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Recommendations for reporting perioperative transoesophageal echo studies

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Every perioperative transoesophageal echo (TEE) study should generate a written report. A verbal report may be given at the time of the study. Important findings must be included in the written report. Where the perioperative TEE findings are new, or have led to a change in operative surgery, postoperative care or in prognosis, it is essential that this information should be reported in writing and available as soon as possible after surgery. The ultrasound technology and methodology used to assess valve pathology, ventricular performance and any other derived information should be included to support any conclusions. This is particularly important in the case of new or unexpected findings. Particular attention should be attached to the echo findings following the completion of surgery. Every written report should include a written conclusion, which should be comprehensible to physicians who are not experts in echocardiography.

Keywords Perioperative transoesophageal echocardiography • Reporting

Introduction

Transoesophageal echocardiography (TEE) was introduced into clinical practice in the late 1970s, and the early reports of its use in the operating room appeared shortly thereafter.[1,2] Recommendations for the use of standard views,[3] recommendations and indications for the use of TEE both inside and outside the operating room,[4,5] and recommendations for training and accreditation have all followed.[6–8] Transthoracic imaging is not routinely feasible for adult cardiac surgery, and TEE has developed into a unique diagnostic and monitoring tool for patients undergoing cardiac surgery. Indeed, the usefulness of perioperative TEE and the lack of available alternatives of comparable effectiveness have led to a marked increase in the use of perioperative TEE in cardiac surgery patients. It has been noted that the perioperative setting is rapidly becoming the most common setting for the use of TEE.[9] The wider availability of new developments, including live 3D imaging, and the value of these developments, may increase the use of perioperative TEE still further.

Cardiologists, cardiac anaesthesiologists, and cardiac surgeons have all become involved in delivering a perioperative echo service. In the main, cardiac anaesthesiologists have taken up the burden of service provision since they are present throughout the case and able to scan the patient at any time. Although echocardiography skills are outside the main training syllabus for anaesthesiology, cardiac anaesthesiologists have accepted the challenge with relish, and are involved worldwide, in programmes of training and accreditation.

One area that has not been authoritatively addressed is the content of a perioperative TEE report. These are not identical to the requirements in cardiology practice. In cardiology, a TEE study is frequently undertaken following a TTE study. The purpose of the TEE study is to answer a specific question, and the two studies are considered to be complementary and may be reported as one.[10] In perioperative TEE, a complete and fully reported TTE study may not have been carried out recently or, more rarely, at all. Where the requirement for a comprehensive TTE study has not been met, the functional assessment by TEE

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both before and after corrective surgery may assume greater importance.

Although it is clear that a TEE report should be produced in every case, there is remarkably little evident agreement about what form this should take or what the essential elements of such a report should be. A number of report forms have been developed with digital reading and computer storage in mind. Many such forms are useful in conveying information to other specialist echocardiographers However, an intraoperative TEE report should also be able to convey essential information to others who are not specialist echocardiographers. Where the intraoperative TEE findings have led to a change in operative surgery or in prognosis, it is essential that this information should be unambiguous and available as soon as possible after surgery.

The need for guidance in producing perioperative TEE reports has been highlighted by the development of the TEE accreditation process developed jointly by the European Association of Echocardiography (EAE) and the European Association of Cardiothoracic Anesthesiologists (EACTA); it is not uncommon for a process of assessment to identify an educational need. This accreditation process has included, from its inception, a knowledge-based assessment testing judgment, and the submission of a logbook of cases undertaken under supervision. Thus a document providing some guidance on the perioperative TEE report would be valuable.

This document aims to provide guidance for physicians on the content and structure of a perioperative TEE report. As already described, there is ample guidance in the literature on how to undertake perioperative TEE[3–5] and recommendations are also available in numerous standard texts. We anticipate that these will be modified over time as newer methodologies become established, and the evidence base for their routine use results in them displacing older techniques.

