Journal of Multidisciplinary Healthcare

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Knowledge, Attitudes and Practices Among Anesthesia and Thoracic Surgery Medical Staff Toward Ai-PCA

Zhenghuan Song[1,*], Jiaqin Cai[2,*], Yihu Zhou[3], Yueyi Jiang[3], Shiyi Huang[2], Lianbing Gu[1,2], Jing Tan[1,2]

[1]Department of Anesthesiology, Jiangsu Cancer Hospital & Jiangsu Institute of Cancer Research & The Affiliated Cancer Hospital of Nanjing Medical University, Nanjing, 21009, People's Republic of China; [2]Xuzhou Medical University, Xuzhou, 21009, People's Republic of China; [3]Nanjing Medical University, Nanjing, 21009, People's Republic of China

*These authors contributed equally to this work

Correspondence: Jing Tan; Lianbing Gu, Department of Anesthesiology, Jiangsu Cancer Hospital & Jiangsu Institute of Cancer Research & The Affiliated Cancer Hospital of Nanjing Medical University, Nanjing, 21009, People's Republic of China, Tel +86-13813967939; +86-13951947684, Email tanjing@njmu.edu.cn; 13951947684@163.com

Purpose: Artificial intelligence (AI) is increasingly influencing various medical fields, including anesthesiology. The Introduction of artificial intelligent patient-controlled analgesia (Ai-PCA) has been seen as a significant advancement in pain management. However, the adoption and practical application of Ai-PCA by medical staff, particularly in anesthesia and thoracic surgery, have not been extensively studied. This study aimed to investigate the knowledge, attitudes and practices (KAP) among anesthesia and thoracic surgery medical staff toward artificial intelligent patient-controlled analgesia (Ai-PCA).

Participants and Methods: This web-based cross-sectional study was conducted between November 1, 2023 and November 15, 2023 at Jiangsu Cancer Hospital. A self-designed questionnaire was developed to collect demographic information of anesthesia and thoracic surgery medical staff, and to assess their knowledge, attitudes and practices toward Ai-PCA.

Results: A total of 519 valid questionnaires were collected. Among the participants, 278 (53.56%) were female, 497 (95.76%) were employed in the field of anesthesiology, and 188 (36.22%) had participated in Ai-PCA training. The mean knowledge, attitude, and practice scores were 7.8±1.75 (possible range: 0–10), 37.43±4.16 (possible range: 9–45), and 28.38±9.27 (possible range: 9–45), respectively.

Conclusion: The findings revealed that anesthesia and thoracic surgery medical staff have sufficient knowledge, active attitudes, but poor practices toward the Ai-PCA. Comprehensive training programs are needed to improve anesthesia and thoracic surgery medical staff's practices in this area.

Keywords: knowledge, attitudes, practices, Ai-PCA, cross-sectional study

Introduction

The capabilities of artificial intelligence (AI) algorithms extend to machine reasoning and decision-making. In the field of anesthesiology, these AI applications have made significant strides in various areas, including the monitoring of anesthesia depth, anesthesia control, risk prediction, and logistics management.[1,2] Within this landscape of AI innovations, artificial intelligent patient-controlled analgesia (Ai-PCA) emerges as an advanced paradigm for pain management.

The utilization of Ai-PCA in postoperative pain management is an undeniable trend.[3] In contrast to conventional Patient-Controlled Analgesia (PCA) methods, Ai-PCA presents a range of noteworthy advantages. It allows for precise adjustments in drug infusion, thereby reducing medication wastage. Moreover, Ai-PCA enables the systematic documentation of pain progression and medication utilization, which is pivotal for generating essential healthcare data.[3,4] Furthermore, Ai-PCA engenders a heightened sense of control and pain relief for patients, ultimately enhancing overall patient satisfaction.[5]

Received: 12 March 2024
Accepted: 27 June 2024
Published: 10 July 2024

Despite these acknowledged potential and benefits associated with Ai-PCA, its practical application in clinical settings remains incomplete. Several studies have reported that although medical workers have expressed interest in the potential benefits of AI-driven models for enhancing their clinical practice, they also always exhibited a certain degree of reluctance in incorporating this tool into their clinical routines.[6–8] However, the perception, awareness, and clinical utilization of Ai-PCA among anesthesia and thoracic medical workers, a group that encounters Ai-PCA most frequently in clinical practice, remains largely unknown.

The Knowledge, Attitude, and Practices (KAP) survey serves as a diagnostic research tool within the domain of health literacy, shedding light on a group's understanding, beliefs, and actions related to a specific subject.[9–11] Research on the KAP among anesthesia and thoracic surgery medical staff toward Ai-PCA is essential due to their interactions with this technology in clinical settings. This study is pivotal for identifying gaps in knowledge, as well as levels of resistance or acceptance among these professionals, who play a critical role in the implementation and optimization of Ai-PCA. By gaining insights into their perspectives, it is possible to develop targeted educational and training programs that increase their familiarity and comfort with Ai-PCA. Such initiatives ultimately aim to enhance patient outcomes in pain management and increase operational efficiency in clinical practices.[3] Therefore, this study aimed to assess the knowledge, attitudes and practices among anesthesia and thoracic surgery medical staff toward Ai-PCA.

