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Research Article

Are residents in India trained in ultrasound guided central venous cannulation? A prospective survey on the training and practices of anaesthesiology residents in central venous cannulation

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ABSTRACT

Background and Aims: The present survey aims to assess the training and practices of Indian anaesthesia residents in central venous cannulation, and the barriers for not using US (ultrasound) and practicing internationally accepted guidelines for improved patient safety.

Methods: The cross-sectional survey was conducted among Doctor of Medicine (MD) and Diplomate of National board of examinations (DNB)anaesthesia residents from different medical institutes across the country.The questionnaire included 20 questions and was validated for content by 6 experts. It was formatted on Google Forms and the link was sent on different zonal PG groups using WhatsApp.

Results: Supervised training method was reported by 84.9% and 74.9% of the residents for landmark and US-guided CVC insertion respectively. Only around 8-9% had attended simulation sessions. Almost one-third of the residents did not have a printed checklist for the same, and one-fifth did not obtain informed consent at alltimes. About 12.2% residents either never followed all aseptic guidelines, or followed them occasionally. The most common barriers for not using US by residents for CVC cannulation were its non-availability in the institute (16.9%), limited availability for residents (63.8%), longer procedure time and learning curve (16.4 % and 12.7% respectively), and faculty preference for teaching by landmark technique (13.4%).

Conclusion: Although anaesthesiology residents are being trained in US-guided CVC insertion, there are various barriers to its use in clinical practice like limited availability of USG for residents after routine hours, longer procedure time and learning curve, and faculty preference for teaching by landmark technique. The survey advocates and encourages simulation based training for the residents, and workshops for training and teaching of US and simulation for the faculty.

Key Words: *central venous catheterisation; landmark; ultrasound.*

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INTRODUCTION

Central venous catheterisation (CVC) is one of the most common procedures performed in the hospital setting.CVC facilitates resuscitation, nutritional support, drug administration, and long-term vascular access in the patients. Traditionally for the landmark method, visible and palpable external landmarks are used to determine the puncture site on the skin. However, the landmark method can have a failure rate of 35% and an overall complication rate of 26%due to several reasons, including abnormal central venous anatomy.[1,2,3,4]Moreover, venous thrombosis in oncologic and critically ill patients can make CVC placement impossible or dangerous for the patient.

Ultrasound (US)-guided CVC insertion was first described in 1986 by Yonei*et al.* and has since been extensively used in various settings.[5]The advantages of US for the placement of CVC compared with the standard landmark

technique include a decrease in the rate of arterial puncture, hematoma formation, number of attempts and time until successful cannulation, and an increase in the success rate with the first attempt of puncture.[6]

Based on evidence from clinical studies, ultrasound (US) for CVC placement in the internal jugular vein (IJV) has been suggested as a standard of care.[7,8]Practice guidelines from the American Society of Anesthesiologists(ASA) task force, 2020recommend using static US imaging in elective situations for pre-puncture identification of the anatomy, vessel localisation and patency, and the real-time US for venipuncture for the IJV. Furthermore, a joint-guidelines from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists also strongly recommend using real-time US for CVC placement in the IJV.[9,10]

Several survey studies have evaluated the attitudes and beliefs of intensivists and anaesthesiologists on the use of US for CVC placement and the frequency of its use in clinical practice. These have shown that landmark techniques continue to be used for various reasons.[11,12]As per the National Medical Council guidelines of 2019 for competency-based anaesthesiology postgraduate training, a postgraduate should be able to use an ultrasound machine competently for venous cannulation. This survey was designed to assess the training, different methods used for training, and current practices of Indian anaesthesia residents (postgraduate students) in central venous cannulation, and the barriers to not using US and practising internationally accepted guidelines for improved patient safety. We hypothesised that the training of residents in India for CVC is not according to the standard CVC insertion guidelines.