Perioperative TEE is most frequently used in adult cardiac surgery and critical care. However, its use in other settings is becoming more widespread, particularly in adult non-cardiac surgery. We believe that the principles described here are applicable in these other settings, although some adjustments of detail may be needed. However, we accept that TEE in congenital heart disease may need a more specialized approach, and we suggest our approach be confined to those cases described as being manageable outside of those specialist centres dealing with congenital heart disease.[11]

Our intention is that these recommendations should be of value both for the purposes of accreditation and for everyday clinical practice.

The perioperative transoesophageal echo report

A perioperative echo report often provides important information to a number of specialists and others caring for the patient throughout their treatment. The information for the surgical team may be a crucial aid to surgical planning, and in formulating a postoperative management plan. The perioperative study before and after surgery is important, since it serves to record the results of surgery both for the patient and interested physicians. The report should include pre- and post-surgery findings in all cases and should be intelligible to the intended reader. A concise summary of findings understandable to the non-echo practitioner is essential. A perioperative TEE report should serve a number of functions.

Perioperative decision making

The information from the TEE needs to be acquired and interpreted relatively quickly and incorporated with other data relating to the patient's haemodynamic state so that a surgical treatment plan can be formulated and followed. Commonly, the surgical plan is merely confirmed. However, echocardiographic findings may cause the plan to be changed.[12,13] Where TEE data lead directly to a change in surgical management, it is essential that the data and the conclusions drawn from those data are fully documented in the written TEE report and permanently recorded. The actual change in surgical plan may be noted also but will in any case be contained within the operative report.

Provision of a comparator for future studies

An echocardiography report leaves a permanent record that allows future studies to follow the progression of a patient's disease or the effect of therapy.

Training and accreditation

The writing of an echocardiography report is as much a part of the TEE training process as is learning to manipulate a probe and acquire images. The presentation of echo reports is used to assess a trainee's ability to assimilate and interpret findings. It is also used to ensure that trainees have performed the required number of studies for accreditation in echocardiography. In Europe and North America, standard requirements for training accreditation and certification have been introduced that specify a number of echo reports to be submitted before accreditation can be granted.[8,14,15]

Where a report of a TEE study is produced by a trainee as part of the training process it should be verified by a trained expert echocardiographer in order to both the assure of the output of echo service and facilitate continuous assessment of the trainee's progress.

Medicolegal issues

It is important to recognize that a perioperative TEE study and report provide a unique record of the patient's cardiac status during, and immediately after, cardiac surgery. The presence of a full and comprehensive report of a TEE examination may provide data that contribute to optimal patient management and explain a subsequent course of action.

While TEE is generally a low-risk procedure, adverse or untoward effects may occur. Some serious adverse events do occur more frequently in the anaesthetized patient. Any adverse incidents must be recorded.

Audit

Echocardiography reporting facilitates audit. The number of reports produced by an echocardiography service provides evidence of activity. These data may be used to support requests for development of the service. It is difficult to plan and develop a service without knowing how much work is done, by whom, and when and where this activity takes place. Continuous audit of the content of echo reports also helps to drive and maintain good standards of clinical practice.

Research

A database of echocardiographic activity and findings in cohorts of patients can be a valuable research tool. TEE reports can and should contain numerical data which may be useful in both controlled trials and observational studies. Failure to record such data is a waste of a potentially valuable resource.

Types of transoesophageal echo report

A TEE examination report is usually paper based but with some data fields electronically generated. Perioperative TEE is additionally verbally reported to the operating surgeons.

The verbal report

Perioperative TEE is unique, in that the echocardiographer is providing information for immediate communication to the surgical team. Verbal reporting is therefore essential. An operating surgeon approaching mitral valve repair surgery needs to be told the mechanism of the mitral lesion clearly and concisely at the start of the procedure and also needs a clear description of the effectiveness of the surgery at the end of cardiopulmonary bypass. Similarly, the state of the left ventricular function should be identified and conveyed accurately and concisely, since immediate clinical management may depend on it. In these circumstances, the report describes the state of the heart at a precise moment in time, with given loading conditions and contractility, both of which may differ from the pre-surgery assessment and be affected by a range of drugs and therapies. It may be appropriate to compare the perioperative echo data with known pre-operative data when it is available.