Methods

Study Design and Participants

This cross-sectional survey was conducted between November 1, 2023 and November 15, 2023 at Jiangsu Cancer Hospital among anesthesia and thoracic surgery medical staff. The study was ethically approved by the Ethics Committee of Jiangsu Cancer Hospital (Approval number 043) and informed consent was obtained from the study participants. The inclusion criteria were defined as follows: 1) Clinical anesthesia and thoracic surgery medical staff, including anesthesiologists, surgeons, and nurses; 2) Willing participation in the study and the signing of informed consent. Retired and rehired anesthesia or thoracic surgery medical personnel were excluded from this study, as the experience of retired or rehired personnel might not accurately represent current operational and clinical conditions.

Questionnaire

The Questionnaire was developed with guidance from the "Intelligent Patient-Controlled Pain Management Expert Consensus",[12] and relevant literatures.[3,13,14] The initial draft underwent revisions based on feedback from two senior experts specializing in anesthesia and thoracic surgery both holding the title of Chief Physician. Subsequently, a preliminary trial was conducted on a limited scale (n=48), resulting in a Cronbach's alpha coefficient value of 0.875, indicating good internal consistency.

The final questionnaire was in Chinese and comprised four dimensions: demographic information, knowledge, attitudes, and practices. The demographic information section included 10 items, while the knowledge, attitudes, and practices dimensions had 12, 9, and 9 items, respectively. Knowledge items were scored 1 point for a correct answer and 0 points for incorrect responses. Questions K3 and K4 were designed as trap questions (the questionnaires that choose the same option at the same time will be considered as logically incorrect and will be eliminated) and did not contribute to the total score calculation. Thus the possible score range of knowledge is 0–10. Attitude items were assessed using a five-point Likert scale, with responses ranging from very positive (5 points) to very negative (1 point), resulting in a potential score range of 9–45. Except for question A3 and A6, which featured a reverse scale for negative statements (a-e:1–5), all other attitude questions followed a positive scale (a-e:5–1). The practice items were also scored using a five-point Likert scale, with options ranging from always (5 points) to never (1 point), and this yielded a potential score range of 9–45 (a-e:5–1).

To effectively manage the process of distributing, collecting, and maintaining the quality control of the questionnaires, face-to-face training to four research assistants was conducted. Data collection for this study was facilitated through an online questionnaire hosted on Sojump (http://www.sojump.com). In order to prevent duplicate responses, an IP restriction was implemented, ensuring that each survey could only be completed once per unique IP address. The questionnaire was disseminated using QR codes, patient groups, social networks, and paper-based forms.

Statistical Analysis

STATA 17.0 (Stata Corporation, College Station, TX, USA) was used for statistical analysis. The continuous variables were expressed as mean ± SD, and the categorical variables was expressed as n (%). The continuous variables conformed to a normal distribution were tested by the *t*-test or ANOVA. In multivariate analysis, 70% of the total score was used as the cut-off value. Pearson correlation was used to analyze the correlation between knowledge, attitudes, and practices. In this analysis, P<0.05 was considered statistically significant.

Results

A total of 519 participants enrolled in this study, among them, 278 (53.56%) were females, with mean age of 37.82 ±10.17 years and mean work experience of 13.80±10.64 years. 386 (74.37%) were married, 239 (46.05%) had education of college and below, 497 (95.76%) were working in anesthesiology department, 439 (84.59%) were doctors, 184 (35.45%) had a junior occupational title, and 188 (36.22%) had participated in Ai-PCA training (Table 1).

The mean knowledge, attitude, and practice scores were 7.8±1.75 (possible range: 0–10), 37.43±4.16 (possible range: 9–45), and 28.38±9.27 (possible range: 9–45), respectively. Higher knowledge scores were observed in male participants (P=0.042), participants from department of anesthesiology (P=0.001), doctors (P=0.003), senior medical workers (P=0.014), and those have

