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Original study

Anaesthetist's adherence to aseptic ultrasound practices when performing Ultrasound Guided Peripheral Intravenous Cannulation (USGPIVC). A quality improvement project

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Abstract

Background: **Sterile ultrasound covers and conducting mediums are recommended when performing ultrasound guided percutaneous procedures to minimise risk of infection to the patient. Purpose manufactured ultrasound transducer cover kits meet these requirements. Transparent dressings meet some of these requirements however, they are not approved for use as ultrasound transducer covers. We recognised that our departmental practice may not adhere to these standards.**
Objective: **The primary objective was to identify and improve the rate of adherence to the recommended aseptic precautions by anaesthetists performing ultrasound guided percutaneous procedures at the Department of Anaesthesia, Royal Brisbane and Women's Hospital, the largest tertiary referral hospital in Queensland, Australia. Secondary objectives were to identify types and rates of use of various probe covers and ultrasound conductive mediums used.**
Design: **A complete quality improvement cycle was undertaken using a plan, do, study, act model. Methods: Firstly, a departmental wide voluntary survey was distributed in March 2019 focused on practitioner's baseline aseptic practices for ultrasound guided peripheral intravenous cannulation (USGPIVC). Subsequently a suite of interventions were undertaken between May 2019 to April 2020 focusing on highlighting recommended aseptic practices through the use of high-quality sterile transducer covers and sterile conducting mediums for all ultrasound guided percutaneous procedures. Components of the intervention included the development of a departmental policy, educational activities, and improving equipment availability and access. A post-intervention follow up audit was repeated in April 2020 to measure changes in practice. Results: Of 134 anaesthetic consultants or trainees 58 completed the pre-intervention survey and 47 completed the post-intervention survey. After the intervention the use of recommended transducer covers and conducting mediums increased from 10.3% to 76.6% and 58.6% to 83.0% respectively. Participants were more likely to choose both a recommended transducer cover and conducting medium than at least one non-recommended option ([OR] 20.4, 95% CI: 7.1 - 58.4). There was a 122% increase in the number of recommended transducer cover kits ordered when comparing stock inventory over a six-month period before and after the intervention.**
Conclusion: **Adherence to the recommended aseptic precautions for USGPIVC improved after the implementation of educational interventions.**

Keywords: **Ultrasonography, Catheterisation, Peripheral, Catheter Related Infections, Asepsis.**

Ethics exemption was sought prospectively and approved by the Royal Brisbane and Women's Hospital Human Research Ethics Committee, Brisbane, Australia (LNR/2019/QRBW.52241), Chairperson Dr Gordon McGurk, approval date: 07 March 2019. Start date: 07 March 2019. End date 7 March 2020.
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Introduction

Problem Description/ Rationale

Multi-societal ultrasound and critical care guidelines universally recommend the use of a high-quality, single use ultrasound transducer cover and sterile conducting mediums for the performance of ultrasound guided percutaneous procedures[1-4]. These recommendations are in place to ensure the invasive procedure is conducted in an aseptic manner, minimising infection risk to the patien[5]. The definition of a "high-quality" transducer cover in these guidelines is variable but there is consensus agreement that the cover needs to ensure that relevant pathogenic microorganisms are prevented from being transferred from the transducer and transducer cable to the patient[1-4]. The manufactured Therapeutic Goods Administration (TGA) approved ultrasound transducer cover kits, containing both a sterile telescopically folded cover and sterile ultrasound gel, meet these requirements[6]. Transparent adhesive dressings (i.e., such as Tegaderm®) are sterile however they commonly only cover part of the transducer and are not approved for use as ultrasound transducer covers by the TGA in Australia and are not recommended as transducer covers by ultrasound manufacturers[7-9]. Through local observation of our departmental practice, we recognised that we may not be adhering to the use of high-quality sterile transducer covers with sterile ultrasound gel for USGPIVC but the scale and significance of the problem was unknown.

