Australian cardiac sonographers' use of industry guidelines when performing a transthoracic echocardiogram

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Abstract

Introduction: Clinical practice guidelines (CPG) are a component of evidence-based practice allowing standardisation across departments and individuals' skill levels. Australian Cardiac Sonographers (ACS) are not obliged to follow specific CPG when performing a transthoracic echocardiogram (TTE). This research aimed to determine guidelines/workplace protocols ACS follow when performing a TTE, and what attitudes, subjective norms and perceived behavioural controls exist that may prevent adherence to guidelines.

Methods: A national mixed methods online survey, exploring adherence to and opinions of guideline use when performing a TTE. The 'Theory of Planned Behaviour' model (attitudes, subjective norms and perceived behavioural controls) was used to develop the survey.

Results: Of n = 131 ACS, 73% reported following a mix of guidelines, practice protocol and doctor preference when performing TTE. The majority followed the American Society of Echocardiography (ASE) guidelines (59%), considered guidelines beneficial (84%) and felt encouraged to adhere to them (56%). Most however (61%) reported finding measurement or pathology discrepancies with their own TTE studies compared with those performed at other practices. Factors negatively influencing guideline adherence included insufficient guideline education, time constraints for scanning and education, leadership influence and lack of quality control. These factors were considered largely workplace dependant.

Conclusion: While the majority of ACS do not follow a single specific guideline when performing a TTE, ACS believe guidelines are important. Several negative influences may prevent adherence in different workplace environments. Further examination of national standardisation and education/quality control programs is recommended with observation of patient and economic outcomes.

KEYWORDS
echocardiography, guidelines, transthoracic, theory of planned behaviour
INTRODUCTION

The primary role of a cardiac sonographer is the performance of a comprehensive transthoracic echocardiogram (TTE). Using a variety of modes including M-mode, two-dimensional (2D) imaging, colour Doppler and spectral Doppler, a TTE provides information on cardiac valves, chambers, great vessels, myocardium and pericardium utilising a series of multiple views. Results can determine cardiac normality or if medical or surgical intervention, chemotherapy regimens and cardiac device insertion, therefore reliable and reproducible results are essential. There are no formal national clinical practice guidelines (CPG) for the performance of a comprehensive TTE in Australia. CPG are a component of evidence based practice, allowing evidence to be applied to clinical situations. Adherence to guidelines is a suggested measure of best practice which can improve patient outcomes. Existing guidelines include those from the American Society of Echocardiography (ASE) and the British Society of Echocardiography, however, individual practice protocols or cardiologist requests may also be utilised. Australian Cardiac Sonographers (ACS) are under no formal obligation to follow a specific guideline in clinical practice. Lack of TTE standardisation has the potential to increase variation in practice, and to affect lifesaving clinical decisions including patient medical and/or surgical management. For example, a study comparing the measurements of the aortic root using TTE guidelines based on different age groups revealed different TTE guidelines produce differing and potentially clinically significant measurements.

Guidelines have been put in place to standardise practice. Barriers to using guidelines include the assumption that they may not fit the clinical presentation or may de-skill the workforce. However, guidelines have the advantage of providing a holistic approach across multiple departments and skill levels enabling transferability of clinical reasoning. Adherence of ACS to guidelines can be understood by using a behavioural model—the ‘Theory of Planned Behaviour’ which is used to explain and predict behaviour. This model argues a combination of attitudes towards the behaviour under review, subjective norms or the degree of social pressure experienced by a person and perceived behavioural control under voluntary control of the person engenders a volitional behaviour or measurable action or knowledge based on a person’s free will. This demonstrates multiple factors may influence the use of protocols and guidelines.

When applied to ACS, attitudes refer to an individual sonographer’s positive or negative perception of adhering to guidelines. Subjective norms are an individual sonographer’s perception of other people’s expectations regarding guideline adherence. Perceived behavioural control is a sonographer’s perception of their ability to adhere to guidelines when contending with facilitators and barriers. Perceived volitional behaviour refers to direct measurable actions and knowledge related to guideline adherence when performing a TTE. While the model of planned behaviour can be used to predict intentions to adhere to guidelines, potential negative factors may include the existence of multiple guidelines, and individual ACS workplace practices.