Table 1 Demographic Characteristics and KAP Scores

	N (%)	Knowledge		Attitudes		Practices	
		Score	P	Score	P	Score	P
Total Score		7.8±1.75		37.43±4.16		28.38±9.27	
Gender			0.042		0.018		0.228
Male	241 (46.44)	7.99±1.58		37.88±4.19		27.94±8.91	
Female	278 (53.56)	7.63±1.87		37.04±4.1		28.76±9.57	
Age	37.82±10.17						
Institution			0.400		0.986		0.073
Non-tertiary	33 (6.36)	7.39±2.29		37.55±4.44		25.39±9.3	
Tertiary	486 (93.64)	7.82±1.71		37.42±4.15		28.58±9.24	
Marital Status			0.436		0.029		0.002
Unmarried and others	133 (25.63)	7.71±1.79		36.72±4.21		26.3±9.26	
Married	386 (74.37)	7.82±1.74		37.67±4.12		29.1±9.18	
Education Level			0.223		0.287		0.349
College and below	239 (46.05)	7.68±1.86		37.18±4.13		29.05±8.97	
Master's	229 (44.12)	7.84±1.68		37.55±4.3		27.68±9.55	
Ph.D. and above	51 (9.83)	8.16±1.5		37.98±3.65		28.41±9.29	
Department			0.001		0.043		0.123
Anesthesiology	497 (95.76)	7.87±1.67		37.5±4.13		28.24±9.33	
Thoracic Surgery	22 (4.24)	6.23±2.62		35.73±4.69		31.5±7.33	
Job Type			0.003		0.008		0.001
Doctor	439 (84.59)	7.89±1.68		37.65±4.22		27.8±9.25	
Non-doctor	80 (15.41)	7.28±2.03		36.2±3.61		31.56±8.8	
Work Experience	13.80±10.64						
Title			0.014		0.019		0.425
Junior	184 (35.45)	7.58±1.91		36.73±4.16		27.71±9.64	
Intermediate	123 (23.7)	7.85±1.65		37.63±4.09		29.09±9.58	
Associate	95 (18.3)	7.73±1.72		38.31±4.41		29.13±8.25	
Senior	117 (22.54)	8.14±1.57		37.59±3.9		28.09±9.15	
Participation in Ai-PCA Training			<0.001		<0.001		<0.001
Yes	188 (36.22)	8.2±1.33		38.23±4.14		32.21±8.56	
No	331 (63.78)	7.57±1.92		36.97±4.11		26.21±8.96	

participated in Ai-PCA training (P<0.001). Higher attitude scores were observed in male participants (P=0.018), married (P=0.029), department of anesthesiology (P=0.043), doctors (P=0.008), associate medical workers (P=0.019) and those have participated in Ai-PCA training (P<0.001). Higher practice scores were observed in married participants (P=0.002), non-doctor (P=0.001), and those have participated in Ai-PCA training (P<0.001) (Table 1).

The three knowledge items with the highest correctness rates were as follows: "Clinical practice with Ai-PCA should follow the principles of full participation and comprehensive quality management, spanning from preoperative patient education to formal use". (K12) with 95.57%, "In response to Ai-PCA-related adverse reactions, prompt evaluation and intervention should be carried out". (K11) with 94.03%, and "During the use of Ai-PCA, close attention should be paid to patient signs, monitoring the operation of Ai-PCA, and analyzing the patient's pain relief needs". (K9) with 93.83%. On the contrary, the three items with the lowest correctness rates were "Ai-PCA does not design dosing plans and configure pain relief drugs on its own; it does not automate these processes". (K6) with 10.21%, "For Ai-PCA ward rounds, ensuring once a week is sufficient". (K8) with 49.33%, and "Ai-PCA is very safe, and there are no pain relief-related adverse reactions". (K10) with 70.91% (Table 2).

Most of the participants acknowledged that receiving Ai-PCA training are crucial (95.76% strongly agree or agree) (A1) and confirmed the necessity of discussing problems encountered in Ai-PCA clinical practice with colleagues and the need for solutions (97.11% strongly agree or agree) (A2). However, 35.45% of them thought that learning Ai-PCA expert consensus and updating relevant knowledge is not very important (A3). Moreover, 28.13% of them believe that adverse events such as drowsiness and nausea and vomiting should not receive excessive attention in Ai-PCA clinical practice (A6). Nevertheless, 96.92% believed to varying degrees that all healthcare professionals are an important part of this chain (A8) (Table 3).

Participants exhibited diverse practices and corresponding frequencies. Specifically, 33.91% of participants occasionally proactively sought Ai-PCA relevant knowledge (P1). Additionally, 28.71% frequently provided in-hospital education