Available Knowledge

Ultrasound guided peripheral intravenous cannulation has been shown to reduce the number of attempts and improve patient satisfaction in those with difficult peripheral intravenous access and as a result it is commonly utilised by Anaesthetists in our department[10,11]. However, incorporating an ultrasound transducer into the procedure of peripheral intravenous cannulation introduces another source of potential pathogenic microbes into the aseptic field. Keys et al found that without adequate cleaning and disinfection, potential pathogens can be found on ultrasound transducers in emergency departments and intensive care units[12].

Preventing and controlling healthcare-associated infection is one of the eight National Safety and Quality Health Service Standard of the Australian Commission on Safety and Quality in Health Care (ACSQHC)[13]. It is estimated that approximately 3000 blood stream infections (BSIs) are associated with intravascular catheters each year in Australia, and of those infections, Staphylococcus aureus (S. aureus) is the most common pathogen[14]. Given the high morbidity, mortality and economic cost of BSIs, mandatory reporting of all hospital acquired S. aureus infections in the public health system was introduced by the ACSQHC in 2011[14,15].This reinforces the importance of appropriate cleaning, disinfection and utilisation of transducer covers for invasive procedures such as USGPIVC[16].

Aims

Our primary aim was to identify and improve the rate of adherence to the recommended aseptic standard of using a sterile ultrasound conducting medium combined with a high-quality sterile ultrasound transducer covers when anaesthetists performed ultrasound guided peripheral venous cannulation (USGPIVC). Secondary aims measures were to examine the types and rates of use of various probe covers and the types and rates of use of different ultrasound conductive mediums used when anaesthetists performed USGPIVC.

Methods

Context and ethical considerations

This study was undertaken at the Department of Anaesthesia, Royal Brisbane and Women's Hospital, the largest tertiary referral hospital in Queensland, Australia, with 22 operating theatres. Ethics exemption was sought prospectively and approved by the Royal Brisbane and Women's Hospital Human Research Ethics Committee, Brisbane, Australia (LNR/2019/QRBW.52241). We have used the Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) guidelines in the production of this publication[17].

Intervention

We undertook a quality improvement cycle using a Plan, Do, Check, Act model[18]. During the planning phase the research team developed a short online questionnaire (Google Forms®) that anaesthetic staff could complete to record their aseptic practices when performing USGPIVC (See Appendix 1). This questionnaire was distributed to all 134 consultant and training anaesthetists in our department to measure baseline practices.

The "Do", or intervention phase, consisted of two main components:

1. Education and raising awareness of the aseptic precautions required for ultrasound guided percutaneous procedures.

• Development of a departmental policy reflecting the aseptic requirements when performing percutaneous ultrasound guided procedures including USGPIVC. (See Appendix 2)

• Education about recommended transducer protection and use of sterile conducting medium through:

i. Presentations at departmental meetings and training sessions as well as departmental wide distribution of the information in a memo via email

ii.Development of a promotional poster (Wipe-Cover-Wipe) positioned in key ultrasound utilisation areas and on or near the ultrasound machines. Available online at: https://metronorth.health.qld.gov.au/uploads/wipe-cover-wipe-poster.pdf (See Appendix 3).

2.Improving the availability of sterile ultrasound transducer covers and conducting medium to encourage uptake and minimise disruption to the normal workflow.

• Ultrasound machines were stocked with TGA approved sterile transducer covers kits (Civ-Flex®) which also incorporated a telescopically folded 14x91.5cm transducer sheath and a 20g sachet of sterile conducting medium.

During the "Check", or post-intervention follow up, the same online questionnaire was repeated though its repeated distribution to all to consultant and training anaesthetists with the department at the RBWH.

The initial survey of practice was conducted in March 2019 through the departmental wide distribution via email and SMS of the electronic questionnaire. Involvement in the survey was voluntary and consent was implied through survey completion. Respondents were informed that the data collection was used as part of a departmental audit of practice and that responses were anonymous to encourage true reporting of current practices. The month of March was chosen to ensure all staff were familiar with local practices and equipment as Anaesthetic trainees rotate into the department in January and August.