Limited information is available on current working environments and Theory of Planned Behaviour factors preventing ACS from following guidelines. Recent preliminary survey results published by the Australasian Sonographers Association (ASA) indicate variability in private and public practice with private sonographers performing more scans in shorter time frames. In addition, a national sonographer workforce shortage may push ACS to scan faster to accommodate more patients. This combination of working environment barriers and a lack of national CPG for the performance of comprehensive TTE may result in guideline use variability which could affect patient outcomes.

The primary aim of this study was to assess if ACS follow workplace protocols or industry guidelines, or a combination of both when performing a TTE. A secondary aim was to determine what behavioural factors exist preventing ACS from following a single and specific industry guideline.

**FIGURE 1** Guideline adherence of Australian cardiac sonographers using a theory of planned behaviour model. 
Source: modified from Ajzen, 1991, figure 1, p. 182
2 METHODS

This was a cross-sectional mixed methods survey. The study was approved by the Central Queensland University Human Research Ethics Committee, approval number 2020-076.

2.1 Study population

An online survey was open to all accredited cardiac sonographers working in Australia and registered with ASAR under Category 1A. Sample size calculation from a population of 1228 ACS with a proportion of .5 and a confidence interval of 0.05 gave a sample size of 293. Multiple online access points were used including ASA discussion forum, industry email chains and social media sites Facebook, LinkedIn and Twitter. Snowball sampling was also utilised to maximise ACS participation. Exclusion criteria included sonographers from modalities other than cardiac, student ACS, and sonographers not currently working in Australia.

2.2 Survey design

A national survey using purposive sampling of ACS was used with a convergent, parallel design. Online platform SurveyMonkey was used. A focus group of six senior and chief ACS were recruited through invitation email to test and refine the survey design. The survey was divided into five sections for analysis including (1) Sociodemographic and professional background characteristics; (2) Attitudes towards TTE guidelines; (3) Subjective norms to guideline adherence; (4) Perceived behavioural controls to following TTE guidelines; and (5) Perceived volitional behaviours to following TTE guidelines. Quantitative and qualitative data were collected, with separate analysis for each methodology.

2.3 Sociodemographic and professional background characteristics

The survey established sociodemographic and professional background information using categorical questions. Fisher’s exact test was used to compare categorical data due to some small cell sizes.

2.4 ACS attitudes, subjective norms, behaviours and perceived behavioural controls to TTE guidelines

A five-point Likert ordinal scale was used to assess ACS attitudes, subjective norms, perceived behavioural controls, and perceived volitional behaviour with regard to TTE guidelines and protocols. Questions were reduced to three categories for ease of analysis: strongly agree/agree; neither agree nor disagree; strongly disagree/disagree, while figures were presented demonstrating the five categories of answers. Information was compared with sociodemographic characteristics using Fisher’s exact test to determine nonrandom associations. Qualitative data were gathered through open-ended questions related to attitudes, subjective norms, perceived behavioural controls and perceived volitional behaviours to following TTE guidelines and protocols.

| TABLE 1 | Demographic and professional characteristics of cardiac sonographers in Australia |
|------------------------|------------------------|------------------------|------------------------|------------------------|
| **Sex**               | **Age (years)**         | **Undergraduate qualification** | **Postgraduate qualification** | **State/territory of employment** |
| **Female**            | **20–29**               | **No undergraduate degree**     | **Grandparenting clause**    | **NSW**                |
| 93 (71)               | 19 (15)                | 4 (3)                               | 11 (8)                        | 42 (33)                |
| **Male**              | **30–39**               | **Medical radiation/imaging**     | **Graduate diploma in medical/cardiac ultrasound** | 39 (31)                |
| 37 (29)               | 44 (33)                | 7 (5)                               | 97 (74)                       | 27 (21)                |
| **40–49**             | **40–49**               | **Biomedical/medical science**    | **Diploma of medical ultrasound** | 21 (16)                |
| 34 (26)               | 34 (26)                | 33 (25)                             | 1 (1)                         | 2 (2)                  |
| **50–59**             | **50–59**               | **Exercise sports science/physiology** | **Master of medical ultrasound** | 3 (2)                  |
| 26 (20)               | 26 (20)                | 45 (35)                             | 1 (1)                         | 8 (6)                  |
| **60+**               | **60+**                 | **Cardiac physiology**            | **Doctor of philosophy**      | 0 (0)                  |
| 8 (6)                 | 8 (6)                  | 16 (12)                             | 1 (1)                         | 7 (5)                  |