Table 2 Distribution of Knowledge

Knowledge	Correct N (%)	Incorrect N (%)	Uncertain N (%)
K1. Ai-PCA refers to a new pain relief technology system formed by the integration of the Internet of Things and artificial intelligence, achieving informatization and intelligence in pain relief. (Correct)	483 (93.06)	3 (0.58)	33 (6.36)
K2. Ai-PCA consists of intelligent infusion devices with wireless communication capabilities, disposable medication reservoirs, wireless transmission equipment, mobile ward inspection systems, and central management systems. (Correct)	474 (91.33)	2 (0.39)	43 (8.29)
K3. Compared to traditional PCA, Ai-PCA is more intelligent and efficient. (Correct)	/	/	/
K4. Ai-PCA is not significantly different from traditional PCA; they are nearly identical. (Incorrect, this question is a trap. It contradicts question 3, and respondents providing the same answers to both questions will have their responses invalidated during analysis.)	/	/	/
K5. The process of issuing orders in Ai-PCA includes assessing whether the patient meets the usage conditions, formulating a pain relief plan, issuing orders, and creating treatment records. (Correct)	459 (88.44)	8 (1.54)	52 (10.02)
K6. Ai-PCA does not design dosing plans and configure pain relief drugs on its own; it does not automate these processes. (Incorrect)	390 (75.14)	53 (10.21)	76 (14.64)
K7. Ai-PCA requires verification before implementation, and installation can proceed after the patient signs. (Correct)	482 (92.87)	13 (2.5)	24 (4.62)
K8. For Ai-PCA ward rounds, ensuring once a week is sufficient. (Incorrect)	144 (27.75)	256 (49.33)	119 (22.93)
K9. During the use of Ai-PCA, close attention should be paid to patient signs, monitoring the operation of Ai-PCA, and analyzing the patient's pain relief needs. (Correct)	487 (93.83)	2 (0.39)	30 (5.78)
K10. Ai-PCA is very safe, and there are no pain relief-related adverse reactions. (Incorrect)	81 (15.61)	368 (70.91)	70 (13.49)
K11. In response to Ai-PCA-related adverse reactions, prompt evaluation and intervention should be carried out. (Correct)	488 (94.03)	7 (1.35)	24 (4.62)
K12. Clinical practice with Ai-PCA should follow the principles of full participation and comprehensive quality management, spanning from preoperative patient education to formal use. (Correct)	496 (95.57)	1 (0.19)	22 (4.24)

Table 3 Distribution of Attitudes

Attitude	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)
A1. You believe that personnel in the department receiving Ai-PCA training are crucial for the execution of clinical tasks and the prognosis of patients. (P)	252 (48.55)	245 (47.21)	22 (4.24)	0 (0)	0 (0)
A2. You are willing to discuss issues encountered in Ai-PCA clinical practice with other healthcare workers and attempt to find solutions. (P)	249 (47.98)	255 (49.13)	15 (2.89)	0 (0)	0 (0)
A3. You think that learning Ai-PCA expert consensus and updating relevant knowledge is not very important. (N)	84 (16.18)	100 (19.27)	28 (5.39)	217 (41.81)	90 (17.34)
A4. You acknowledge the advantages of Ai-PCA over traditional PCA in data feedback and recording. (P)	237 (45.66)	259 (49.9)	20 (3.85)	2 (0.39)	1 (0.19)
A5. You acknowledge the role of Ai-PCA in reducing adverse events related to pain relief. (P)	183 (35.26)	283 (54.53)	50 (9.63)	2 (0.39)	1 (0.19)
A6. You believe that adverse events such as drowsiness and nausea and vomiting should not receive excessive attention in Ai-PCA clinical practice. (N)	67 (12.91)	79 (15.22)	19 (3.66)	219 (42.2)	135 (26.01)
A7. You believe that Ai-PCA can significantly improve patient clinical satisfaction compared to traditional PCA. (P)	195 (37.57)	285 (54.91)	37 (7.13)	2 (0.39)	0 (0)
A8. You recognize that improving the clinical application quality of Ai-PCA requires following the principle of full participation, where all healthcare personnel are integral parts of the process. (P)	227 (43.74)	276 (53.18)	14 (2.7)	2 (0.39)	0 (0)
A9. You believe that Ai-PCA has vast application prospects and will contribute to enhancing the effectiveness of healthcare quality control and improving pain relief quality. (P)	239 (46.05)	255 (49.13)	21 (4.05)	4 (0.77)	0 (0)

Notes: P=positive, indicating a positive statement, with options from a to e assigned values from 5 to 1. N=negative, indicating a negative statement, with options from a to e assigned values from 1 to 5.

to patients (P2), while 24.86% never adjusted the number of visits in a timely manner based on Ai-PCA usage (P3). Furthermore, 29.87% frequently initiated surveys on patients' analgesic needs (P4), and a substantial 65.32% displayed a high frequency of concern for suspected analgesia-related adverse reactions in patients (P6). Moreover, 35.07% frequently inquired about patients' satisfaction with analgesia (P8). A majority of 52.02% either always or often summarized the Ai-PCA analgesic experience and applied it to their subsequent analgesic practices (P9) (Table 4).

Correlation analysis showed that significant positive correlations were found between knowledge and attitude ($r=0.318$, $P<0.001$), as well as between attitude and practice ($r=0.185$, $P<0.001$) (Table 5).