The intervention phase was undertaken between May 2019 to April 2020. This allowed time for staff to change their practice if needed and assess if any change would persist. This period would see several anaesthetic trainees rotate in and out of the department with minimal change to the consultant anaesthetist staff.

The post-intervention audit was conducted in April 2020 using the same methodology of departmental distribution to all consultant and training anaesthetists at the RBWH (Figure 1).

Measures and Analysis

Adherence to aseptic precautions was measured using the self-reported answers to the electronic questionnaire. Stock utilisation using the local inventory management software over a six-month time period before (1 September 2018 to 28 February 2019), during (1 October 2019 to 31 March 2020) and after the intervention (1 May 2020 to 31 October 2020) was used as a surrogate measure of utilisation sterile ultrasound transducer kits.

Data was collected using Google Forms® and exported to Microsoft Excel (version 2012) for analysis. All participant responses were categorical and summarised by frequency and percentage. Pre- and post-intervention survey groups were considered independent for analysis with associations between survey groups examined using $\chi 2$ tests of independence or the Fisher's exact test, where more than 20% of the expected values were less than five. The odds ratios were assessed

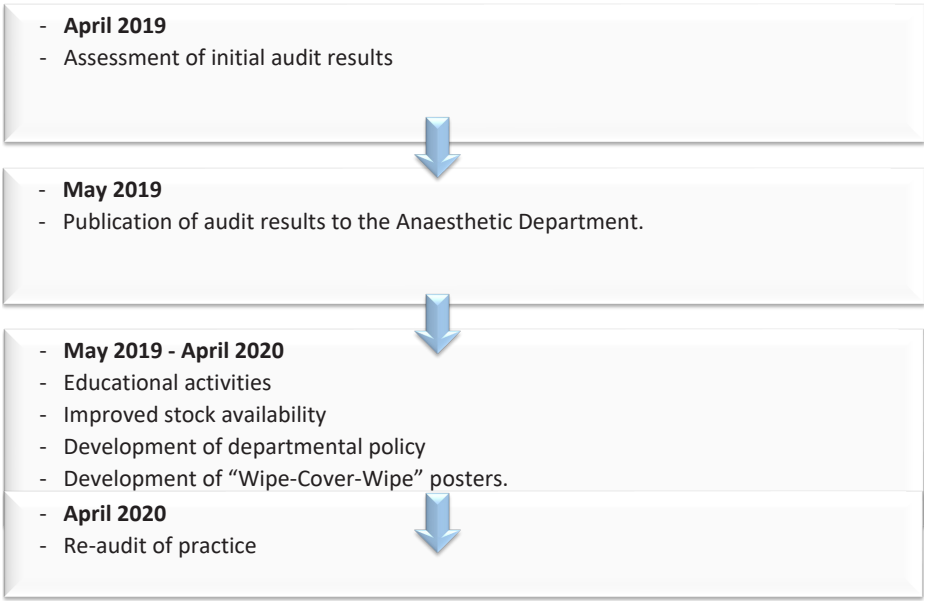

Fig. 1 — Intervention timeline.

for outcome variables found to be associated with pre- and post-intervention survey groups. Statistical analyses were performed in Stata version 15 (StataCorp, College Station, TX, U.S.A.). Transducer covers were classified as recommended, high-quality sterile full length covering transducer and cable e.g., Civ-Flex®, or not recommended, no cover used or any other covering methods that did not covering all the transducer and some of the cable (ie sterile, clear adhesive dressings). Ultrasound conducting mediums were classified as recommended (sterile) vs not-recommended (non-sterile).

Results

There were 58 respondents in the initial survey and 47 in the post-intervention survey. Characteristics of these participants can be seen in Table I. There was no significant difference between the participant populations or the pre- and post-intervention survey groups in terms of the level of experience (p= 0.70) and frequency of USGPIVC performed (p=0.94).

