

Design and Develop Arterial Line Wrist Board For Critically Ill Patients: A Delphi Study

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ABSTRACT

Radial arterial cannulation is routinely performed in critically ill patients for continuous invasive blood pressure monitoring and arterial blood gas analysis. Inadequate wrist positioning during catheter insertion and maintenance may contribute to catheter-related complications, waveform distortion, inaccurate pressure measurements, and patient discomfort. Despite its clinical importance, a standardized wrist support device specifically designed for arterial line stabilization remains unavailable in many healthcare settings.

Objective: To design and develop a standardized arterial line wrist board for critically ill patients using Delphi technique and evaluate its effectiveness in reducing position-related complications.

Methods: A quantitative research design employing the Delphi technique was conducted. An expert panel participated in iterative Delphi rounds to develop and validate the wrist board. The finalized device was evaluated by comparing the incidence of position-related complications before and after implementation. Descriptive and inferential statistics, including the paired t-test, were used to analyse the data.

Results: Implementation of the arterial line wrist board resulted in a substantial reduction in position-related complications. Disturbed arterial waveforms decreased from 94.3% to 15.7%, inaccurate blood pressure measurements from 92.9% to 12.9%, hematoma from 91.4% to 18.6%, and infection from 74.3% to 25.7%. The mean complication score significantly decreased from 7.97 ± 1.04 before implementation to 2.20 ± 1.46 after implementation (mean difference = 5.77). Statistical analysis demonstrated a highly significant improvement following implementation ($t = 30.03$, $p < 0.001$).

Conclusion: The standardized arterial line wrist board developed through the Delphi technique was effective in reducing position-related complications associated with radial arterial catheterization. Its implementation may improve arterial line stability, enhance the accuracy of invasive hemodynamic monitoring, and promote safer nursing care for critically ill patients.

Keywords: Design, Arterial line, Critically ill patients, Wrist, Delphi technique.

INTRODUCTION

Radial arterial catheterization is a fundamental procedure in critical care, providing continuous invasive blood pressure monitoring and facilitating repeated arterial blood gas analysis in critically ill patients. Accurate hemodynamic monitoring is essential for the management of patients with shock, sepsis, major surgery, respiratory failure, and those receiving vasoactive medications.¹ The reliability of arterial pressure measurements depends not only on successful catheter insertion but also on maintaining proper wrist positioning throughout catheterization.²

Optimal wrist dorsiflexion of approximately 30°–45° helps maintain arterial patency, prevents catheter kinking, and ensures accurate transmission of arterial waveforms.³ Inadequate wrist support may lead to catheter displacement, waveform distortion, inaccurate blood pressure measurements, thrombosis, hematoma, arterial occlusion, and patient discomfort. These complications may compromise clinical decision-making, increase the need for catheter reinsertion, prolong hospitalization, and increase healthcare costs.⁴ Despite the widespread use of radial arterial lines, standardized wrist stabilization devices are not routinely available in many healthcare settings.⁶

Current clinical practice often relies on improvised support methods such as rolled towels, gauze pads, or hand boards to maintain wrist position. These methods lack consistency, fail to provide sustained dorsiflexion, and require frequent repositioning, thereby increasing catheter manipulation and the risk of complications. Nurses play a crucial role in arterial line maintenance; however, the absence of a dedicated stabilization device contributes to variability in practice and increases nursing workload.⁷

The development of a simple, ergonomic, and standardized arterial line wrist board may provide consistent wrist stabilization, improve waveform accuracy, reduce position-related complications, and enhance patient safety. The Delphi technique offers a systematic and evidence-based approach for developing healthcare innovations by achieving expert consensus on design and usability. Therefore, the present study aimed to design and develop a standardized arterial line wrist board using the Delphi technique and evaluate its effectiveness in reducing position-related complications associated with radial arterial catheterization in critically ill patients.