Table 4 Distribution of Practices

Practice	Always N (%)	Often N (%)	Sometimes N (%)	Occasionally N (%)	Never N (%)
P1 How often do you actively acquire Ai-PCA-related knowledge through various channels (eg, participating in training, reading literature or expert consensus, communicating with other healthcare workers)?	53 (10.21)	92 (17.73)	112 (21.58)	176 (33.91)	86 (16.57)
P2 How often do you conduct in-house education for patients (eg, avoiding patients' misconceptions about medications, preoperative education)?	79 (15.22)	149 (28.71)	127 (24.47)	120 (23.12)	44 (8.48)

(*Continued*)

Table 4 (Continued).

Practice	Always N (%)	Often N (%)	Sometimes N (%)	Occasionally N (%)	Never N (%)
P3 How often do you adjust the frequency of patient rounds promptly based on Ai-PCA usage?。	60 (11.56)	111 (21.39)	116 (22.35)	103 (19.85)	129 (24.86)
P4 How often do you proactively inquire about patients' pain relief needs during rounds or nursing care?	101 (19.46)	155 (29.87)	116 (22.35)	87 (16.76)	60 (11.56)
P5 How often do you promptly adjust pain relief plans and dosing frequencies based on Ai-PCA backend data analysis?	79 (15.22)	136 (26.2)	111 (21.39)	80 (15.41)	113 (21.77)
P6 How often do you monitor suspected pain relief-related adverse reactions in patients, such as drowsiness, nausea, vomiting, or low blood pressure?	157 (30.25)	182 (35.07)	85 (16.38)	58 (11.18)	37 (7.13)
P7 How often do you report the rounds of patients using Ai-PCA and conduct brief case discussions during morning meetings?	71 (13.68)	114 (21.97)	108 (20.81)	87 (16.76)	139 (26.78)
P8 How often do you inquire about pain relief satisfaction from patients?	149 (28.71)	182 (35.07)	92 (17.73)	66 (12.72)	30 (5.78)
P9 How often do you summarize Ai-PCA pain relief experiences and apply them to the next pain relief practice?	121 (23.31)	149 (28.71)	99 (19.08)	60 (11.56)	90 (17.34)

Notes: a, Always (practice frequency in the past 2 months > 6 times) b, Often (practice frequency in the past 2 months is 5–6 times) c, Sometimes (practice frequency in the past 2 months is 3–4 times) d, Occasionally (practice frequency in the past 2 months is 1–2 times) e, Never (practice frequency in the past 2 months is 0 times).

Table 5 Pearson's Analysis

	Knowledge	Attitudes	Practices
Knowledge	–		
Attitudes	0.318 (P<0.001)	–	
Practices	0.011 (P=0.803)	0.185 (P<0.001)	–

Table 6 Multivariate Analyses of Practices

Practices	Univariate		Multivariate	
	95% CI	P	95% CI	
Knowledge Dimension	1.045 (0.944–1.158)	0.394		
Attitude Dimension	1.094 (1.048–1.143)	<0.001	1.086 (1.037–1.137)	<0.001
Gender				
Male	REF			
Female	1.34 (0.941–1.908)	0.105		
Age	1.01 (0.993–1.028)	0.246		
Nature of Institution				
Non-tertiary	REF			
Tertiary	2.204 (0.974–4.986)	0.058		
Marital Status				
Unmarried and others	REF		REF	
Married	1.897 (1.241–2.899)	0.003	1.526 (0.975–2.386)	0.064
Education Level				
College and below	REF			
Master's	0.982 (0.678–1.422)	0.924		
Ph.D. and above	1.13 (0.613–2.083)	0.695		

(*Continued*)

Table 6 (Continued).

Practices	Univariate		Multivariate	
	95% CI	P	95% CI	
Department				
Anesthesiology	REF			
Thoracic Surgery	1.51 (0.642–3.55)	0.345		
Job Type				
Doctor	REF		REF	
Non-doctor	1.8 (1.115–2.907)	0.016	1.938 (1.16–3.238)	0.012
Years of Work Experience	1.012 (0.996–1.029)	0.147		
Title				
Junior	REF			
Intermediate	1.517 (0.95–2.42)	0.081		
Associate	1.424 (0.858–2.363)	0.172		
Senior	1.351 (0.839–2.176)	0.216		
Participation in Ai-PCA Training				
Yes	REF		REF	
No	0.303 (0.208–0.44)	<0.001	0.353 (0.24–0.519)	<0.001

Multivariate logistic regression showed that attitudes (OR=1.086, 95% CI: 1.037–1.137, P<0.001), non-physician occupations (OR=1.938, 95% CI: 1.16–3.238, P=0.012), and never participated in Ai-PCA training (OR=0.353, 95% CI: 0.24–0.519, P<0.001) were independently associated with proactive practice (Table 6).

