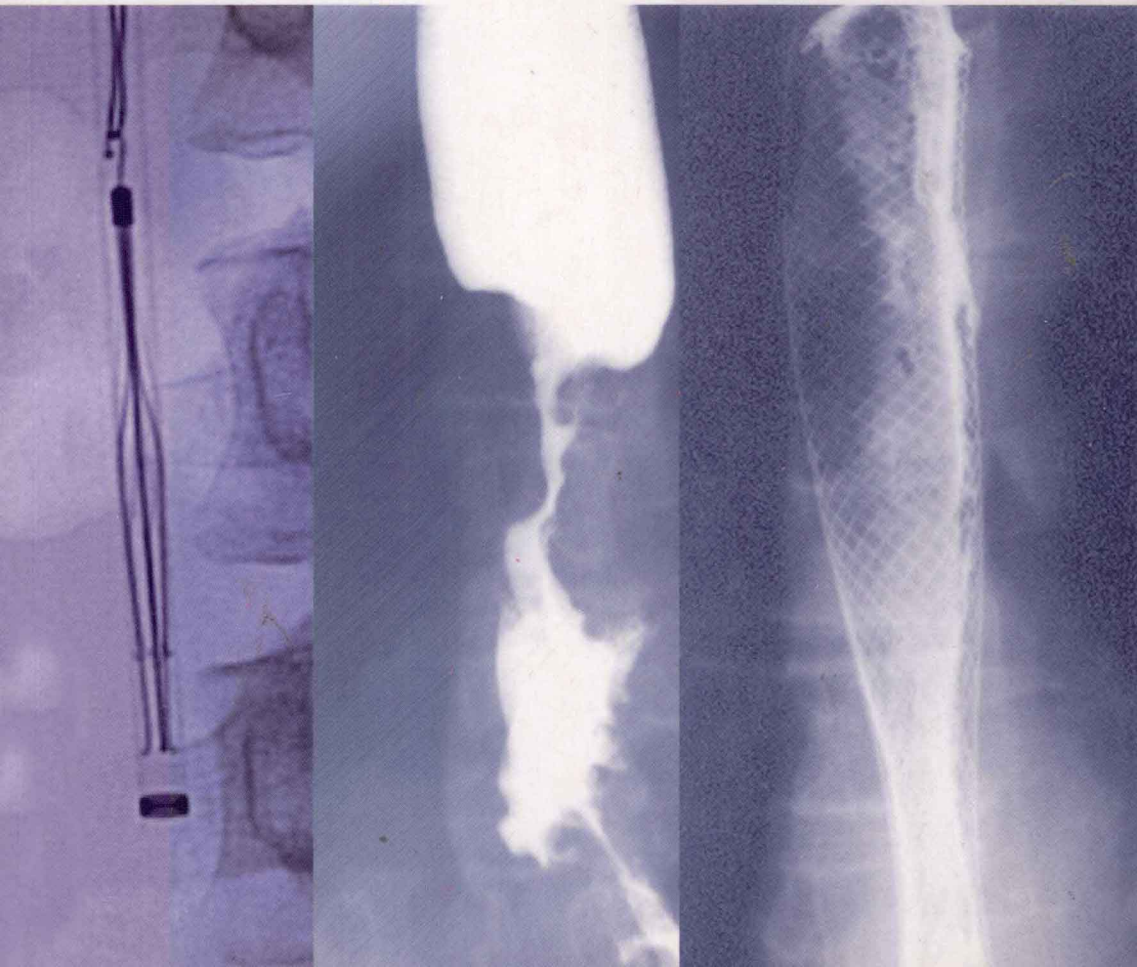
A Survival Guide

SECOND EDITION



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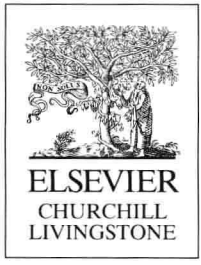

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Foreword

I am honored to write the introduction for the second edition of *Interventional Radiology – A Survival Guide* by Drs. David Kessel and Iain Roberston. When I opened the first edition in 2000, my immediate reaction was actually a horrible sinking feeling. Having recently agreed to a similar project myself, I looked through pages of concise insightful text, expertly selected and presented illustrations with comprehensive subject matter and realized that I was in trouble. This was something special. The book was the right size, the right length, easy to navigate, fun to read and truly stuffed with real-world information. It was clearly a book written by people who knew what they were doing and knew how to communicate it to others. For me, it was love at first sight.