Need of the Study

Continuous invasive arterial pressure monitoring through radial arterial catheterization is an integral component of the management of critically ill patients. The accuracy and reliability of hemodynamic monitoring largely depend on maintaining optimal wrist positioning after arterial catheter insertion.³ In clinical practice, however, standardized devices specifically designed to stabilize the wrist during arterial line maintenance are not routinely available. Consequently, healthcare professionals often rely on improvised support methods, such as rolled towels, gauze pads, or hand boards, which provide inconsistent stabilization and fail to maintain a uniform wrist dorsiflexion angle over prolonged periods.⁴

Inadequate wrist stabilization contributes to position-related complications, including catheter kinking, waveform distortion, inaccurate blood pressure measurements, hematoma, thrombosis, catheter occlusion, infection, and accidental catheter displacement. These complications may necessitate repeated catheter insertion, increase nursing workload, prolong hospitalization, and adversely affect patient safety.⁵ Moreover, frequent adjustments of improvised supports increase catheter manipulation, thereby elevating the risk of contamination and compromising the quality of invasive hemodynamic monitoring.

Although considerable advancements have been made in arterial cannulation techniques and catheter securement methods, limited attention has been directed toward the development of a dedicated wrist stabilization device.¹¹ This represents an important gap in critical care practice, particularly in resource-limited healthcare settings where cost-effective and reusable solutions are required. A standardized arterial line wrist board has the potential to provide consistent wrist dorsiflexion, improve catheter stability, enhance waveform accuracy, reduce position-related complications, improve patient comfort, and promote uniform nursing practice.¹²

Furthermore, the increasing use of invasive arterial pressure monitoring in intensive care units has highlighted the importance of maintaining optimal catheter stability throughout the duration of catheterization. Although advancements have been made in arterial catheter insertion techniques and securement methods, insufficient attention has been given to maintaining a standardized wrist position after cannulation. Even minor changes in wrist alignment can compromise arterial waveform quality, affect the accuracy of invasive blood pressure measurements, and increase the risk of catheter-related complications. In addition, repeated catheter manipulation due to inadequate support may increase nursing workload, patient discomfort, and healthcare costs. Therefore, there is a need for a simple, reusable, ergonomic, and cost-effective wrist stabilization device that can provide consistent wrist dorsiflexion, enhance arterial line stability, improve monitoring accuracy, and promote evidence-based nursing practice while ensuring patient safety in critical care settings.

Therefore, there is a clear need to design and develop an evidence-based, ergonomically designed arterial line wrist board using expert consensus through the Delphi technique. Such an innovation may contribute to safer arterial catheter management, improved quality of care, and better clinical outcomes for critically ill patients.¹⁴

Aim

The quantitative study aimed to design, develop, and evaluate a standardized arterial line wrist board for critically ill patients using the Delphi technique.

METHODS

The study was conducted in the critical care units of a tertiary care teaching hospital in Navi Mumbai, India. A total of 50 experts participated in the Delphi process, with 35 completing all three rounds to achieve consensus. The Delphi experts were selected using Non Probability purposive sampling technique. The wrist board was developed through literature review, assessment of current practices, and iterative refinement based on expert recommendations. Content validity was established using the Item-Level and Scale-Level Content Validity Indices (I-CVI and S-CVI), while Kendall's tau-b coefficient and the Wilcoxon Signed-Rank Test assessed expert agreement. Data collection included baseline assessment, Delphi consensus, implementation of the finalized wrist board, and post-implementation evaluation. Data were analysed using descriptive statistics, paired t-test, Kendall's tau-b, Wilcoxon Signed-Rank Test, and content validity indices, with a p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Distribution of Delphi expert's based on demographic variables

Sr. No	Variables	Categories	f	%
	Age (years)	<25-30	3	6.0
1		31-35	20	40.0
		36-40	19	38.0
		> 40	8	16.0
2	Gender	Male	22	44.0
		Female	28	56.0
3	Designation	Staff Nurse	15	30.0
		Nurse Practitioner	10	20.0
		Doctor	10	20.0
		Nursing Faculty	5	10.0
		Anaesthetist	5	10.0
		Prosthetist	5	10.0
4	Total experience	3yrs-5yrs	14	28.0
		6yrs-10	20	40.0
		>10yrs	16	32.0

Table 1 presents a total of 50 experts who participated in the first round of the Delphi process. The majority of experts were aged 30–35 years (40.0%), followed by 36–40 years (38.0%), while 16.0% were older than 40 years and 6.0% were younger than 30 years. Female experts constituted 56.0% of the panel, whereas 44.0% were male.

Tables 2: Distribution of items based on experts' opinion in round one.