**Workplace description**

| **Private practice** | 45 (35) |
| **Local/regional hospital** | 18 (14) |
| **Teaching hospital** | 43 (34) |
| **Mixed employment** | 16 (13) |
| **Locum** | 3 (2) |
| **Non-clinical/academic** | 3 (2) |
RESULTS

3.1 | Sociodemographic and professional background characteristics

The survey was completed by 131 ACS working in Australia at the time of survey. Table 1 summarises the demographic and professional characteristics of respondents. Majority of participants were female, had a biomedical/sports science undergraduate background, a Graduate Diploma in Medical/Cardiac Ultrasound, worked in the eastern states in a teaching hospital or private practice. No responses were received from the Northern Territory, which was removed from the analysis.

3.2 | ACS perceived volitional behaviours to performing TTEs and following guidelines

Perceived volitional behaviours in the workplace regarding both performing TTEs and following guidelines were mixed. Results are shown in Figure 2. When questioned on specific guidelines used in the workplace more than half [72/122 (59%)] of ACS reported following guidelines from the ASE while 1/122 (0.8%) reported following guidelines from the British Society of Echocardiography. Almost three-quarters of participants 88/120 (73%) reported not solely following a specific guideline when performing a TTE, instead using a mix of guidelines, doctor preference, and practice protocol. Over half [83/127 (65%)] of ACS reported capturing less than 92 images per study as recommended by the ASE, while 33/127 (26%) reported capturing less than 70 images per study as recommended by the British Society of Echocardiography (see Figure 3). A large proportion, 78/120 (65%) of ACS are unaware of TTE guidelines used by other practices, and 69/114 (61%) often find measurement or pathology discrepancies with their own TTEs and those from other practices.

Table 2 demonstrates perceived volitional behavioural themes that were developed from ACS qualitative data on the use of TTE guidelines by sonographers in the workplace. Use of guidelines was assumed to be a positive behavioural theme while negative behaviour was defined as lack of guideline use. Positive themes included early career graduates being more likely to follow guidelines and having a workplace environment that is supportive of guideline use. Negative themes that were seen to decrease adherence to guidelines included increased experience of sonographer, and a reported lack of consistency to following guidelines across different workplaces.

3.3 | ACS perceived attitudes towards using TTE guidelines

Attitudes towards using guidelines when performing a TTE were largely positive (Figure 4). The majority of respondents 85/101 (84%) considered guidelines beneficial for detecting pathology, 78/96 (82%) suggested guidelines reduced the need for repeat scans, 98/100
(98%) reported guidelines improved standardisation and homogeneity of measurements, and 99/101 (98%) believe guidelines benefit the patient.

Table 2 demonstrates positive and negative themes that were developed from ACS comments on attitudes towards using TTE guidelines. Positive attitude themes included ensuring measurement reproducibility and patient safety, while negative attitude themes included guideline rigidity reducing clinical focus and relevance, and guidelines not being physically adaptable to the workplace or patients.