MATERIALS AND METHODS

The present cross-sectional survey enrolled Indian anaesthesia residents from different medical institutes across the country and was conducted over 4 months, from November to March 2022. Institutional ethics committee approval was obtained, and the standards for reporting qualitative research were followed.[13]An online web-based survey was developed after reviewing previous national surveys and literature pertaining to central venous cannulation, in consultation with a panel of experienced anaesthesiologists, and pilot tested before distribution. It initially consisted of 30 closed multiple choice questions, which were then modified. Twenty questions were short-listed by consensus in the final questionnaire.

The content validity of the questionnaire was performed by six experts (four PG teachers and two PGS), who rated each question on a Likert scale based on simplicity, clarity, ambiguity, and relevance. Overall agreement calculated was 80.43% for simplicity, 72.7% for clarity, 81.66% for ambiguity, and 73.21% for significance. The questionnaire was provided on a single scrolling page. It consisted of general information about the residents (type of college, the region where it is situated, and the year of residency) and their training and practices regarding CVC. A brief overview of the survey was provided before the commencement of the survey.

The questionnaire was formatted on Google Forms and the link to the form was sent to the participants of different zonal PG groups on WhatsApp with a covering message to explain the purpose of the survey. All PGs studying for the Doctor of Medicine (MD) and Diplomate of National board of examinations (DNB) course broad speciality (anaesthesia) were included in the study. This gave the survey a national representation. Strict anonymity of the responders was maintained. Reminders were sent twice a month to all since non-responders could not be identified. Survey participation was voluntary, and responding to the survey was considered as consent to participate in the study.

For calculating the sample size, the approximate number of anaesthesia residents across India was approximately 12000, per the Medical Council of India and DNB websites.[14] Assuming that, with a 95% confidence level and 10% margin of error(confidence interval), a minimum sample size of 373 was calculated. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 22 (SPSS Inc., Chicago, IL, USA). Updated ASA practice guidelines for central venous access 2020 were the standard for assessment. Data on demography, residents' training methods and their practices of CVC insertion were collected and analysed descriptively using frequencies and percentages. The multiple response questions were represented as the percentage of cases.

RESULTS

The survey's link was sent to a total of635 residents. We received 403 responses (response rate: 63.4%)that were included in the final analysis. Most of the respondents were third-year postgraduate residents (52.4%) from government colleges/institutions(66.30%) situated in the north region (41.7%), as shown in Table 1.

Table 1: Demographic characteristics of the responders.

Parameters	Categories	N (%)
Year of residency	PG 1st	79 (19.6%)
	PG 2nd	113 (28%)
	PG 3rd	211 (52.4%)
Type of medical colleges	Government	267 (66.3%)

	Private	112(27.8%)
	Autonomous	24 (6%)
Region where the college is situated	North	168(41.7%)
	South	129(32%)
	East	40(9.9%)
	West	36(8.9%)
	Central	30(7.4%)