The rate of use of high-quality sterile transducer covers combined with sterile ultrasound conductive medium by anaesthetists performing USGPIVC increased from 10.3% before to 76.6% after the intervention phase. The percentage of anaesthetists selecting transparent adhesive dressings as a transducer cover fell from 65.5% before to 17% after the intervention phase. The percentage of anaesthetists using no transducer cover for USGPIVC fell from 24.1% before to 6.4% after the intervention. The use of sterile conducting mediums increased from 58.6% before to 83% after the intervention. The proportion of anaesthetists selecting transparent adhesive dressings as a transducer cover in combination with non-sterile conducting mediums was 24.1% in the pre-intervention survey. This fell to 8.4% after the intervention. Participant survey response outcome details can be seen in Table II and II.

Table I. — Patient demographics.

n (%)	Initial	Follow up	p-value
	N=58	N=47	
Current position			0.70
Anaesthetic consultant	33 (56.9%)	25 (53.2%)	
Anaesthetic trainee	25 (43.1%)	22 (46.8%)	
Number of USGPIVC			0.94
Less than 20	21 (36.2%)	17 (36.2%)	
20-50	27 (46.6%)	23 (48.9%)	
More than 50	10 (17.2%)	7 (14.9%)	

Table II. — Participant survey response outcome details for type of transducer cover and conducting medium.

	Initial	Follow up
n (%)	N=58	N=47
Type of transducer cover and medium		
No transducer cover + non-sterile medium	10 (17.2%)	1 (2.1%)
No transducer cover + sterile medium	4 (6.9%)	2 (4.3%)
Sterile transparent adhesive dressing + non-sterile conducting medium	14 (24.1%)	4 (8.5%)
Sterile transparent dressing + sterile medium	24 (41.4%)	4 (8.5%)
High-quality sterile transducer cover + non-sterile conducting medium	0 (0.0%)	3 (6.4%)
High-quality sterile transducer cover + sterile conducting medium	6 (10.3%)	33 (70.2%)

Table III. — Participant survey response outcome details for of recommended versus non-recommended transducer covers and conducting mediums.

Type of Transducer cover		
Not-recommended – No transducer cover	14 (24.1%)	3 (6.4%)
Not-recommended – Sterile transparent adhesive dressing	38 (65.5%)	8 (17.0%)
Recommended - High-quality sterile transducer cover	6 (10.3%)	36 (76.6%)
Sterility of Conducting medium		
Not recommended: non-sterile conducting medium	24 (41.4%)	8 (17.0%)
Recommended: Sterile conducting medium	34 (58.6%)	39 (83.0%)

There was very strong evidence of an association between sterility of probe cover and conducting medium across both survey groups ($\chi 2$ (2) = 21.8, $p<0.001$),) indicating that in the majority of cases when the participant selected a recommended high quality transducer cover, they also selected a sterile conducting medium; including 100% (6/6) of participants selecting the recommended transducer cover in the pre-intervention survey and 91.7% (33/36) of participants in the post-intervention survey.

There was also very strong evidence of an association between pre- and post-intervention surveys in the selection of sterility of probe cover and conducting medium combined ($\chi 2$ (2) = 40.2, $p<0.001$). Post-intervention participants were found to be twenty times more likely to select the recommended transducer cover in addition to

a sterile conducting medium (versus at least one not-recommended option) than those prior to the intervention (OR 20.4, 95% CI: 7.1 – 58.4) (See Table III).

Hospital inventory ordering records were reviewed to investigate any change in ordering patterns of high-quality sterile transducer covers in the pre- and post-intervention periods. A review of our hospital inventory ordering records revealed that 888 sterile transducer cover kits were ordered in the six months before our initial audit from 1 September 2018 to 28 February 2019. This increased to 1008 in a six-month period during the intervention from 1 October 2019 to 31 March 2020. A further increase in stock demand was observed in six-month time period following our intervention from 1 May 2020 to 31 October 2020 with 1968 sterile transducer cover kits ordered in this time period. This equates to a 122% increase in the number of transducer cover kits purchased for use after the intervention period.