The Survival Guide has stood up very well to the passage of the few years. As recommended reading for residents and fellows at our institution (and I am sure many others) the content remains just as valuable as when published. So why a second edition so soon – are the authors restless, sadistic, or maybe masochistic? If you look through the table of contents and the chapters, I think you will quickly see that the authors are too excited about our explosively expanding, fascinating specialty to let things be. So much has happened in just a few years, resulting in enough wonderful, new material that I guess they just couldn't help themselves. And for that the rest of us are very grateful.

Whether you are an experienced interventionalist, a fellow, a first year trainee, or a medical student, you will gain from this book. Where appropriate, the existing chapters have been revised, embellished, and strengthened. The new chapters on such topics as non-invasive vascular imaging, non-vascular intervention and fibroid embolization further the 'realness' of the book by providing the reader with the same essential and practical information required to take care of patients. The book has lost none of its character in the new edition, remaining accessible and even fun to read.

This is much more than a survival guide. This book is more akin to a fine distilled beverage, in that it concentrates the essential elements of the specialty into something that is complex, stimulating, and pleasant to ingest. Actually, after that, the analogy doesn't really hold that well; if you absorb large quantities of this book you won't just think that you are smarter and better, you will be. I raise a literary glass to Drs. Kessel and Robertson for another outstanding contribution to the specialty of interventional radiology!

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19 November 2004

Preface

Second edition – how flattering, sure no problem.

Writing a second edition should be both easier and more pleasant than wrestling the text onto the page from two, sometimes disparate, minds. After all, the hard work's been done. It seemed only a limited amount of effort would be required to continue the book and perpetuate our status as authors.

We were wrong – it's been really hard work.

In the true spirit of intervention we haven't taken the quick easy route. The text has been extensively rewritten including new chapters on arterial closure, non-invasive vascular imaging and expanding the sections on GI intervention and embolization. Every chapter has been reviewed and many new figures have been added throughout the book.

Feedback from the first edition of the book has been very encouraging and we are delighted that the book has been adopted as a bench book in many departments. Indeed several departments have told us that the *Interventional Survival Guide* has now become "the book most often stolen". Certainly, there is nothing more pleasing than meeting a colleague who found the book helpful during a new or unfamiliar procedure. Well … on reflection it would be possibly even more pleasing hearing the same information from someone who had actually bought their own copy of the book!

Regardless of the ownership of this copy of the book we are sure you will find it a practical guide to surviving, and hopefully even enjoying, the rigours of interventional radiology.

Acknowledgements

We are both greatly indebted to the many people who have contributed to the delivery of this text.

Thanks to everyone who told us that they appreciated the first edition and motivated us to get typing again. We must mention the many patients who have endured and frequently entertained us during procedures and who have allowed us to use their images in the book. We are grateful to representatives from industry for providing some of the equipment that we have used to illustrate the manuscript. Lastly there are radiologists, surgeons, nurses and radiographers and nurses who have helped us practically and willingly shared their knowledge, skill and wisdom with us.

Special thanks to our families: Ben, Holly, Jamie, Ross and Anna, children who have not questioned what their dads were up to. Carrie and Debbie our much better halves who supported us throughout the writing and editing.