Careful thought should be given to the way a verbal report is phrased. The report may have a profound impact on the way an individual patient is treated, and reflect on the expertise and opinion of the echocardiographer in the future. Too much information may confuse, but sufficient data must be given to ensure that the listener understands the principal findings. If the echocardiographer has interpreted the data, it is important to communicate how certain one is of the findings. Verbal reporting should have the same consistency and reproducibility as written reporting. For example, the surgeon and the anaesthesiologist must both think that the term 'moderate global LV function' means the same thing.

The verbal report will inevitably concentrate on the most relevant issues only, without being a comprehensive report of the whole TEE examination. Thus it is essential that any verbal report should be followed by a permanent comprehensive written report which should be generated within a short time of the examination itself. A verbal report should never replace a written report.

The written report

For most operators, some form of standardized reporting system alleviates the problem of a lot of repetitive material which of necessity is involved in echo reporting. Standardized systems can also contain useful information, including the normal range of values for cavity dimensions, wall thicknesses, pressure gradients, velocity/time integrals, valve areas, and any other variables which are frequently reported.

A standardized report form can also act as an aide memoire to ensure a comprehensive study.

There are a number of tick-box type TEE report forms in use which greatly simplify the recording of data.[16] These have been found useful in perioperative echocardiography. A disadvantage, however, is that it does not allow the operator room to explain the data that led to a particular item being recorded, or the degree of certainty of a finding. For example, a box indicating severe aortic stenosis may be ticked, but there may be no supporting data recorded. This type of form often has little scope for free text to explain conclusions or to summarize findings in patients where more than one pathological finding is present. In general, we would not recommend generating a report which only records conclusions, rather than showing how those conclusions were reached from raw data.

The computerized report

A standardized written reporting system is relatively easy to adapt to computerized storage and recall. In some institutions, echo data are collected onto standardized forms which can be entered into a database. The tick-box form is particularly easy to use in this way and may explain their current popularity. Most modern echocardiography platforms contain some sort of reporting feature, and in the absence of any other institutional system these will provide acceptably formatted reports.

Since digital storage of data is now commonplace, moving and still images that demonstrate echo findings from an examination can easily be stored to compliment the non-visual data. Computer-based reporting systems have been available for some time, and newer more interactive systems are still under development.[17]

The content of a perioperative written transoesophageal echo report

There is currently no defined and agreed minimum data set for a perioperative TEE report. The following are recommendation for safe and efficient practice.

Patient demographics

The name, date of birth, and hospital ID of the patient are mandatory requirements. The age of the patient may guide the

interpretation of certain data, as may the patient's height, weight, and body surface area.

Date, time, and location of the study

Name and grade of the operator

It is important to document who performed a study and who reported it.

Destination of a written report

Normally a perioperative report will become part of the patient's operative/anaesthetic record, although this may vary between institutions. However, it is important that there is a clear policy identifying where such reports or records may be found for easy reference.

Equipment employed

There is no doubt that technology is evolving rapidly and the use of more modern equipment is associated with better studies. Newer technologies, including 3D echo, should be identified whenever used.

Indications for performing the study

The nature of the surgery and any questions specifically asked should be recorded. Although we recommend the comprehensive approach to echocardiography, the indication for the study may place greater emphasis on some areas of structure and function than others.

Quality of the study, difficulties, and complications

Poor echo windows and imaging difficulties need to be indicated in the report. Any difficulties with probe insertion, physical trauma, or other complications must be recorded.

Haemodynamic conditions

Many features of the findings of a TEE examination are related to the haemodynamic state of the patient at the time of the examination. Heavy sedation, general anaesthesia, and the supine position may all affect preload, afterload, and contractility. Patients with valve regurgitations may appear to have less severe lesions in the anaesthetized, supine state that when awake. Estimates of ventricular function may be similarly affected. This is particularly important in patients undergoing mitral valve repair. We strongly recommend that a comment be made on the patient's blood pressure at the time of the primary pre-surgery assessment and after corrective surgery. It is vital that these data are recorded in any patient who is undergoing a planned on-table assessment of the mitral valve, or any patient in whom the operative plan is changed.