Discussion

Summary

Our quality improvement project revealed that adherence to the recommended aseptic precautions required of anaesthetists when performing USGPIVC was initially poor. We showed that through implementing a series of targeted interventions we were able to improve self-reported adherence to aseptic practices within our department. This has the potential to improve patient outcomes and patient care through reducing the risk of catheter related BSI for patients.

Interpretation

The appreciable increase in self-reported usage of sterile transducer cover kits observed in our audit from initially 10.3% to 76.6% suggests that our intervention led to a notable change in practice. Our initial audit revealed that most anaesthetists were taking steps to either protect the transducer and the patient, however this was often through the use of a sterile transparent adhesive dressing. These dressings are not TGA approved for use as protective covers for ultrasound transducers and most ultrasound transducer manufacturers do not recommend their use on ultrasound transducers[7-9]. The number of anaesthetists selecting sterile transparent adhesive dressings as a method of transducer coverage fell from 64% before the intervention to 17% after the intervention. The number of anaesthetists using no transducer cover for USGPIVC fell from 24% before the intervention to 2% after the intervention. This is a reassuring change in practise but highlights the need for ongoing education and awareness.

Our results indicated that a large proportion of anaesthetists selecting sterile transparent adhesive dressings as transducer covers, were also selecting non-sterile gel as a conducting medium. Using non-sterile conducting medium on a sterile transducer cover negates the sterility benefits conferred by the sterile cover. Utilisation of sterile conducting medium usage rose from 58.6% to 83% following the intervention. This rise is likely due to encouraging the usage of transducer cover kits, which included both the sterile transducer cover and sterile conducting medium conveniently packaged together.

Our results are further supported by a 122% increase in the number of sterile transducer cover kits ordered in the six months after our intervention, when compared with the number of transducer covers ordered in the six months prior to our intervention. This considerable increase is likely indicative of a wider adoption of sterile transducer cover kits to other ultrasound guided percutaneous procedures ie regional anaesthesia and ultrasound guided peripheral arterial access. Educational material designed as part of the intervention phase of the project highlighted the importance of utilising similar aseptic precautions for all peripheral percutaneous ultrasound guided procedures as well as recommendations for transducer cleaning and disinfection based on the consensus statements of multiple Australian and international ultrasound and critical care societies[19].

Changing our practise to be more compliant with the national and international recommended standards comes at a increased financial cost. The cost of a sterile transducer cover kit including the sachet of single use sterile gel costs $10.27 based on our institutions most recent purchasing data. This is more expensive than the combination of a sterile transparent adhesive dressing ($0.64) in addition to 20g sterile gel sachet ($1.55). The total cost of high-quality sterile transducer cover kits ordered in the six months before and after our quality improvement intervention is $9120.5 and $20 213 respectively. However, infection prevention in healthcare settings is cost effective[20]. While the incidence of BSI related to PIVC insertion is low[21] the cost associated with the accompanying mortality, morbidity and increased length of stay as a result of a S.aureus bacteraemia is likely to be considerably more than the increased expenditure on transducer cover kits required to meet the recommended aseptic precautions. An Australian study by Collignon et al estimated that each episode of hospital acquired S. aureus bacteraemia in 1998

had an additional cost of $22000. When accounting for the national incidence of hospital acquired S. aureus bacteraemia the authors estimated the economic burden to be 150 million dollars per year in 1998[22]. It can therefore be argued that the increase in the cost of consumables, is likely to be cost-effective if it prevents even one episode of line related S. aureus bacteraemia in 2022.