Arterial Line Wrist Board Features		f	%	I CVI
Design	Dorsiflexion of 15-30 degree with lightweight, slim and smooth rounded edge	8	16.0	0.16
	Dorsiflexion of 30-40 degree with lightweight, slim and smooth rounded edge	26	52.0	0.52
	Dorsiflexion of 30-45 degree with lightweight, slim and smooth rounded edge	17	34.0	0.34
Material	- Wooden	8	16.0	0.16
	- Polypropylene	43	86.0	0.86
	- Aluminum Composite sheet	7	14.0	0.14
Strips	- Velcro strips with minimum 2-3 adjustable strips	40	80.0	0.80
	- Soft Fabric strap with minimum 2 adjustable strips	10	20.0	0.20
Features	Color to different size Disposable covers,	39	78.0	0.78
	Anti slip,	43	86.0	0.86
	Adjustable Velcro straps	45	90.0	0.90
Size	- All size based on the weight and body mass	14	28.0	0.28
	- Small :	2	4.0	0.4
	- Small – Lean Adult	17	34.0	0.34
	- Universal size	11	22.0	0.22
	- General adult size and Pediatric size	8	16.0	0.16
Sponge	- Medical Foam	25	50.0	0.50
	- Memory foam	21	42.0	0.42
	- Silicone gel pad	5	10.0	0.10
Safety	Anti-slip	39	78.0	0.78
	Rounded corner	42	84.0	0.84
	Non-conductive material,	46	92.0	0.92
	Secure but not restricted straps.,	38	76.0	0.76
	Fluid Resistance surface	45	90.0	0.90
Handling	Easy to attach and remove	37	74.0	0.74

	Each duty shift assessment of wrist board and site.	41	82.0	0.82
Cleaning	- 70% isopropyl alcohol / Hospital disinfectant	36	72.0	0.72
	- Autoclave/ETO	8	16.0	0.16
	- Hospital wipes	7	14.0	0.14
Precaution	Do not make straps too tight	46	92.0	0.92
	Avoid sharp edges or hard projection	41	82.0	0.82
	Ensure easy cleaning and disinfection	12	24.0	0.24
	Latex free material to prevent allergy	38	76.0	0.76
	Board angle should not hyperextend wrist (>30 degree)	41	82.0	0.82
	Sponge should not absorb fluids.	45	90.0	0.90
Advantages	Prevent accidental arterial line dislodgement,	39	78.0	0.78
	Enhance patient comfort,	41	82.0	0.82
	Cost effective,	45	90.0	0.90
	Reusable	46	92.0	0.92

Table 2 presents the distribution of arterial line wrist board items based on expert responses in Round 1. For the design, the most preferred option was dorsiflexion of 30–40 degrees with a lightweight, slim, and smooth rounded edge, selected by 26 experts (52.0%), followed by dorsiflexion of 30–45 degrees (34.0%) and 15–30 degrees (16.0%). In terms of material, polypropylene was highly preferred by 43 experts (86.0%), while wooden and aluminum composite options received lower agreement at 16.0% and 14.0%, respectively. For straps, Velcro strips with a minimum of 2–3 adjustable strips were favored by 80.0% of experts, compared to 20.0% for soft fabric straps with 2 adjustable strips. Regarding additional features, adjustable Velcro straps had the highest agreement (90.0%), followed by anti-slip (86.0%) and color-coded disposable covers (78.0%).

For size, the options “Small – Lean Adult” (34.0%) and “All size based on weight and body mass” (28.0%) received moderate preference, while universal and general adult/pediatric sizes had lower agreement. Among sponge types, medical foam was selected by 50.0% of experts, memory foam by 42.0%, and silicone gel pads by 10.0%. Safety features showed strong consensus, with non-conductive material (92.0%), fluid-resistant surface (90.0%), rounded corners (84.0%), anti-slip (78.0%), and secure but not restricted straps (76.0%) being preferred. Handling options such as “each duty shift assessment of wrist board and site” (82.0%) and “easy to attach and remove” (74.0%) were also favored.

For cleaning, 70% isopropyl alcohol or hospital disinfectant was preferred by 72.0% of experts, while autoclave/ETO and hospital wipes were less favored (16.0% and 14.0%, respectively). Precautionary items showed high agreement for “do not make straps too tight” (92.0%), “sponge should not absorb fluids” (90.0%), and “avoid sharp edges or hard projection” (82.0%), while “ensure easy cleaning and disinfection” had lower agreement (24.0%). Finally, for advantages, the highest agreement was observed for “reusable” (92.0%) and “cost-effective” (90.0%), followed by “enhance patient comfort” (82.0%) and “prevent accidental arterial line dislodgement” (78.0%). Overall, these results highlight the items with the highest consensus among experts in Round 1, which can guide further refinement in subsequent Delphi rounds.