Abbreviations

AAA	abdominal aortic aneurysm
AV	atrioventricular
CCA	common carotid artery
CCF	congestive cardiac failure
CE-MRA	contrast-enhanced MRA
CFA	common femoral artery
CFV	common femoral vein
CIA	common iliac artery
CTA	computed tomography angiography
CVA	cerebrovascular accident
DSA	digital subtraction angiography
DVT	deep vein thrombosis
EIA	external iliac artery
ERCP	endoscopic retrograde cholangiopancreatography
FBC	full blood count
FFP	fresh frozen plasma
FNA	fine-needle aspiration
FNAC	fine-needle aspiration cytology
fps	frames per second
GTN	glyceryl trinitrate
IADSA	intra-arterial digital subtraction angiography
IJV	internal jugular vein
IM	intramuscular
IMA	inferior mesenteric artery
IV	intravenous
IVC	inferior vena cava
LAO	left anterior oblique
LGA	left gastric artery
MIP	maximum intensity projection
MPDSA	multiposition DSA
MRA	magnetic resonance angiography
MRI	magnetic resonance imaging
NSAID	non-steroidal anti-inflammatory drug
PA	popliteal artery
PE	pulmonary embolism
PFA	profunda femoris artery
PIG	peroral image-guided gastrostomy
PTC	percutaneous transhepatic cholangiography
PV	popliteal vein
PVA	polyvinyl alcohol

RAO	right anterior oblique
RAS	renal artery stenosis
RHV	right hepatic vein
RIG	radiologically inserted gastrostomy
RIJV	right internal jugular vein
RPV	right portal vein
rt-PA	recombinant tissue plasminogen activator
RVEDP	right ventricular end-diastolic pressure
SFA	superficial femoral artery
STD	sodium tetradecyl sulphate
SVCO	superior vena cava obstruction
SVT	supraventricular tachycardia
TIPS	transjugular intrahepatic portosystemic shunting
TJB	transjugular liver biopsy
TN	tibial nerve
TOS	thoracic outlet syndrome

Contents

Section One

General principles of angiography and intervention

Chapter One

Basic principles of intervention

Interventional radiologists are clinicians in their own right. Along with the satisfaction of performing interventions comes the responsibility to assess the patient, explain the procedure to them and to follow up treatment outcomes. The latter is often the most rewarding aspect of clinical practice. Before rushing off to start practical procedures, stop and think, ensure that both you and your patient are properly prepared for the intervention and understand what the procedure entails. Consider the safe use of contrast, sedation and drugs. These are the cornerstones of good practice and risk management. You may be tempted to skip past here to get to the action and give this section little more than a perfunctory glance. Do so at your own peril!

Keys to successful intervention:

- Make sure that the procedure is appropriate in the clinical situation.
- Confirm that you and the patient have similar understanding of the procedure.
- Check that you have the same expectations of the likely short- and long-term technical and clinical outcomes.
- Understanding of the risks and benefits of the procedure.

Patient preparation

There are three key elements to ensure that patients are properly prepared for a procedure. Each assumes that you understand the procedure yourself.

Evaluation It is essential that patients undergoing an interventional procedure are adequately evaluated to identify any factors that may increase the risk of the procedure.

Action You must have strategies to deal with patients who are at increased risk.

Information The patient must then be given an indication of any significant risks and the likelihood of success when they are asked to give consent for the procedure.

Screening tests

Routine investigation (blood testing and electrocardiogram – ECG) of all patients is unnecessary and merely increases the cost of care. In deciding who to screen, consider the 'invasiveness' of the planned procedure and the likelihood of detecting an abnormality that would affect patient management. The guidelines below are suggestions for screening and are not absolute; if in doubt, it is better to perform a non-invasive test.

Clotting studies are indicated when the patient:

- Has clinical evidence of a coagulopathy.
- Has a disease likely to affect clotting. For instance, liver disease frequently causes deranged clotting; therefore, it is unwise to perform a liver biopsy without knowing the coagulation status as this substantially alters the risk of the procedure.
- Is taking medication that affects coagulation, e.g. heparin or warfarin.

Evaluation of renal function is indicated when the patient:

- Has a history of renal dysfunction.
- Has a disease likely to impair renal function, e.g. hypertension, especially with peripheral vascular disease.
- Is diabetic and has not had a recent evaluation of renal function.
- Has heart failure.
- Is receiving nephrotoxic drugs.

ECG is indicated when the patient:

- Has a history of cardiac disease.
- Is to undergo a procedure likely to affect cardiac output or cause arrhythmia, e.g. cardiac catheterization.