Data expressed as numbers and percentages

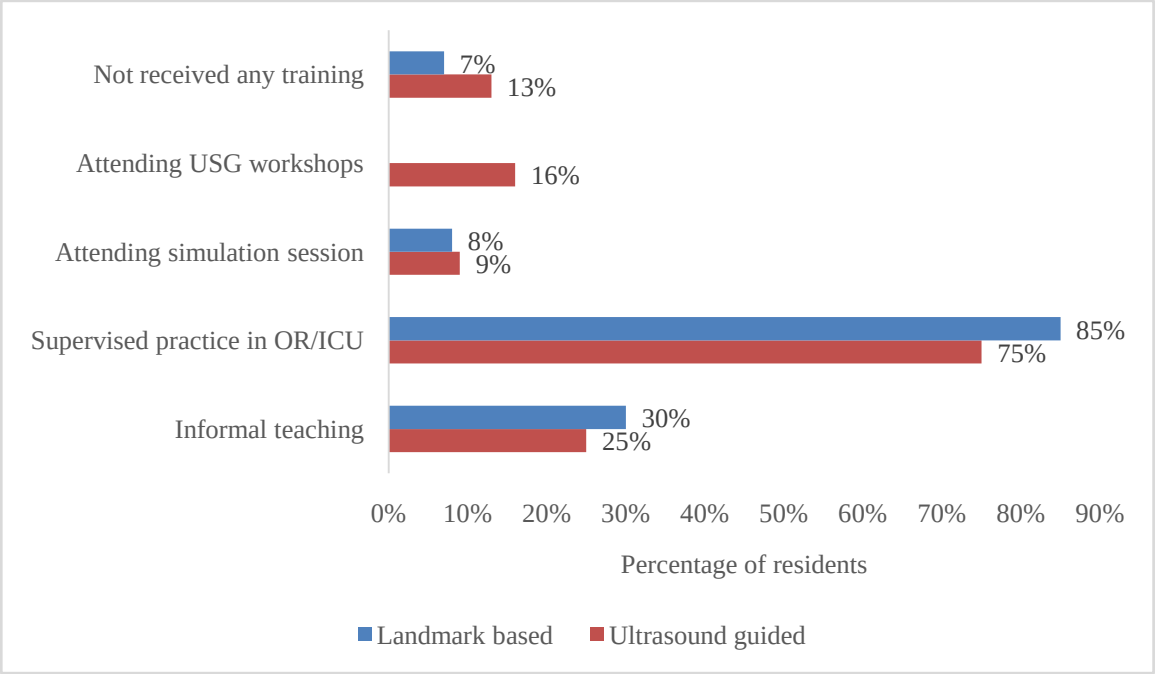

Figure 1: Bar diagram showing CVC training methods for residents

The majority of the residents reported that the training method for landmark (84.9%), as well as US (74.9%), guided approach for inserting CVC in their institutes was a supervised practice in OR (operation room)/ICU (intensive care unit)(Figure 1). More than two-thirds (69.5%) of the respondents had assisted CVC insertions, while 38.2% of residents had only observed before the first independent insertion. Moreover, 10.9% of residents attempted their first CVC insertion based on theoretical teaching, and only 6.5% of residents had practised CVC insertion on a mannequin during the simulation session. The majority (72.2 %) of the PGS were of the opinion that the most effective method for CVC training is supervised practice in the operating room. Around 14.9% felt that mannequin and simulation-based teaching should be employed; 9.2% thought attending workshops would be the most effective teaching method. (Table 2)

Table 2: Practices regarding CVC by residents

Question	Response	n	%
What was the method you used while attempting first CVC insertion?	Landmark	294	73%
	USG	109	27%
Do you feel confident in CVC insertion by?	Landmark	100	24.8%
	USG	108	26.8%
	Both technique	145	36%
	Not confident	50	12.4%
Do you have printed checklist in your institute for performing thecentral venous catheterization?	Yes	124	30.8%
	No	279	69.2%
Do you take informed consent before placing central venous catheter?	Always	332	82.4%
	Sometimes	35	8.7%
	Only in ICU	28	6.9%
	Only in emergency	4	0.9%
	Never	4	0.9%
In which setting you have performed the maximum central venous	Cardiac OT	45	11.2%

catheterization?	Neuro OT	41	10.2%
	ICU	219	54.3%
	Emergency OT	98	24.3%
Do you follow all aseptic guidelines (scrubbing, gowning, cleaning, draping) while performing CVC in Emergency OT?	Always	354	87.8%
	Sometimes	48	11.9%
	Never	1	0.25%
Do you follow all aseptic guidelines (scrubbing, gowning, cleaning, draping) while performing CVC in ICU?	Always	354	87.8%
	Sometimes	46	11.4%
	Never	3	0.74%
Which ultrasound (US) technique do you use?	Static	85	21.1%
	Real time	208	51.6%
	Both	66	16.4%
What teaching method do you think is most effective for training residents in CVC insertion?	Informal teaching (verbal/diagrams)	12	3%
	Supervised practice in OR	291	72.2%
	Mannequin and Simulation based		
	Attending workshops	60	14.9%
		37	9.2%