Table 3: Distribution of items and I-CVI scores based on expert opinion in round two

Arterial Line Wrist Board Features		f	%	I-CVI
Design	Dorsiflexion of 15-30 degree with lightweight, slim and smooth rounded edge	3	7.8	0.07
	Dorsiflexion of 30-40 degree with lightweight, slim and smooth rounded edge	5	13.1	0.13
	Dorsiflexion of 30-45 degree with lightweight, slim and smooth rounded edge	30	78.9	0.78
Material	- Polypropylene	34	89.0	0.89
	-Aluminum composite sheet	4	10.5	0.10
Strips	- Velcro strips with minimum 2-3 adjustable strips	35	92.1	0.92
	- Soft Fabric strap with minimum 2 adjustable strips	3	7.8	0.07
Features	Color to different size Disposable covers,	15	39.4	0.39
	Anti slip,	32	84.0	0.84
	Adjustable Velcro straps	35	92	0.92
Size	- All size based on the weight and body mass	2	5.0	0.05

	Small : length 6-7 inches and width 2-3 inches Medium : length 8-9 inches and width 3.5-4.5 inches Large : length 10-12 inches and width 4.5-5 inches	1	2.6	0.26
	- Universal size Length 8-9 inches Width 2.5 – 3.5 inches Thickness – 3mm	35	92.0	0.92
Sponge	- Medical Foam	31	81.5	0.81
	- Memory foam	5	13.1	0.
	- Silicone gel pad	2	5.2	0.05
Safety	Anti-slip	32	84.0	0.84
	Rounded corner	33	86.8	0.86
	Non-conductive material,	37	97.0	0.97
	Secure but not restricted straps.,	35	92.1	0.92
	Fluid Resistance surface	36	94.7	0.94
Handling	Easy to attach and remove	37	97.3	0.97
	Each duty shift assessment of wrist board and site.	36	94.3	0.94
Cleaning	- 70% isopropyl alcohol / Hospital disinfectant	37	97.3	0.97
	- Autoclave/ETO	25	65.7	0.65
	-Hospital wipes	1	2.6	0.02
Precaution	Do not make straps too tight	38	100	94
	Avoid sharp edges or hard projection	38	100	1
	Ensure easy cleaning and disinfection	38	100	1
	Latex free material to prevent allergy	32	84.0	0.84
	Board angle should not hyperextend wrist (>30 degree)	38	100	1
	Sponge should not absorb fluids.	38	100	1
Advantages	Prevent accidental arterial line dislodgement,	36	94.7	0.94
	Enhance patient comfort,	35	92.1	0.92
	Cost effective,	37	97.3	0.97
	Reusable	36	94.7	0.94

Table 3 presents the distribution of arterial line wrist board items based on expert responses in Round 2. For design, the highest agreement was observed for dorsiflexion of 30-45 degrees with a lightweight, slim, and smooth rounded edge, selected by 30 experts (78.9%), followed by dorsiflexion of 30–40 degrees (13.1%), while dorsiflexion of 15-30 degrees received lower agreement (7.8%). In terms of material, Polypropylene sheet were preferred by 34 experts (89.0%), whereas Aluminium composite sheet was selected by only 4 experts (10.5%). For straps, Velcro strips with a minimum of 2–3 adjustable strips had strong consensus 35 (92.1%) compared to soft fabric straps 3 (7.8%). Regarding additional features, adjustable Velcro straps 35 (92.0%) and anti-slip surfaces 32 (84.0%) were favoured, while color-coded disposable covers received moderate agreement 15 (39.4%).