High-risk patients

Consider the risk in the context of the patient's condition. Although the risks of the procedure should be minimized, a life-saving procedure should not be delayed. From time to time you will be told that 'the patient is too unstable to bring to radiology', but remember, there is no logic saying that the patient is too ill to have a life-saving procedure! This section aims to help you keep the risk to yourself and the patient as small as possible.

This list is not comprehensive, so pause to consider before every case and never hesitate to seek advice.

The patient has a history of anaphylactic reaction to intravascular contrast This is fully discussed in the section on contrast media (p. 11). Remember to consider alternative strategies, such as Duplex ultrasound, magnetic resonance angiography, or another contrast agent such as gadolinium or carbon dioxide (CO_2) depending on the local expertise. If angiography is essential, be prepared; if possible, get an anaesthetist, and at a minimum have the crash trolley ready and ensure the patient has venous access before starting.

The patient is anticoagulated or has a severe bleeding diathesis The risk relates to the procedure; simple drainage and venous puncture are safer than arterial puncture or core biopsy. In the presence of mildly deranged clotting (international normalized ratio (INR) < 3), use a 3Fr catheter. If larger catheters are needed or the INR > 3, elective procedures should be postponed to allow investigation and correction of the coagulopathy. Only intervene to correct the clotting if the procedure is urgent. The risk of haematoma following angiography increases when the platelet count is 100×10^9/L. For surgery and invasive procedures the platelet count should be $= 50 \times 10^9$/L. Correction of coagulopathy is discussed in Chapter 4 (p. 27).

Tip: Abnormal clotting is relevant mainly when the time comes to obtain haemostasis. Consider using a closure device (Chapter 9). Alternatively, leave a sheath in the artery until the clotting is corrected. An arterial line may be helpful for intensive therapy unit patients.

Diabetes Diabetic patients are at particular risk because of:

- The protean manifestations of diabetes, especially cardiovascular and renal disease.
- Potential problems with diabetic control in the periprocedural period.

Non-insulin dependent diabetics The current UK recommendation is that non-insulin dependent diabetics should stop metformin at the time of any procedure involving intravascular iodinated contrast, and should not restart until renal function has been checked 48 hours after the procedure. The risk of lactic acidosis is vanishingly small unless there is prior renal dysfunction. Some patients will need to take insulin to control their diabetes over this period.

Insulin-dependent diabetics should avoid prolonged fasting; they should be scheduled to have their procedure early in the morning. In this case they should take their long-acting insulin as usual but omit the short-acting insulin. If the procedure is later in the day, leave out the short-acting insulin and halve the dose of the long-acting insulin. A 5% dextrose solution should be infused to provide 5–10 g/h of glucose; this will normally maintain the blood glucose in the range 6–11 mmol/L.

Renal failure Chronic renal impairment is relatively common in patients with peripheral vascular disease and may be exacerbated by contrast. The aetiology of contrast-induced nephropathy (a rise in creatinine of 0.5–1 mg/dL or 44–88 mmol/L) is complex. Although few patients will require dialysis, prevention is better than cure. Consider using alternative tests. The most important factor in protecting renal function is ensuring adequate hydration. If iodinated contrast is essential then non-ionic iso-osmolar agents such as iodixanol (Visipaque) will minimize the risk. There is sufficient evidence suggesting a renoprotective effect of *N*-acetylcysteine (600 mg PO, two doses pre and post procedure) to support its use.

Tip: Remember that roughly 50% of renal function has been lost by the time the creatinine rises above the normal limit. Creatinine clearance can be estimated by the Cockcroft Gault method:

$$\text{CrCl} = [(140 - \text{age}) \times \text{weight (kg)}]/\text{Cr} \quad (\mu\text{mol/L}).$$

Multiply by 0.85 for female patients.

It is helpful to adopt a simple pragmatic strategy for managing patients with renal impairment based on the risk of developing contrast-induced nephropathy. If your centre does not have clear guidelines the following may help:

1. Is this the most appropriate investigation? (Consider MRA, Doppler, CO_2.)
2. Review medication: if possible, stop
   - NSAIDs
   - ACE-I (unless CCF)

- Metformin (stop for 48 h and restart if creatinine stable)
- Avoid loop diuretics if possible.