Data expressed as numbers and percentages

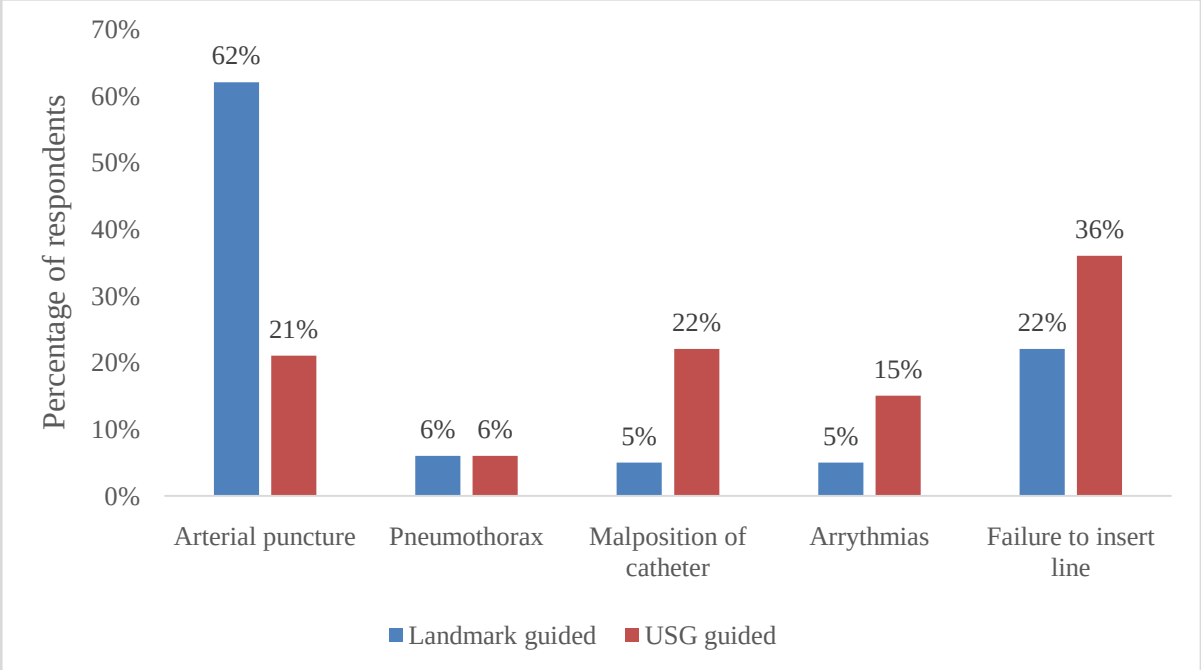

Figure 2:Bar diagram showing complications during internal jugular vein cannulation