For size, “Universal size” was highly preferred by 35 experts (92.0%), while other size options had very low agreement. Among sponge types, medical foam was preferred by 31 experts (81.5%) with memory foam 5 (13.1%) and silicone gel pads 2 (5.2%) less favoured. Safety features showed very strong consensus, with secure but not restricted straps selected by 100% of experts, non-conductive material selected by 37 experts (97.0%) and fluid-resistant surfaces selected by 36 experts (94.7%) and Anti-slip and rounded corners were also highly rated (84.0% and 86.6%, respectively). For handling, “each duty shift assessment” and “easy to attach and remove” received near-total agreement (97.3% and 94.7%). Cleaning preferences were highest for 70% isopropyl alcohol or hospital disinfectant 37 (97.3%), followed by autoclave/ETO 25 (65.7%), with hospital wipes least preferred 1 (2.6%). Precautionary items such as “do not make straps too tight,” “avoid sharp edges,” “ensure easy cleaning,” “board angle not hyperextending wrist,” and “sponge should not absorb fluids” all received 100% agreement, while latex-free material had slightly lower agreement 32 (84.0%). For advantages, “cost-effective” received 37 agreement (100%), followed by “enhance patient comfort” 35 (92.1%), “prevent accidental arterial line

dislodgement” 36 (94.7%), and “reusable” 36 (94.7%). Overall, Round 2 responses show increased consensus compared to Round 1, highlighting items with the highest expert agreement for further validation.

Table 4. Comparison of inclusion of item based on experts’ opinion in round two and three

Characteristics	Round	Kendall’s tau b	P value	Significance at 5% Level
Design	2&3	0.816	0.221	NS
Material	2&3	1	0.00	S
Strips	2&3	1	0.00	S
Features	2&3	0.333	0.602	NS
Size	2&3	0.333	0.602	NS
Sponge	2&3	0.816	0.221	NS
Safety	2&3	0.354	0.42	NS
Handling	2&3	0.864	0.536	NS
Cleaning	2&3	0.816	0.221	NS
Precaution	2&3	0.674	0.111	NS
Advantages	2&3	0.903	0.071	NS
Overall	2&3	0.749	0.001	S

Table 4 shows the comparison of inclusion of arterial line wrist board items based on experts’ opinions in Rounds 2 and 3 using Kendall’s tau-b correlation. The analysis indicates a strong positive correlation for most characteristics, reflecting agreement between the two rounds. Perfect agreement ($\tau_b = 1$) was observed for material and strips, indicating that experts’ opinions on these items did not change between rounds. High correlations were also seen for design (0.816), sponge (0.816), handling (0.864), cleaning (0.816), and advantages (0.903), suggesting consistent expert consensus across rounds. Moderate agreement was observed for precaution (0.674), while lower correlations were found for features (0.333), size (0.333), and safety (0.354), indicating some variation in expert ratings for these items.

Overall, the Kendall’s tau-b for all items was 0.749 with a p-value of 0.001, which is statistically significant, demonstrating a strong overall agreement between Rounds 2 and 3. This indicates that the Delphi process achieved substantial consensus among experts, particularly for critical design, material, and safety-related aspects of the wrist board.

Table 5: Distribution of items based on Delphi experts’ opinion in round three.

Arterial Line Wrist Board Features		f	%	I-CVI
Design	Dorsiflexion of 15-30 degree with lightweight, slim and smooth rounded edge	33	94.3	0.94
Material	- Polypropylene	35	100.0	1.00
Strips	- Velcro strips with minimum 2-3 adjustable strips	34	97.1	0.97
Features	Adjustable Velcro straps	32	91.4	0.91
	Anti slip,	33	94.3	0.94
Size	- All size based on the weight and body mass	33	94.3	0.94
Sponge	- Medical Foam	33	94.3	0.94
Safety	Anti-slip	33	94.3	0.94
	Rounded corner	34	97.1	0.97
	Non-conductive material,	35	100.0	1.00
	Secure but not restricted straps.,	34	97.1	0.97
	Fluid Resistance surface	33	94.3	0.94
Handling	Easy to attach and remove	34	97.1	0.97
	Each duty shift assessment of wrist board and site.	33	94.3	0.94
Cleaning	- 70% isopropyl alcohol / Hospital disinfectant	35	100.0	1.00
	Do not make straps too tight	34	97.1	0.97
	Avoid sharp edges or hard projection	35	100.0	1.00

Precaution	Ensure easy cleaning and disinfection	34	97.1	0.97
	Latex free material to prevent allergy	33	94.3	0.94
	Board angle should not hyperextend wrist (>30 degree)	35	100.0	1.00
	Sponge should not absorb fluids.	34	97.1	0.97
Advantages	Prevent accidental arterial line dislodgement,	32	91.4	0.91
	Enhance patient comfort,	34	97.1	0.97
	Cost effective,	35	100.0	1.00
	Reusable	34	97.1	0.97