Discussion

The findings revealed that anesthesia and thoracic surgery medical staff have sufficient knowledge, active attitudes, but poor practices toward the Ai-PCA.

These findings indicate a certain level of preparedness and willingness among the staff to embrace Ai-PCA as a valuable tool in clinical practice. However, to further enhance clinical practice in this context, it is imperative to focus on bridging the gap between knowledge and practice.[15,16] This can be achieved through tailored training programs and continuous education to actively encourage and empower medical staff to translate their knowledge and positive attitudes into more proactive and effective practices.[17,18] Additionally, fostering interdisciplinary collaboration and communication among staff members can be instrumental in promoting a seamless integration of Ai-PCA into clinical settings, thereby optimizing patient care and outcomes.[19]

The influence of various demographic factors, including gender, department, title, job type, participation in Ai-PCA training, and marital status, was evident in the differences in knowledge, attitude, and practice scores among participants. These findings underscore the importance of tailoring strategies to address these variations and foster a more consistent and proactive adoption of Ai-PCA in clinical practice. Multivariate logistic regression further revealed that attitude, non-physician occupations, and participation in Ai-PCA training independently associated with practices. It's also noteworthy that the correlation between knowledge and practice was found to be non-significant, suggesting that possessing knowledge alone may not necessarily translate into active practice. As such, interventions should focus on enhancing not only knowledge but also attitude alignment and the active engagement of medical staff.[20,21] This can be achieved through targeted training programs, interdisciplinary collaboration, and structured initiatives that account for the diverse backgrounds and roles of healthcare professionals, ultimately promoting the optimal integration of Ai-PCA and improving patient care outcomes.[22]

The distribution of knowledge among medical staff regarding Ai-PCA reveals a combination of correct understanding and misconceptions. While there is a strong grasp of certain key aspects, such as Ai-PCA's integration of IoT and AI for intelligent pain relief and the importance of close attention to patient signs during its use, there are notable deficiencies in

understanding, such as the misconception that Ai-PCA does not design dosing plans and configure pain relief drugs on its own. These findings highlight a need to address specific knowledge gaps and dispel misconceptions through targeted educational initiatives and training programs.[23,24] Furthermore, it is essential to emphasize the holistic approach to Ai-PCA implementation, covering aspects from preoperative patient education to formal use, as a means of improving clinical practice.[25] Initiatives should focus on enhancing staff knowledge, fostering a culture of continuous learning, and promoting comprehensive quality management, with the ultimate goal of optimizing patient care and ensuring the safe and effective use of Ai-PCA in clinical settings.[26]

The distribution of attitudes among medical staff regarding Ai-PCA reveals a mix of positive and negative perceptions. While a substantial portion of the staff recognizes the importance of personnel receiving Ai-PCA training, is willing to collaborate with peers in problem-solving, and acknowledges the advantages of Ai-PCA in data feedback and patient satisfaction, there are noticeable deficiencies in attitude, such as the belief that learning Ai-PCA expert consensus and updating relevant knowledge is not very important and downplaying the significance of addressing adverse events. These findings underscore the need for initiatives to foster a more positive and informed attitude towards Ai-PCA in clinical practice. To improve clinical practice, it is essential to prioritize ongoing education and training, emphasizing the value of staying updated with expert consensus.[27,28] Additionally, there should be a focus on raising awareness about the importance of addressing adverse events, as patient safety is paramount. Encouraging a culture of open communication and collaboration among healthcare workers can further enhance the collective approach to patient care and clinical application quality, aligning with the principle of full participation. Recognizing the vast potential of Ai-PCA in enhancing healthcare quality control and pain relief quality should be a driving force in promoting a more optimistic and proactive attitude toward its use.[29–31]

The distribution of practices among medical staff in the context of Ai-PCA implementation reveals a varied landscape, with some areas exhibiting proactive behaviors while others demonstrate room for improvement. Initiatives to enhance clinical practice should target deficiencies and capitalize on existing strengths. To address these issues, a multifaceted approach is recommended. Firstly, the promotion of active knowledge acquisition through various channels, including continuous training, reading relevant literature, and fostering communication among healthcare workers, should be encouraged. Secondly, the frequency of in-house education for patients should be increased, focusing on dispelling misconceptions about medications and providing comprehensive preoperative education.[32] Thirdly, practices should be adjusted promptly based on Ai-PCA usage, with particular emphasis on inquiring about patient pain relief needs during rounds and actively responding to backend data analysis. Monitoring and reporting of suspected pain relief-related adverse reactions, coupled with case Discussions during morning meetings, can enhance patient safety. Additionally, the regular assessment of patient satisfaction and the systematic application of pain relief experiences to subsequent practices should be institutionalized.[33]

This study had limitations. First, it is a single-center study conducted at Jiangsu Cancer Hospital, which might restrict the generalizability of the findings to a wider population of anesthesia and thoracic surgery medical staff. Moreover, the study relies on self-reported data gathered through a questionnaire, which is susceptible to response bias and may not always accurately represent the actual knowledge and behavior of the participants.