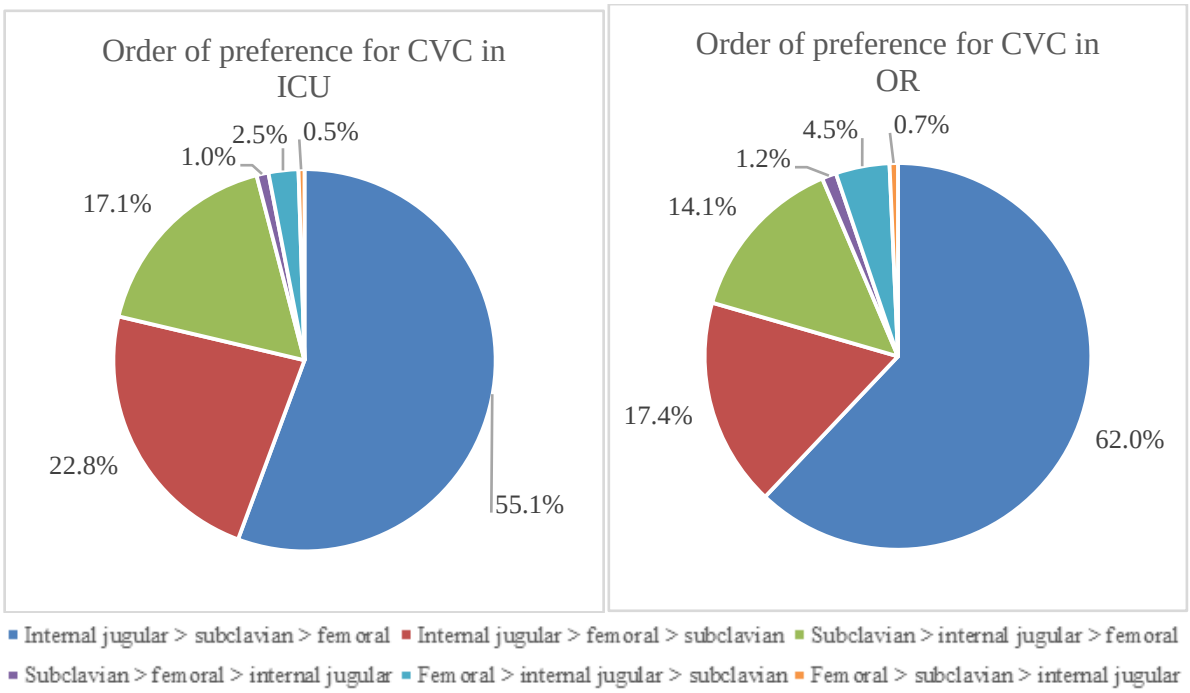

Figure 3: Pie chart showing order of preference for CVC in ICU and OR

The responses to the questions regarding CVC insertion practices in their institute are shown in Table 2. The vein preference for central cannulation was internal jugular > subclavian >femoral by 55% of residents in ICU and 62% in emergency OR, as shown in Figure 3. The most common complication during landmark-guided CVC was an arterial puncture, reported by 62% of residents, and failure to insert a line during the US-guided cannulation, as answered by 36% of respondents (Figure 2).

DISCUSSION

This survey is an endeavour to identify the practices and measure the adequacy of training concerning CVC insertion among anaesthesiology residents and is probably the first of its kind in the country.

Most residents in the present survey had supervised CVC insertions by landmark and US-guided approach as part of their teaching and training before performing the procedure independently. Moreover, as a part of their feedback on training, most residents felt that supervised training would be the most effective method of training for CVC insertion. Historically, supervised practice has been the most common technique to teach CVC, with several reported benefits like cost-effectiveness, feedback and learning assessment.

As the significant limitation to supervised practice is that there is a patient at the other end of the trainee's practising hand, this risk can be mitigated by simulation-based training so that there is an opportunity of providing specific feedback on a skill that requires improvement and practice over and over again.[15]The systematic review and meta-analysis by Ma et al. evaluated the outcomes of simulation-based teaching at various levels. All the included studies reported improvements in learner performance and attitudes, patient outcomes and cost-effectiveness as the adverse events could be avoided.[16]However, in the present survey, less than 10% of residents were trained using simulation.

For teaching and training, CVC should be taught by landmark and US-guided techniques. Although various studies have demonstrated the superiority of US-guided technique for CVC over the landmark technique, and the practice guidelines from the American Society of Anesthesiologists task force, 2020recommend the use of US imaging for IJV cannulation,[17]emergencies with limited time for setting the US machine are a justification of the use of landmark approach as a rescue technique.[18]

Moreover, ASA 2020 practice guidelines recommend using real-time ultrasound guidance for vessel localization and venipuncture when the internal jugular vein is selected for cannulation. As per the present survey, real-time US was used by most of the respondents who used US. ASA also recommends using achecklist or protocol for placement and maintenance of central venous catheters. They also recommend aseptic techniques (*e.g.*, hand washing) and maximal barrier precautions (*e.g.*, sterile gowns, sterile gloves, caps, masks covering both mouth and nose, and full-body patient drapes) during preparation for the placement of central venous catheters.[17]In the survey, almost one-third of the residents reported not having a printed checklist for central line insertion. Even though it is mandatory to obtain voluntary and informed consent before any procedure, one-fifth reported that they did not obtain it at alltimes. About

12.2% of residents in emergency OT or ICU either never followed all aseptic guidelines or followed them occasionally. The fallibility of these practices needs to be addressed at the institute level to confer to the international recommendations.