Table 5 presents the distribution of arterial line wrist board items based on expert responses in Round 3. For design, dorsiflexion of 15–30 degrees with a lightweight, slim, and smooth rounded edge received the highest agreement, with 33 experts (94.3%) selecting it. Regarding material, wooden boards achieved full consensus, with 35 experts (100%) agreeing. For straps, Velcro strips with a minimum of 2–3 adjustable strips were strongly preferred (97.1%). Among additional features, Adjustable Velcro straps were selected by 32 experts (91.4%), and anti-slip features by 33 experts (94.3%). For size, “all sizes based on weight and body mass” had strong agreement (94.3%). Medical foam was the most preferred sponge type (94.3%). Safety features continued to show high consensus, including anti-slip (94.3%), rounded corners (97.1%), non-conductive material (100%), secure but not restricted straps (97.1%), and fluid-resistant surfaces (94.3%). Handling items were also highly rated, with “easy to attach and remove” (97.1%) and “each duty shift assessment of wrist board and site” (94.3%). For cleaning, 70% isopropyl alcohol or hospital disinfectant achieved full agreement (100%). Precautionary items such as “do not make straps too tight” (97.1%), “avoid sharp edges or hard projection” (100%), “ensure easy cleaning and disinfection” (97.1%), “latex-free material” (94.3%), “board angle should not hyperextend wrist” (100%), and “sponge should not absorb fluids” (97.1%) were highly endorsed. Finally, for advantages, “cost-effective” received full agreement (100%), while “enhance patient comfort” and “reusable” were selected by 97.1%, and “prevent accidental arterial line dislodgement” by 91.4%. Overall, Round 3 responses indicate that expert consensus was very high across almost all items, reflecting stability and convergence of opinions compared to previous rounds.

Table 6: Distribution of level of agreement of Delphi experts of Round Three

Arterial Line Wrist Board Features		Agreement		Disagreement	
		f	%	f	%
Design	Dorsiflexion of 15-30 degree with lightweight, slim and smooth rounded edge	33	94.3	02	5.7
Material	- Polypropylene	35	100.0	00	00
Strips	- Velcro strips with minimum 2-3 adjustable strips	34	97.1	01	2.8
Features	Adjustable Velcro straps	32	91.4	03	8.5
	Anti slip,	33	94.3	02	5.7
Size	- All size based on the weight and body mass	33	94.3	02	5.7
Sponge	- Medical Foam	33	94.3	02	5.7
Safety	Anti-slip	33	94.3	02	5.7
	Rounded corner	34	97.1	01	2.8
	Non-conductive material,	35	100.0	00	00
	Secure but not restricted straps.,	34	97.1	01	2.8
	Fluid Resistance surface	33	94.3	02	5.7
Handling	Easy to attach and remove	34	97.1	01	2.8
	Each duty shift assessment of wrist board and site.	33	94.3	02	5.7
Cleaning	- 70% isopropyl alcohol / Hospital disinfectant	35	100.0	00	00
	Do not make straps too tight	34	97.1	01	2.8

Precaution	Avoid sharp edges or hard projection	35	100.0	00	00
	Ensure easy cleaning and disinfection	34	97.1	01	2.8
	Latex free material to prevent allergy	33	94.3	02	5.7
	Board angle should not hyperextend wrist (>30 degree)	35	100.0	00	00
	Sponge should not absorb fluids.	34	97.1	01	2.8
Advantages	Prevent accidental arterial line dislodgement,	32	91.4	03	8.5
	Enhance patient comfort,	34	97.1	01	2.8
	Cost effective,	35	100	00	00
	Reusable	34	97.1	01	2.8

Table 6 shows that, out of 35 experts had given 35 (100%) Polypropylene, Non-conductive material, 70% isopropyl Alcohol, Avoid sharp edges, Board angle should not be hyperextended, Cost effective, 34 (97.1%) Experts given opinion Velcro straps with minimum 2-3 straps, rounded corners, secure but not restricted, easy to attach and remove, Do not make straps too tight, Ensure easy cleaning and disinfection, Sponge should not absorb fluid, Enhance patient comfort, Reusable, 33 (94.3%) Experts given Dorsiflexion of 15-30 degree with lightweight, slim and smooth rounded edge, Anti slip, Fluid resistance surface, Each duty shift assessment of wrist board and site, Latex free material to prevent allergy, 32 (91.4%) Adjustable Velcro straps, Experts given Prevent accidental arterial line dislodgement.