| Concept | Key themes | Example quotations |
|---------|------------|--------------------|
| Positive perceived volitional behavioural themes | Early career graduates more likely to follow guidelines | 'As I am newly graduate I consult guidelines.' |
| | Workplace environment supports guideline use | 'In the private practice I am currently in; there is an attitude that scans that are not comprehensive are subpar; and that we should always strive for full comprehensive scans. Our cardiologists are willing to educate and happy to sit with sonographers to review scans should a “rare” pathology present. Guidelines (ASE guidelines) are strongly recommended and adhered to in clinic.' |
| Negative perceived volitional behavioural themes | Increasing experience of sonographers decreases adherence to guidelines | 'The more recent graduates follow along the QUT guidelines roughly, while other more senior sonographers do studies that are probable half the length of those.' |
| | Lack of consistency across workplaces | 'Quite often I find considerable differences in scan quality, incorrect diagnoses or missed pathologies from scans performed at other practices.' |
| Positive attitudes to following TTE guidelines | Ensures reproducibility of measurements. | 'Very important. Provides reproducibility among different sonographers and allows for accurate serial echoes.' |
| | Ensures patient safety | 'To reduce the likelihood pathology is missed or incorrectly reported/diagnosed.' |
| Negative attitudes to following TTE guidelines | Rigidity reduces clinical focus/relevance | 'TTE guidelines are too number focussed and too often distract from a comprehensive and clinical directed study, leading to a robotic performance of echoes and disregarding the individual patient’s reason for requiring the study.' |
| | Not physically adaptable to clinical workplace and patients | 'Sometimes guidelines don’t take into account the technically difficult patient.' |
| Supportive subjective norms regarding guideline adherence | Use of guidelines positively influenced by cardiology management | 'The cardiology team at my practice is very receptive to the guidelines and follow accordingly.' |
| | Use of guidelines positively influenced by peers | 'I believe I and my fellow sonographers follow the same guidelines for performing a TTE.' |
| Unsupportive subjective norms regarding guideline adherence | Lack of knowledge and/or interest reduces value of guidelines by Cardiology/management | 'Only cardiologists who have done an echo fellowship seem interested in quality and adherence to guidelines.' |
| | Belief that experience of sonographers negates need to follow guidelines | 'Some senior sonographers cut corners and do extremely short echoes, because they state that their experience allows them to do this.' |
| Positive perceived behavioural control | Positive reinforcement from management and senior staff encourages adherence to guidelines | 'I’m grateful to be in a centre that values quality, and supports the sonographers in obtaining, maintaining and expanding their skills.' |
| | Value of quality over time | 'In my practice, an echo takes as long as it takes.' |
| Negative perceived behavioural control | Lack of leadership to follow guidelines | 'There is not a lot of consideration/importance given to guideline adherence by the majority of management and Cardiology teams.' |
| | Time constraints affect adherence to guidelines | 'Our TTE booking times don’t allow for full standard TTE.' |

3.4 | ACS perceived subjective norms to using TTE guidelines

More than half of participants felt encouraged by co-workers 69/112 (62%), management 67/118 (57%), and cardiologists 66/118 (56%) to adhere to guidelines, however 27/118 (23%) of participants did not feel encouraged to adhere to guidelines by their management team (Figure 5).

Themes reported by participants included supportive subjective norms of positive influence from both cardiology/management and
peers, and unsupportive subjective norms including a lack of knowledge/interest from cardiologists and management, and a belief that experience negated the need to follow guidelines (Table 2).

### 3.5 | Perceived behavioural controls to following TTE guidelines

Perceived behavioural controls to following TTE guidelines included internal (knowledge and attitude) and external (guideline and environmental) facilitators and barriers. Internal perceived behavioural controls (Figure 6) included having insufficient guideline specific education available 42/116 (36%), feeling uncertain about what TTE guidelines to follow 24/117 (21%) and finding TTE guidelines difficult to follow 10/117 (9%). Almost half of respondents considered their clinical experience more valuable than specific TTE guidelines 57/122 (47%).

External perceived behavioural controls included guideline specific controls, time for education, time allocated per TTE, encouragement to adhere to guidelines, and continuous quality control and improvement (Figure 7). Less than half of ACS report being given time in the workplace for ongoing education 56/118 (48%). Some participants reported current industry guidelines cumbersome 27/116 (23%), or felt they were not given adequate information on expectations of guideline use in their workplace 43/117 (37%). More participants 87/117 (74%) reported they would perform a comprehensive TTE if they did not feel rushed. Participants reported feeling rushed due to high patient workload 61/117 (52%), management expectations 53/117 (45%), cardiologist expectations 31/111 (28%), and staff shortages 43/117 (36%). Some participants reported feeling unhappy with management support in the workplace [39/115 (34%)], with time allocated per TTE [26/110 (24%)], with quality control performed in the workplace [49/116 (42%)] and with continuous quality improvement of TTEs in the workplace [42/116 (36%)].