Residents' feedback can help identify and rectify the gaps in learning and practices in CVC. In this survey, it was hypothesised that the residents' training in the country in performing CVC cannulation would be deficient, but the results have shown that it is largely adequate, although there are few barriers to translation of the evidence of the benefits of US-guidance to clinical practice. Most respondents reported limited availability of US for residents after routine hours. Other reasons were longer procedure time, learning curve, and faculty preference for teaching by landmark technique (Table 3). Maizelet al. also observed that limited access to equipment and proper training were the major barriers to ultrasound-guided CVC.[16]Availability of US under supervision beyond the routine working hours and guidelines of use for the same would further aid in learning. More workshops need to be organised for the faculty for US training and training in simulation-based teaching.

Table 3: The barriers for not using USG routinely.

Barriers	n	%
It is not available in the institute	68	16.9%
Limited availability of USG for residents	257	63.8%
Faculty preferred to teach by landmark method than USG	54	13.4%
You find difficulty in learning by USG as compared to landmark procedure	51	12.7%
You find procedure is longer with ultrasound	66	16.4%
Other reasons	32	7.9%

Data expressed as numbers and percentages

Most survey participants performed the maximum number of central line cannulations in the ICU. The ICU setting may not be an optimal environment for the initial learning of central venous access due to the critical patient condition, suboptimal positioning, and lack of time, thus, increasing the risk of complications. Moreover, the techniques are easier to learn and practice on the unconscious and sedated patients, which may not always be possible in intensive care patients.[19]

In the current survey, 73% of the residents had attempted their first CVC insertion using the landmark technique. Only 36% percent felt confident in performing both techniques. Mc Grattan *et al.* surveyed the members of the Association of Anaesthetists of Great Britain and Ireland. They reported that only 27% of respondents used USG as their first choice for IJV cannulation, while 30% preferred palpation and 50% preferred surface landmarks.[20]

Teaching and training policies for invasive procedures should be implemented for a better learning experience and patient safety as a part of residency programs. In the first stage of training, the resident doctors should learn about the procedure's indications, contraindications, possible complications, preparation specifics, necessary equipment, etc. This should be followed by verbal and diagrammatical teaching and demonstrations of the procedure on simulators and manikins. Next, observation of the procedure and performance of less critical steps should be performed under supervision. The resident trainee should acquire the competency levels during various phases of training: learner phase, competence phase and teaching phase. Appropriate patient selection during the initial learning phase is essential as multiple attempts and failed cannulations in patients with obesity, coagulopathy, un-resuscitated shock, lack of cooperation, and altered anatomy could harm the patient as well as the confidence of the trainee. The goal of the competence phase should be to allow independent placements of CVC by the residents.[19] As there may be substantial variation in procedure learning and performance among residents, a structured formal quality evaluation of residency programs in the country is required for competency assessment to boost learner confidence and satisfaction of the supervising anaesthesiologist.

The present survey has a few limitations. The non-responders could not be identified, so non-responder bias was not assessed. We did not separately analyse the learning and practices among MD and DNB residents. Our study also relied upon the learners' self-assessment of competency. Although residents' self-reported confidence validates their skill and complications during CVC placement, further research is needed to compare objective skill and patient outcomes prospectively.

CONCLUSION

To conclude, the present survey reveals that most of the anaesthesiology residents had attempted their first CVC insertion using the landmark technique. Approximately quarter of the respondents only, were confident in US-guided CVC insertion because of various barriers like limited availability of USG machine or faculty preference of teaching by landmark method. The survey advocates and suggests simulation-based training for the residents and workshops for simulation-based teaching and training of US for the faculty. It suggests including, step-wise training policies and

competency assessment for better patient safety and learner confidence and periodic formal evaluation of the quality of residency programs in the country.

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Name: Sargam Goel
Contribution: This author helped analyze the data, and in literature search, manuscript preparation and editing.
Name: Dr Swathi Pandurangi
Contribution: This author helped design the study, analyze the data and in literature search.
Name: Megha Maheshwari
Contribution: This author helped design the study, analyze the data.
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The manuscript has been read and approved by all the authors, the requirements for authorship as stated have been met, each author believes that the manuscript represents honest work.