Specific findings

Two dimensional transoesophageal echo cardiac dimensions

Recommendations for chamber quantification have recently been published by a joint group representing both the American Society of Echocardiography and the EAE.[18] While acknowledging that past publications have noted differences in chamber dimensions,[19–21] the writing group noted that these differences are primarily attributable to the inability to obtain from the transoesophageal approach the standardized imaging planes/views used when quantifying chamber dimensions transthoracically.[22,23] They concluded that the same range of normal values for chamber dimensions and volumes should apply for both TEE and TTE, particularly where TEE images allow measurements of cardiac structures along imaging planes that are analogous to TTE.[18] However, we must recognize that anaesthesia and intermittent positive pressure ventilation may themselves affect normal chamber dimensions in TEE compared with the awake state.[24]

From the above, we would conclude that the perioperative echocardiographer should report what they find. It is the interpretation of those findings that may be more controversial. Clearly small differences in measurements may exist between TTE and TEE, particularly of left atrial diameter[19–21] and possibly of diameter of the left ventricular outflow tract.[25] We recommend that when measurements of left atrial diameter are reported, the view used should be stated.

Transoesophageal echocardiography Doppler flow velocities

It has long been recognized that accurate calculation of blood flow velocity by the Doppler technique is dependent on the ultrasound beam being as closely as possible parallel to the direction of blood flow. The intercept angle should not be more than 20°, otherwise the resulting error will be more than 6% of the actual velocity.

There may be differences in normal reference values between awake and anaesthetized patients,[26] but otherwise there is no inherent reason why Doppler velocities measured by TEE should be any less accurate than that by TTE, other than a failure to achieve a low intercept angle. Satisfactory values have been shown to be obtainable in more than 80% of patients studied.[27–29] Where there is a probability of a greater intercept angle, this should be noted and included in the report.

Cardiac chambers

Atria

Left and right atrial dimensions should be reported.

Spontaneous contrast, mass, the presence of thrombus, and the presence of devices should be sought and reported. Patients in atrial fibrillation should have the left atrial appendage screened, and a positive or negative report for thrombus noted.

The visualization of one or more pulmonary veins should be noted. The visualization of the superior and inferior vena cavae should recorded.

Atrial septum

The atrial septum may be reported simply as normal, provided there is no morphological abnormality and the presence of defects and shunt direction/velocity have been sought. Any abnormality should be noted specifically.

Left ventricle

The LV systolic and diastolic cavity dimensions should be noted along with the view in which they are measured.

It should be reported that those LV segments available to standard long- and short-axis TEE views have been seen. We recommend using the 2002 nomenclature. This has standardized both the names of the ventricular walls and the segmentation of the left ventricle across all imaging modalities.[28]

Global systolic function should be reported. Any relevant abnormality of the regional wall motion should be reported, both in location and severity.

An estimate of LV ejection fraction should be reported. Given the wide variety of techniques available for this purpose, we strongly recommend including in the report the method used to obtain it.

LV wall thickness, including septal wall thickness, should be reported, noting thinning or hypertrophy.

Where there is significant abnormality of the left ventricle (e.g. apical dilatation, aneurysm, etc.) this should be reported. The presence or absence of LV thrombus should be noted in conditions where it might be expected.

Right ventricle

Right ventricular function and dimensions should be reported.

The method used to assess function should be specified. A qualitative assessment of RV function may be adequate in many cases.

Valves

Known valve disease

Patients undergoing surgery for valve disease should already have had a detailed assessment of the valve in question. A perioperative report should serve to confirm and/or refine those findings. Any abnormality of leaflet motion and morphology, calcification of the valve, annulus or subvalvar apparatus should be noted.

The severity of valve stenosis or regurgitation should be noted, and we strongly recommend that the method used for calculation or assessment be stated. Other relevant surgical factors (aortic root dimensions, etc.) should be reported.

It is imperative that any findings that alter the operative plan be stated specifically. The description of abnormal findings must be accompanied by the data which supports those findings.

Patients with previously implanted prosthetic valves should have both the presence of the valve noted, and where possible an assessment of the function noted also. Again, this is essential if the perioperative echo findings lead to a change in the surgical plan.