In conclusion, anesthesia and thoracic surgery medical staff have sufficient knowledge, active attitudes, and poor practices toward the Ai-PCA. Implementing comprehensive training programs can bridge the gap between knowledge and practice.

Abbreviations

AI, Artificial intelligence; Ai-PCA, artificial intelligent patient-controlled analgesia; KAP, knowledge, attitude, and practice.

Data Sharing Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This work has been carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association. This study was approved by Ethics Committee of Jiangsu Cancer Hospital[2023-043], and all participants provided written informed consent.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

There is no funding to report.

Disclosure

The authors declare that they have no competing interests for this work.

References

1. Hashimoto DA, Witkowski E, Gao L, Meireles O, Rosman G. Artificial intelligence in anesthesiology: current techniques, clinical applications, and limitations. *Anesthesiology*. 2020;132(2):379–394. doi:10.1097/ALN.0000000000002960
2. Shalbaf A, Saffar M, Sleigh JW, Shalbaf R. Monitoring the depth of anesthesia using a new adaptive neurofuzzy system. *IEEE J Biomed Health Inform*. 2018;22(3):671–677. doi:10.1109/JBHI.2017.2709841
3. Wang R, Wang S, Duan N, Wang Q. From patient-controlled analgesia to artificial intelligence-assisted patient-controlled analgesia: practices and perspectives. *Front Med Lausanne*. 2020;7:145. doi:10.3389/fmed.2020.00145
4. Liu D, Li X, Nie X, et al. Artificial intelligent patient-controlled intravenous analgesia improves the outcomes of older patients with laparoscopic radical resection for colorectal cancer. *Eur Geriatric Med*. 2023;14:1403–1410. doi:10.1007/s41999-023-00873-z
5. Shouzhang S. Clinical application research of innovation leading intelligent patient-controlled analgesia. *Guangdong Med J*. 2023;44(03):265–270.
6. Liu X, Barreto EF, Dong Y, et al. Discrepancy between perceptions and acceptance of clinical decision support Systems: implementation of artificial intelligence for vancomycin dosing. *BMC Med Inf Decis Making*. 2023;23(1):157. doi:10.1186/s12911-023-02254-9
7. Krishnamoorthy S, Tr E, Muruganathan A, Ramakrishan S, Nanda S, Radhakrishnan P. The impact of cultural dimensions of clinicians on the adoption of artificial intelligence in healthcare. *J Associat Phys India*. 2022;70(1):11–12.
8. Zheng B, Wu MN, Zhu SJ, et al. Attitudes of medical workers in China toward artificial intelligence in ophthalmology: a comparative survey. *BMC Health Serv Res*. 2021;21(1):1067. doi:10.1186/s12913-021-07044-5
9. Khalid A, Haque S, Alvi S, et al. Promoting health literacy about cancer screening among Muslim immigrants in Canada: perspectives of imams on the role they can play in community. *J Prim Care Comm Health*. 2022;13:21501319211063051. doi:10.1177/21501319211063051
10. Koni A, Taha S, Daifallah A, et al. A cross-sectional evaluation of knowledge, attitudes, practices, and perceived challenges among Palestinian pharmacists regarding COVID-19. *SAGE Open Medicine*. 2022;10:20503121211069278. doi:10.1177/20503121211069278
11. Shubayr MA, Kruger E, Tennant M. Oral health providers' views of oral health promotion in Jazan, Saudi Arabia: a qualitative study. *BMC Health Serv Res*. 2023;23(1):214. doi:10.1186/s12913-023-09170-8
12. Chinese Medical Association Anesthesiology Branch. Intelligent patient-controlled pain management expert consensus" working group, Xi, Jg: expert consensus on intelligent patient-controlled pain management. *Chin J Anesthesiol*. 2018;10:1161–1165.
13. Shieh JS, Dai CY, Wen YR, Sun WZ. A novel fuzzy pain demand index derived from patient-controlled analgesia for postoperative pain. *IEEE transact Bio-med Engin*. 2007;54(12):2123–2132. doi:10.1109/TBME.2007.896584
14. Wang D, Guo Y, Yin Q, et al. Analgesia quality index improves the quality of postoperative pain management: a retrospective observational study of 14,747 patients between 2014 and 2021. *BMC Anesthesiol*. 2023;23(1):281. doi:10.1186/s12871-023-02240-8
15. Ishtiak ASM, Ahmed N, Gaffar F, Khan MAS, Yasmeen F. Knowledge, practice and associated factors of breast self-examination among female university students of Bangladesh. *Heliyon*. 2022;8(11):e11780. doi:10.1016/j.heliyon.2022.e11780
16. Turin TC, Chowdhury N, Vaska M, Rumana N, Lasker MAA, Chowdhury MZI. Knowledge mobilisation in bridging community-practice-academia -policy through meaningful engagement: systematic integrative review protocol focusing on studies conducted on health and wellness among immigrant communities. *BMJ open*. 2020;10(4):e036081. doi:10.1136/bmjopen-2019-036081
17. Al-Akash H, Abu arrah A, Bhatti F, Maabreh R, Abu Arrah R. The effect of food safety training program on food safety knowledge and practices in hotels' and hospitals' food services. *Italian J Food Safety*. 2022;11(1):9914. doi:10.4081/ijfs.2022.9914
18. Hanevold C, Halbach S, Mou J, Yonekawa K. Changing outpatient referral patterns in a small pediatric nephrology practice. *BMC Pediatric*. 2018;18(1):195. doi:10.1186/s12887-018-1164-1
19. Crigger E, Reinbold K, Hanson C, Kao A, Blake K, Irons M. Trustworthy augmented intelligence in health care. *J Med Syst*. 2022;46(2):12. doi:10.1007/s10916-021-01790-z
20. Cheewakriangkrai C, Kietpeerakool C, Charoenkwan K, et al. Health education interventions to promote early presentation and referral for women with symptoms of endometrial cancer. *Cochrane Database Syst Rev*. 2020;3(3):Cd013253. doi:10.1002/14651858.CD013253.pub2