REFERENCES

1. Merrer J, De Jonghe B, Golliot F, Lefrant JY, Raffy B, Barre E, Rigaud JP, Casciani D, Misset B, Bosquet C, Outin H(2001). Complications of femoral and subclavian venous catheterization in critically ill patients: a randomized controlled trial. Jama. Aug 8;286(6):700-7.
2. Sznajder JI, Zveibil FR, Bitterman H, Weiner P, Bursztein S(1986). Central vein catheterization: failure and complication rates by three percutaneous approaches. Archives of internal medicine. Feb 1;146(2):259-61.
3. Katiyar S, Jain RK(2010). Entrapped central venous catheter guide wire. Indian J Anaesth. Jul;54(4):354.
4. Wadehra A, Ganjoo P, Tandon M(2010). Guide wire loss during central venous cannulation. Indian J Anaesth. 2010 Nov 1;54(6):587.
5. National Institute for Clinical Excellence. (2002). Guidance on the use of ultrasound locating devices for placing central venous catheters. http://www. nice. org. uk/nicemedia/pdf/Ultrasound_49_GUIDANCE. pdf.
6. Bernd S, Thomas WL, Jean LT(2017). Ultrasound – guided central venous catheter placement: a structured review and recommendations for clinical practice. Critical care; 21:225-236.
7. Hind D, Calvert N, McWilliams R, Davidson A, Paisley S, Beverley C, Thomas S(2003). Ultrasonic locating devices for central venous cannulation: meta-analysis. Bmj. Aug 14;327(7411):361.
8. Feller-Kopman D(2005). Ultrasound-guided central venous catheter placement: the new standard of care?. Critical care medicine. Aug 1;33(8):1875-7.
9. Rupp SM, Apfelbaum JL, Blitt C et al (2012). Practice guidelines for central venous access: a report by the American Society of Anesthesiologists Task Force on Central Venous Acess. Anesthesiology; 116:539-73.
10. Troinas CO, Hartman GS, Glas KE et al(2012). Special articles: guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. AnesthAnalg; 114:46-72.
11. Bailey PL, Glance LG, Eaton MP, Parshall B, McIntosh S(2007). A survey of the use of ultrasound during central venous catheterization. AnesthAnalg; 104:491–7.
12. Lindgren S, Pikwer A, Ricksten SE, Åkeson J(2013). Survey of central venous catheterisation practice in Sweden. Acta Anaesthesiol Scand.; 57:1237–44.
13. O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA(2014). Standards for reporting qualitative research: a synthesis of recommendations. Academic medicine. Sep 1;89(9):1245-51.
14. Haldar R, Kannaujia AK, Shamim R, Dongare P, Mondal H, Agarwal A(2020). A national survey evaluating the effect of COVID-19 pandemic on the teaching and training of anaesthesiology postgraduate students in India.Indian J Anaesth. Sep;64(Suppl 4):S227.
15. Soffler MI, Hayes MM, Smith CC(2018). Central venous catheterization training: current perspectives on the role of simulation. Advances in medical education and practice; 9:395.
16. Ma IW, Brindle ME, Ronksley PE, Lorenzetti DL, Sauve RS, Ghali WA(2011). Use of simulation-based education to improve outcomes of central venous catheterization: a systematic review and meta-analysis. Academic Medicine. Sep 1;86(9):1137-47.

17. Apfelbaum JL, Rupp SM, Tung A, Connis RT, Domino KB, Grant MD, Mark JB(2020). Practice guidelines for central venous access 2020 an updated report by the American Society of Anesthesiologists Task Force on central venous access. Anesthesiology. Jan 1;132(1):8-43.
18. Maizel, J., Bastide, M. A., Richecoeur, J., Frenoy, E., Lemaire, C., Sauneuf, B., ... & Du Cheyron, D. (2016). Practice of ultrasound-guided central venous catheter technique by the French intensivists: a survey from the BoReal study group. Annals of intensive care, 6(1), 1-8.
19. Protas VV(2018). Mastering the Central Line Placement Techniques Through Effective Resident Training Environment. Archive of Clinical Medicine. 5;24(1).
20. Lau, C. S., & Chamberlain, R. S. (2016). Ultrasound-guided central venous catheter placement increases success rates in pediatric patients: a meta-analysis. Pediatric research, 80(2), 178-184.