Limitations

We acknowledge several limitations of our quality improvement project. Our chosen method of auditing practise was in the form of a self-reported voluntary survey. However, the limitation of the self-reported nature of this study was that actual practice was not examined and that participants may have provided answers not in keeping with their usual practice. Another limitation of the post-intervention survey is that of the Hawthorne effect which recognises that respondent's answers can change simply as a result of the intervention being undertaken without these changes being adopted into practice. We are uncertain if the responses to our survey are truly reflective of an individual's clinical practise, or whether raising awareness of this issue has changed individual behaviours only when being observed or tested. The considerable increase in the number of transducer covers ordered by our institution, however, supports the increase in sterile transducer cover use seen in the survey results. We have attempted to minimise the effect of this limitation by making our survey anonymous. The anonymity of responses, however, has potentially limited our results even further as some participants may be the same in the pre- and post-intervention survey and the results may be biased due to a change in practice at the participant level rather than the population level. As the surveys were voluntary, the data is prone to selection bias, as those who are more interested in ultrasound guided percutaneous procedures are perhaps more likely to respond to our survey. We are uncertain how this has affected our results.

Conclusion

We have demonstrated that through a set of simple interventions self-reported adherence of anaesthetists to aseptic precautions when performing USGPIVC has improved. It appears that the two interventions that had the most impact on changing local practice were increasing the departmental awareness of the expected aseptic standard for percutaneous ultrasound guided procedures and increasing the availability of ultrasound transducer cover kits (containing both the sterile cover and conductive medium). Overall, this brings the practise of our department closer to the recommended aseptic standard however ongoing education and auditing are required to continue to improve our compliance and to determine if this will result in longer term change. Further research focusing on patient outcomes is required to determine if this improves patient safety.

Acknowledgments: The authorship team declares that there are no conflicts of interest.

Appendix 3 — Wipe-Cover-Wipe Poster.

Appendix 1 — Questionnaire distributed to staff to audit aseptic practice for USGPIVC.

Ultrasound Guided Peripheral IV Cannulation (USGPIVC) Survey

1. What is your current position?
   a. Anaesthetic Consultant
   b. Anaesthetic Trainee
   c. other
2. How many USGPIVC have you performed in the last year?
   a. Less than 20
   b. 20 – 50
   c. More than 50
3. During cannula insertion what type of ultrasound gel do you use?
   a. Sterile gel
   b. Non-sterile gel
4. During cannula insertion what type of ultrasound probe cover do you use?
   a. Tegederm® (transparent dressing)
   b. Full length sterile probe cover
   c. No probe cover
   d. other
5. Which cannula device do you use most commonly for ultrasound guided peripheral cannulation?
   a. 20G Insyte – 40mm "long pink"
   b. Other "usual length" 25-30mm cannula
   c. 16G "angiocath" cannula
   d. 14G Instyte – 45mm cannula

Appendix 2 — Departmental policy on aseptic procedure for USGPIVC.

A "**Protecting the probe = Protecting the patient"** approach should be adopted and incorporated into procedures and protocols where applicable. This should include:

1. **Strict adherence to cleaning and low-level disinfection (using Clinell® wipes) before and after** using external ultrasound probes. It is the responsibility of the clinician (or their delegate Anaesthetic Health Practitioner) using the ultrasound to clean the probes, cables, and machine.
2. **Low level disinfection (Clinell® wipes) should occur immediately prior to the application of the high-quality US probe cover for all US guided percutaneous procedures.** This will ensure that in the unlikely event of a breach in the US probe cover integrity the probe has recently undergone disinfection. Tegaderm® dressings are not considered high quality covers.
3. **High-quality US probe covers are required for ALL US guided percutaneous procedures where there is a possibility of exposure to blood of bodily fluids to the probe.** The level of probe cover sterility should be dictated by the level of procedural sterility. Full length sterile probe covers will be made increasingly available for this purpose.
4. **Single use ultrasound gel sachets should be used for all US guided percutaneous procedures.**

These recommendations are based on ANZCA Position Statement 28 – Guidelines on infection Control in Anaesthesia. Available online at: https://www.anzca.edu.au/getattachment/e4e601e6-d344-42ce-9849-7ae9bfa19f15/PG28(A)-Guideline-on-infection-control-in-anaesthesia

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