21. Noroozi F, Fararouei M, Kojuri J, Ghahremani L, Ghodrati K. Salt consumption and blood pressure in rural hypertensive participants: a community filed trial. *Sci World J*. 2022;2022:2908811. doi:10.1155/2022/2908811
22. Zhang Y, Weng Y, Lund J. Applications of Explainable Artificial Intelligence in Diagnosis and Surgery. *Diagnostics*. 2022;12(2):1.
23. Melino S, Mormone E. On the interplay between the medicine of Hildegard of Bingen and modern medicine: the role of estrogen receptor as an example of biodynamic interface for studying the chronic disease's complexity. *Front Neurosci*. 2022;16:745138. doi:10.3389/fnins.2022.745138
24. Zhou W, Zheng Q, Huang M, et al. Knowledge, attitude, and practice toward delirium and subtype assessment among Chinese clinical nurses and determinant factors: a multicentre cross-section study. *Frontiers in Psychiatry*. 2022;13:1017283. doi:10.3389/fpsyt.2022.1017283
25. Mackova Porter D, Al Harbi M, Tawfeeq NA, Pokorna A. Awareness of general nurses in management of postoperative pain through patient controlled analgesia - comparison among the Czech Republic and the Kingdom of Saudi Arabia. *Saudi J Anaesth*. 2022;16(1):10–16. doi:10.4103/sja.sja_318_21
26. Cooper TE, Hambleton IR, Ballas SK, Johnston BA, Wiffen PJ. Pharmacological interventions for painful sickle cell vaso-occlusive crises in adults. *Cochrane Database Syst Rev*. 2019;2019(11). doi:10.1002/14651858.CD012187.pub2
27. Bagnasco A, Costa A, Catania G, et al. Improving the quality of communication during handover in a paediatric emergency department: a qualitative pilot study. *J Prev Med Hyg*. 2019;60(3):E219–E225. doi:10.15167/2421-4248/jpmh2019.60.3.1042
28. Boyer MS, Widmer D, Cohidon C, et al. Representations of personalised medicine in family medicine: a qualitative analysis. *BMC Prim Care*. 2022;23(1):37. doi:10.1186/s12875-022-01650-w
29. Esmaeilzadeh P. Use of AI-based tools for healthcare purposes: a survey study from consumers' perspectives. *BMC Med Inf Decis Making*. 2020;20(1):170. doi:10.1186/s12911-020-01191-1
30. Kim S, Lee H, Lee S, Song JY, Lee JK, Lee NW. Role of Artificial Intelligence Interpretation of Colposcopic Images in Cervical Cancer Screening. *Healthcare*. 2022;10(3):1.
31. Nittari G, Khuman R, Baldoni S, et al. Telemedicine practice: review of the current ethical and legal challenges. *Telemed J e-health*. 2020;26(12):1427–1437. doi:10.1089/tmj.2019.0158
32. Jiang F, Liu Y, Hu J, Chen X. Understanding health empowerment from the perspective of information processing: questionnaire study. *J Med Inter Res*. 2022;24(1):e27178. doi:10.2196/27178
33. Duc Thanh N, My Anh BT, Xiem CH, et al. Patient Satisfaction with healthcare service quality and its associated factors at one polyclinic in Hanoi, Vietnam. *Internat J Public Health*. 2022;67:1605055. doi:10.3389/ijph.2022.1605055