When comparing perceived behavioural controls and professional characteristics, ACS who captured a higher number of images and measurements per TTE were more likely to report feeling encouraged by management ($p = .003$) and cardiologists ($p = .026$) to adhere to guidelines. They are also more likely to approve of time they have allocated per scan ($p = .025$). Workplace environment also affected
perceived behavioural controls. ACS employed in private or mixed employment were less likely to report being given time in practice for ongoing guideline education compared with hospital employees ($p = .012$). They were also less likely to be given guidance on the expectation of guideline adherence in the workplace ($p < .001$).

Table 2 demonstrates the themes that were developed from ACS comments on perceived behavioural controls affecting guideline adherence. Positive perceived behavioural control themes included positive reinforcement from management and senior staff, and a value of quality over time to perform a study. Negative perceived behavioural control themes included a lack of leadership to follow guidelines, and time constraints restricting adherence to guidelines.

4 | DISCUSSION

This is the first study examining the adherence to guidelines when performing a TTE by cardiac sonographers in Australia. We have demonstrated that the majority of ACS follow a combination of workplace protocols and industry guidelines when performing a TTE. The most commonly reported industry guidelines used are from the ASE, however more than half of the participants reported taking less images than what is recommended by these guidelines.²

The Theory of Planned Behaviour has previously been used to study behaviour in various fields including education, healthcare and marketing.²⁷⁻²⁹ It is based on the theory that behaviour of an individual is highly correlated to their intention, which is a summation of attitude (if the behaviour is viewed positively), subjective norm (if others view the behaviour positively), and perceived behavioural control (self-belief in the ability to perform a behaviour).¹² Using this model, an assessment of reported knowledge and behaviours in addition to the three core components of attitude, subjective norms, and perceived behavioural control were performed. While attitudes towards using guidelines when performing a TTE were largely positive, resultant behaviour was not
consistent, with 61% of participants reporting measurement or pathology discrepancies compared with TTEs from other practices. We suggest this deviation may be a consequence of subjective norms and perceived behavioural controls negatively impacting the sonographers’ intention to follow guidelines completely and precisely. We propose a national standardisation of guidelines and increased educational initiatives targeting leadership, quality control, and time constraints may improve guideline adherence.

4.1 ACS reported knowledge and behaviours to performing TTEs and following guidelines

Seventy-three percent of participants reported using a combination of guidelines and practice protocols. Subsequently a large proportion (65%) of ACS reported being unaware of specific guidelines used by other practices. In addition, while students are educated in Australia to follow guidelines from the ASE, passive release of updated guidelines have previously been demonstrated to have minimal effect on behaviour change. Incorporation of evidence-based guidelines into curricula may explain why new graduates are more likely to follow guidelines while increased sonographer experience with reduced adherence may occur due to less formal continued education. Further research is needed to examine how ongoing education can be provided around guideline updates, and how local work practice protocols may influence updated guideline uptake and adherence by experienced ACS.

Due to a lack of national standardisation, there may be discrepancies in reporting systems and templates between practices, resulting in differences in data reporting. Standardisation is needed in Australia for both TTE performance and TTE reporting. Our study demonstrated most ACS use practice protocols in combination with guidelines, therefore consultation with industry experts and professional societies is needed to decide on minimum acceptable standards for a comprehensive TTE in Australia. Future research using the Delphi technique may enable industry consensus and ultimately improve guideline uptake.