Mitral valve

The dimension of the mitral annulus should be reported when it is considered to be relevant. Leaflet morphology and motion, and the severity and location of any calcification should be noted also. The mechanism and severity of mitral regurgitation should be reported. Similarly, any evidence of mitral stenosis and reduced mitral valve area should be noted. We strongly recommend that the method(s) used to assess severity of regurgitation and stenosis be stated.

Aortic valve

Dimensions of the annulus, sinuses of valsalva, and sinotubular junction should be noted, with leaflet morphology and motion.

TEE evaluation of the aortic valve may be difficult in patients with calcific aortic stenosis.[29] However, in patients who are not scheduled to undergo aortic valve replacement, evidence of early aortic sclerosis or stenosis should be noted.

Evidence of aortic regurgitation should be reported. We strongly recommend detailing the method(s) used and the presence of other supportive data (e.g. LV chamber size).

Tricuspid valve

Leaflet morphology and motion, and annular dimensions should be reported when they are considered to be relevant. Significant tricuspid regurgitation consequent on tricuspid annular dilatation should be noted, and right ventricular systolic pressure reported where possible.

Great vessels

All patients should have simple observations of the great vessels reported, in particular, examination of the descending aorta. The presence and severity of atheroma should be reported.

In patients in whom the primary pathology lies in the great vessels, a detailed assessment and report will need to be carried out. This will include the vessel dimensions, the nature and extent of the lesion and any complicating factors. Where appropriate, the use of imaging modalities (e.g. colour flow Doppler) should be reported.

Pericardium

In patients in whom the primary pathology lies in the pericardium, a detailed assessment and report will be needed, including the presence of effusion, fluid, solid material, and calcification.

Pleurae

In patients with significant heart failure and/or pericardial effusion, the presence of effusions should be noted.

Post-cardiopulmonary bypass study

Every perioperative TEE should include a study following corrective surgery. This is one of the most important aspects of perioperative TEE, and the study should be fully reported. We would recommend the following.

(i) Report when the study was performed. In the cardiac surgical patient this might be immediately following CPB, following protamine, before or after chest closure. The findings at these times may be markedly different, and it is therefore important to note when the study was recorded.

(ii) Report the state of the LV function. This should include a note of any concurrent supportive treatment, i.e. inotropic drug, mechanical device support, etc. In patients undergoing revascularization attention should be directed to, and a note made of significant regional wall motion abnormality in the relevant areas.

(iii) Surgical outcome

  (a) In valve replacement surgery the prosthetic valve function should be noted, any regurgitant jets including normal 'washing' jets should be noted.

  (b) In valve repair, the severity and nature of any residual regurgitation should be noted. The method of assessment

and the concommittant haemodynamic conditions must be stated.

(c) In other surgery, any further information that may reflect on the success of the surgery should be noted.

(iv) Any information that may guide those physicians and others responsible for the clinical management of the patient postoperatively should be reported.

We strongly recommend that any abnormal findings are also discussed with the surgical team and that fact noted in the TEE report.

The purpose of the study is to identify the outcomes of the surgery and to identify cardiac function. It should concentrate on those areas that may have changed, or where no change is an important finding.

Report conclusions

Although the concluding statement may be one of the last things that the echocardiographer writes in a report, it may be the most important part of the report for many readers.

It should be a clear, concise, and logical summary of the findings of the examination. The pathology should be presented in order of significance and severity. Where there is more than one abnormal finding, the conclusion should, if possible, link the findings in such a way as to make a coherent pathophysiological story. Similarly, where there are apparently conflicting findings this too should be highlighted. Less significant pathology should be mentioned later.

The conclusion must be intelligible to a non-echo trained physician.

Therapeutic suggestions

The perioperative TEE is primarily directed towards the surgical episode, and the report will reflect this. However, it may be useful to make recommendations either for further follow-up or therapy within the report.

In conclusion, we have presented a coherent and comprehensive approach to compiling a perioperative TEE report. The TEE report should not simply concentrate of reproducing those findings that may have been available from pre-operative investigations, but should pay particular attention to unexpected findings and those findings following corrective surgery. We believe these recommendations will result in good practice, and we are confident that adherence to the principles and practice we have outlined will be beneficial for candidates seeking accreditation in TEE.

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