3. Act according to the creatinine clearance (serum creatinine if you don't have a calculator)

Minimal risk CrCl > 60 or Cr < 120

- Ensure hydration: oral fluids 1 L pre and post procedure.

Low risk CrCl 30–60 or Cr 120–180

- **Inpatient**: non-ionic contrast, IV normal saline 1 mL/kg/h 12 h pre and post procedure
- **Outpatient**: iso-osmolar contrast (iodixanol) Encourage oral fluids 1 L pre and post procedure; if possible IV normal saline started on arrival 1 L over 4 h.

Intermediate risk CrCl < 30, Cr > 180 or renal transplant

- If possible admit for procedure; iso-osmolar contrast (iodixanol) IV normal saline 1 mL/kg/h (caution if CCF) 12 h pre and post procedure; *N*-acetylcysteine 600 mg PO (two doses pre and post procedure).

High risk CrCl < 20 mL/min

- Admit for procedure; iso-osmolar contrast (iodixanol), IV normal saline 1 mL/kg/h (caution if CCF) 12 h pre and post procedure; *N*-acetylcysteine 600 mg PO (two doses pre and post procedure). Repeat Cr at 7 days.

Avoid further contrast exposure for 72 h if possible.

4. Other risk factors, e.g. diabetes mellitus, multiple myeloma, CCF, cirrhosis; consider promoting to the next level of CrCl.

Tip: Hydration – in the presence of CCF or cirrhosis with ascites use 5% dextrose instead of saline.

Hypertension This is a common problem and is exacerbated by anxiety and pain. Hypertension increases the risk of haematoma. Review the ward charts to check the normal baseline blood pressure (BP). The Society of Cardiovascular and Interventional Radiology (SCVIR) standards define uncontrolled hypertension as a diastolic pressure >100 mmHg. Systolic hypertension is present when the systolic pressure is >180 mmHg.

Control of high blood pressure starts on the ward; the patient should take any antihypertensive medication (except diuretics) as normal. If the patient remains hypertensive in the angiography suite, he or she can be given 10 mg of nifedepine. Sedation and analgesia may also help blood pressure control. Aim to reduce the mean blood pressure by no more than 25%.

Tip: If the blood pressure cannot be controlled by these simple measures, postpone elective cases until the patient is appropriately medicated on the ward.

Heart failure The patient's condition should be optimized before angiography. Diuretics should be avoided if possible to minimize the risk of nephrotoxicity. Limit the study to the essential details. If necessary, breathless patients can sit up slightly: this can be compensated for by craniocaudal angulation of the C-arm. Use oxygen as necessary.

Table 1.1 Fasting times prior to intervention

Oral intake	Fasting time
Solids and non-clear liquids	6–8 h
Clear liquids	2–3 h

Gastric contents It is normal to fast patients before invasive procedures, but the risk of aspiration of gastric contents is very small except in sedated patients. General guidelines are shown in Table 1.1. These are mandatory before conscious sedation or anaesthesia, and advisable before other cases.

In urgent cases, seek anaesthetic advice, avoid sedation and consider metoclopramide to promote gastric emptying, H_2 antagonists or proton pump inhibitors to increase gastric pH, and antiemetics to minimize the risk of vomiting.

Tip: Diabetic patients and those at the extremes of age should be given maintenance IV fluids to cover the periprocedural period.

Demented, anxious and agitated patients These patients may require sedation or general anaesthesia for angiography. A general anaesthetic is often the safest option for both patient and staff, and maximizes the chance of performing the procedure successfully. Consent issues are also relevant in this group of patients (see below).

Consent

Informed consent Patients have a legal (and moral) right to be given sufficient information to make informed decisions about the investigation/treatment (these terms will be used synonymously) options available to them.

Imagine what you would want to know before undergoing a procedure yourself:

- Are there alternative options?
- What are the risks or the procedures?
- What is the likelihood of the procedure being a technical success?
- Will this translate to having the clinically desired effect?
- What is the likelihood of recurrence?
- Will this treatment strategy affect their future management?

In practical terms a patient can only make a choice when they are empowered with sufficient knowledge. Your role is to provide relevant information in a way that the patient can comprehend. The laws regarding informed consent vary from country to country;