Table 7: Item wise content validity index

Arterial Line Wrist Board Features		f	%	CVIe
Design	Dorsiflexion of 15-30 degree with lightweight, slim and smooth rounded edge	33	94.3	0.9
Material	- Polypropylene	35	100.0	1
Strips	- Velcro strips with - minimum 2-3 adjustable strips	34	97.1	0.9
Features	Adjustable Velcro straps	32	91.4	0.9
	Anti slip,	33	94.3	0.9
Size	- All size based on the weight and body mass	33	94.3	0.9
Sponge	- Medical Foam	33	94.3	0.9
Safety	Anti-slip	33	94.3	0.9
	Rounded corner	34	97.1	0.9
	Non-conductive material,	35	100.0	1
	Secure but not restricted straps.,	34	97.1	0.9
	Fluid Resistance surface	33	94.3	0.9
Handling	Easy to attach and remove	34	97.1	0.9
	Each duty shift assessment of wrist board and site.	33	94.3	0.9
Cleaning	- 70% isopropyl alcohol / Hospital disinfectant	35	100.0	1
Precaution	Do not make straps too tight	34	97.1	0.9
	Avoid sharp edges or hard projection	35	100.0	1
	Ensure easy cleaning and disinfection	34	97.1	0.9
	Latex free material to prevent allergy	33	94.3	0.9
	Board angle should not hyperextend wrist (>30 degree)	35	100.0	1
	Sponge should not absorb fluids.	34	97.1	0.9
Advantages	Prevent accidental arterial line dislodgement,	32	91.4	0.9
	Enhance patient comfort,	34	97.1	0.9
	Cost effective,	35	100.0	1
	Reusable	34	97.1	0.9

Table 7 shows that, out of 35 experts had given 35 (100%) Polypropylene, Non-conductive material, 70% isopropyl Alcohol, Avoid sharp edges, Board angle should not be hyperextended, Cost effective, 34 (97.1%) Experts given opinion Velcro straps with minimum 2-3 straps, rounded corners, secure but not restricted, easy to attach and remove, Do not make straps too tight, Ensure easy cleaning and disinfection, Sponge should not absorb fluid, Enhance patient comfort, Reusable, 33 (94.3%) Experts given Dorsiflexion of 15-30 degree with lightweight, slim and smooth rounded edge, Anti slip, Fluid resistance surface, Each duty shift assessment of wrist board and site, Latex free material to prevent allergy, 32 (91.4%) Adjustable Velcro straps, Experts given Prevent accidental arterial line dislodgement, can be divided in three level, instructions, after each item pieces replacement. also, represent with CVI-I with 1 are Polypropylene, Non-conductive material, 70% isopropyl alcohol / Hospital disinfectant, Avoid sharp edge and hard projection, Board angle should not hyperextend wrist (>30 degree), Cost effective, given by experts I-CVI with 1 and others 0.9.

Table 8: Distribution of Position-related Complications before and after wrist board implementation

Sr. No	Complications	Before implementation		After implementation	
		f	%	f	%
1	Kinking	68	97.1%	16	22.9%
2	Disturbed waveform	66	94.3%	11	15.7%
3	Embolism	62	88.6%	34	48.6%
4	Accommodates multiple wrist position	62	88.6%	0	0.0%
5	Inaccurate BP measures	65	92.9%	9	12.9%
6	Occlusion	60	85.7%	27	38.6%
7	Thrombosis	59	84.3%	24	34.3%
8	Hematoma	64	91.4%	13	18.6%
9	Infection	52	74.3%	18	25.7%

The 8 table presents the distribution of position-related complications among patients with radial arterial lines before and after implementation of wrist board. It was observed that most of the complications were highly prevalent, with C1 (97.1%) and C2 (94.3%) being the most frequently reported. Several other complications such as C5 (92.9%) and C8 (91.4%) also showed high occurrence. In contrast, C9 (74.3%) was comparatively less frequent than the others before implementation of wrist board. Following the application of the arterial line wrist board. It is observed that the frequency of complications has considerably decreased compared to the pre-intervention phase. Certain complications such as C4 were completely absent (0%), indicating effective control after intervention. Other complications like C2 (15.7%) and C5 (12.9%) were also reported at lower levels. Although some complications such as C3 (48.6%) and C6 (38.6%) were still present, their occurrence was reduced when compared to earlier findings. Overall, the results suggest that the implementation of the wrist board contributed to a reduction in complications, thereby improving patient care and arterial line stability.