4.2 ACS perceived attitudes towards using TTE guidelines

A favourable attitude to using TTE guidelines represents a belief that guideline use will result in positive outcomes of standardisation, pathology detection and patient benefit using an expectancy-value formulation. Ninety-eight percent of participants believed that following TTE guidelines improved standardisation of measurements and was beneficial for the patient. This was reiterated with qualitative themes of ensuring reproducibility of measurements and ensuring patient safety. Positive attitudes to using guidelines were offset by minimal negative concerns of reducing the clinical relevance of a study, and guidelines not being physically adaptable to the workplace due to patient/sonographer/erodynamic limitations. Future research should focus on overcoming these concerns and improving positive attitudes towards TTE guidelines enabling uptake of Australian standards that allow flexibility in the presence of practical contingencies.

4.3 ACS perceived subjective norms to using TTE guidelines

The Theory of Planned Behaviour demonstrates subjective norms have the weakest correlation with behavioural intention out of the three core components of attitudes, subjective norms and perceived behavioural control. Our study assessed subjective norms as perceived encouragement to adhere to guidelines. We demonstrated that while the majority of ACS felt encouraged to adhere to guidelines by co-workers and cardiologists, a smaller number did not feel encouraged to adhere to guidelines, particularly by management. This indicates a possible obstacle in leadership support in different workplace environments. Themes indicated support was highly workplace dependent with variable knowledge and interest in adherence to guidelines from cardiologists and management. Senior sonographers were perceived to focus on experience over rigidity. We suggest any quality improvement initiatives for guideline adherence should involve leadership and senior sonographer groups to improve hierarchical expectations of sonographers to adhere to guidelines.

4.4 Perceived behavioural controls to following TTE guidelines

Perceived behavioural controls have been shown to significantly affect behaviour of the individual. Our research demonstrated the main internal perceived behavioural controls to following TTE guidelines were perceiving clinical experience as more valuable than guidelines, and/or having insufficient guideline education available. This finding again corresponds with passive release of guidelines having a minimal effect on changing behaviour, as there are currently limited formal guideline education initiatives in place for ACS beyond their university studies. In addition to education initiatives involving senior sonographers, we suggest future research examining patient outcomes and or economic benefit when guidelines are used compared with limited or no formal guideline application.

External perceived behavioural controls to following TTE guidelines included time constraints for both scanning and education, leadership influence and quality control and improvement. These controls were again workplace dependant with management and cardiology teams varied in positive reinforcement towards following guidelines, quality improvement programs, education programs and patient scheduling. This indicates guideline adherence has significant variability between centres. Previous research has demonstrated improved patient outcomes following guideline adherence, however, there are limited studies to support this finding. Further research is needed examining patient and economic benefits following TTE guideline adherence.
A limitation of this study was the number of participants not meeting the sample size calculation, preventing statistical comparison of survey responses with sociodemographic and professional background characteristics. It may also signify an overrepresentation of highly motivated ACS. A second limitation was the Likert survey-based format favouring socially desirable responses. Random sampling of actual TTE guideline adherence from multiple sites may provide more robust data. Finally, it is noted that guidelines cannot always be followed due to environmental limitations, which is reflected in participant responses.

5 | CONCLUSION

This study has demonstrated ACS follow a combination of industry guidelines, practice protocols and cardiologist preference when performing a TTE. The most followed guideline is from the ASE, however participant reported discrepancy in measurement and pathology findings between centres are common. Perceived attitudes indicate guidelines are important to ACS for improving clinical practice, and subjective norms show the influence of leadership in adhering to guidelines. ACS have largely positive attitudes towards guideline use with the majority feeling supported by co-workers, management and cardiologists. A number of workplace dependant perceived behavioural controls may reduce adherence to following TTE guidelines, including insufficient guideline education, time constraints for scanning, lack of quality control and education and leadership influence.

Development of an Australian guideline in consultation with industry experts and professional bodies may benefit ACS by incorporating local needs and expectations. In addition, we recommend further studies examining quality improvement initiatives for guideline uptake, with emphasis on active education of senior sonographers and management teams, and improved methods for communicating guideline updates. Further studies are needed examining the effect of TTE guideline adherence and/or non-adherence on clinical and economic outcomes in Australia.

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CONFLICT OF INTEREST

Ann Quinton is an Editorial Board member of Sonography and a co-author of this article. To minimise bias, they were excluded from all editorial decision-making related to the acceptance of this article for publication.

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