Table 9: Comparison of complications in patients with Radial Arterial line before and after application of Arterial line wrist board

Complications	Mean	Standard Deviation	t value	df	p-value	Significance at 5% Level
Before application of Arterial Wrist Board	7.97	1.04	30.03	69	0.00	S
After application of Arterial Wrist Board	2.20	1.46				

The effectiveness of the arterial line wrist board was assessed by comparing the pre-test and post-test scores. The mean pre-test score (7.97 ± 1.04) was considerably higher than the mean post-test score (2.20 ± 1.46), indicating a reduction in complications following the implementation of the wrist board. The paired t-test revealed a statistically significant difference between pre-test and post-test values ($t = 30.03$, $p < 0.001$). This demonstrates that the use of the arterial line wrist board was highly effective in minimizing position-related complications and improving patient outcomes. Hence, the developed arterial line wrist board was found to be effective.

DISCUSSION

The developed arterial line wrist board demonstrated excellent expert agreement, with most design components achieving an Item Content Validity Index (I-CVI) of ≥ 0.90 and an overall Scale Content Validity Index (S-CVI) of 1.00. These findings indicate that the design was considered relevant, appropriate, and clinically acceptable by the multidisciplinary expert panel. The findings are consistent with established recommendations that consider I-CVI ≥ 0.78 and S-CVI ≥ 0.90 indicative of excellent content validity. Similar findings have been reported in healthcare device development studies, where high content validity indices reflected strong expert consensus and clinical applicability.¹⁸⁻²⁰

The study demonstrated a high prevalence of position-related complications before implementation of the wrist board, indicating that inadequate wrist stabilization may adversely affect catheter function and invasive hemodynamic monitoring. Frequent catheter kinking, disturbed arterial waveforms, and inaccurate blood pressure measurements suggest that improper wrist positioning can compromise catheter patency and waveform transmission. Hematoma, thrombosis, occlusion, embolism, and infection further highlight the potential clinical consequences of inadequate stabilization.¹⁵⁻¹⁷ The findings are consistent with previous evidence showing that inadequate catheter stabilization increases thrombosis, catheter occlusion, inaccurate blood pressure monitoring, and waveform distortion. Adamo et al. reported increased arterial catheter complications with inadequate stabilization, while Baptistella et al. identified poor wrist positioning as an important contributor to waveform distortion. Ullman et al. also emphasized the importance of effective vascular access stabilization for catheter function and patient safety.²¹⁻²²

Implementation of wrist board produced a marked reduction in position-related complications, including kinking, waveform disturbance, hematoma, thrombosis, occlusion, embolism, and infection. Improved wrist positioning likely maintained catheter patency, reduced catheter movement and manipulation, and enhanced monitoring accuracy. The overall mean complication score decreased from 7.97 ± 1.04 to 2.20 ± 1.46 , with a statistically significant paired t-test result ($t = 30.03$, $p < 0.001$). These findings support the effectiveness of the developed wrist board and are consistent with evidence that dedicated wrist stabilization improves arterial catheter stability and reduces mechanical complications.⁸ The wrist board therefore represents a simple, cost-effective, and evidence-based innovation for safer arterial line management in critical care practice.

CONCLUSION

The present study concludes that proper wrist positioning plays a vital role in the effective management of radial arterial lines in critically ill patients. Lack of a standardized support device resulted in a high prevalence of position-related complications. These complications not only affected the accuracy of hemodynamic monitoring but also posed risks to patient safety. The arterial line wrist board developed in this study, using a structured Delphi technique, proved to be a scientifically sound and clinically relevant solution. The high level of expert agreement and excellent content validity confirmed that the device is appropriate for use in critical care settings. The implementation of the wrist board demonstrated a significant reduction in complications such as kinking, disturbed waveform, inaccurate blood pressure readings, and other related issues. The statistical analysis further validated the effectiveness of the intervention, showing a highly significant difference between pre- and post-intervention scores. This indicates that the improvements observed were directly associated with the use of the wrist board rather than random variation. Overall, the study highlights that a simple, cost-effective, and standardized device can significantly enhance arterial line stability, improve monitoring accuracy, and reduce complication rates. The arterial line wrist board can therefore be considered a valuable addition to clinical practice, contributing to improved patient outcomes and supporting evidence-based care in critical care settings.

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