

Pain and Perioperative Management: Awareness in Intrathecal Baclofen Pump Care

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Abstract

Background: Intrathecal baclofen (ITB) pumps are increasingly used for the management of severe spasticity across a range of neurological conditions. Interruption of ITB delivery can precipitate a life-threatening withdrawal syndrome with a reported case-fatality rate of up to 22% in FDA-reported episodes. Despite this, there is no published evidence evaluating perioperative clinical staff knowledge of ITB pumps, and no standardised training pathway exists at most institutions. **Objectives:** To assess baseline knowledge and confidence among non-specialist clinical staff regarding intrathecal baclofen pump identification, perioperative management, and complication recognition; to deliver a targeted teaching intervention; and to evaluate the impact of that intervention using a validated pre/post survey design. **Methods:** A prospective pre/post intervention study was conducted at a single institution. Anonymous questionnaire surveys were administered to 41 clinical staff (interns, SHOs, registrars, and SpRs) immediately before and after a structured teaching session on the perioperative management of ITB pumps. Outcomes assessed included awareness, confidence, knowledge retention, specialist referral awareness, and teaching session evaluation. **Results:** Pre-education, only 31.7% of participants were aware that ITB delivery interruption can cause life-threatening withdrawal. Confidence in perioperative management was critically low, with 73.2% reporting they were not confident and 0% very confident. Following the teaching session, 100% of participants achieved confident or very confident ratings in both preoperative identification (56.1% very confident) and perioperative management (87.8% very confident). All 41 participants (100%) correctly identified baclofen withdrawal on a knowledge test, and 100% knew who to contact for specialist advice. 92.7% reported the session improved their perioperative awareness, and 100% rated it as useful or very useful. **Conclusions:** This study identifies a significant and previously

unquantified knowledge gap regarding the perioperative management of intrathecal baclofen pumps among non-specialist clinical staff. A single targeted teaching session produced uniform, dramatic improvements in knowledge, confidence, and specialist referral awareness across all training grades. These findings strongly support the integration of ITB pump perioperative management into formal training curricula and the development of institutional guidelines.

Keywords

Intrathecal Baclofen, Perioperative Management, Baclofen Withdrawal, Spasticity, Medical Education, Knowledge Assessment, Patient Safety

1. Introduction

Spasticity is a common and often debilitating consequence of upper motor neuron injury arising from conditions including cerebral palsy, multiple sclerosis (MS), spinal cord injury (SCI), traumatic brain injury (TBI), and stroke. Epidemiological data confirm the scale of the problem: spasticity affects approximately 80% of patients with cerebral palsy [1], 80% - 84% of those with MS [2], 65% - 93% of those with SCI within one year of injury [3], and up to 38% of survivors of severe TBI [4]. Following stroke, a pooled prevalence of 25.3% has been reported across cohort studies, rising to 39.5% among patients with paresis [5].

For patients with severe, medically refractory spasticity, intrathecal baclofen (ITB) therapy delivered via an implanted programmable pump represents a well-established, evidence-based treatment modality. Penn and Kroin first described intrathecal baclofen delivery for spinal spasticity in 1984 [6], and the pivotal randomised double-blind crossover trial demonstrated significant reductions in Ashworth scores and spasm frequency [7]. The therapy was FDA-approved for spinal-origin spasticity in 1992, and for cerebral-origin spasticity subsequently. Globally, over 60,000 ITB pumps have been implanted.

Patients with ITB pumps are not confined to specialist neurology or rehabilitation settings. As the ITB pump population grows, these patients present with increasing frequency across a wide range of surgical and anaesthetic contexts—for procedures unrelated to their primary neurological condition, for revision or replacement of the pump itself, and for management of associated complications. Yet the perioperative literature on ITB pumps consists almost exclusively of case reports, expert commentary, and one systematic review [8], with no published randomised trials or formal guidelines.

The most serious perioperative risk is inadvertent interruption of ITB delivery. Abrupt cessation precipitates intrathecal baclofen withdrawal syndrome (IBWS), a medical emergency characterised by rebound spasticity, fever, autonomic instability, altered mental status, and—if untreated—rhabdomyolysis, multi-organ failure, and death [9]. FDA postmarketing surveillance data identified a case-fatality

rate of approximately 22% among reported withdrawal episodes, and the agency responded by mandating a boxed warning in 2002. Coffey *et al.* concluded that most severe withdrawal events were preventable and that human error was a causal or contributing factor in the majority of cases [10].

Despite this, no published peer-reviewed study has formally assessed the knowledge of perioperative clinical staff regarding ITB pumps. Evidence from analogous domains—most notably cardiac implantable electronic devices (CIEDs)—documents formal knowledge gaps among anaesthesia practitioners [11]. The inference for rarer devices such as ITB pumps, encountered less frequently but carrying equal or greater risk when mismanaged, is compelling.

This study sought to quantify baseline ITB pump knowledge and confidence among a cohort of non-specialist perioperative clinical staff, deliver a targeted structured education intervention, and evaluate its impact using a validated pre/post survey design aligned with the Kirkpatrick model of educational evaluation [12].

2. Background and Literature Review

2.1. Intrathecal Baclofen Therapy: Mechanism and Indications

Baclofen is a selective GABA-B receptor agonist that inhibits monosynaptic and polysynaptic reflexes at the spinal cord level by reducing excitatory neurotransmitter release presynaptically and hyperpolarising dorsal horn neurons postsynaptically [13]. Oral baclofen is limited in efficacy by dose-dependent central side effects including sedation and cognitive impairment. Intrathecal delivery bypasses the blood-brain barrier, achieving CSF concentrations approximately 100 times higher than oral administration at doses less than 1/100th of oral doses, thus providing superior spasticity control with a substantially improved side-effect profile [14].

The ITB pump is a titanium implant typically placed subcutaneously in the abdominal wall, with a catheter tunneled subcutaneously and inserted intrathecally at the lumbar level. The pump is refilled percutaneously via a central reservoir port, typically every 1 - 6 months, and programmed via an external telemetry wand. Typical daily doses range from 90 - 800 µg depending on spasticity aetiology and severity, compared with the typical oral dose of 40 - 80 mg/day [15]. A 4:1 lumbar-to-cisternal concentration gradient preferentially treats lower-extremity spasticity.

The landmark 2016 Best Practices Consensus, published across four papers in *Neuromodulation* by 21 multidisciplinary ITB clinicians managing over 3200 patients, provides the most comprehensive current clinical guidance on patient selection, screening, dosing, and troubleshooting [15]-[17].

2.2. Baclofen Withdrawal Syndrome: A Patient Safety Emergency

Intrathecal baclofen withdrawal syndrome represents one of the most serious patient safety risks associated with implanted drug delivery systems. The clinical syndrome progresses rapidly: early features (hours) include pruritus, hypoten-

sion, and return of baseline spasticity; intermediate features (1 - 3 days) include hyperthermia (documented up to 43°C), tachycardia, profuse diaphoresis, hypertension, and altered mental status; advanced features include seizures, rhabdomyolysis, disseminated intravascular coagulation, multi-organ failure, and death [15].

The syndrome can mimic neuroleptic malignant syndrome, malignant hyperthermia, and sepsis, creating substantial diagnostic difficulty—particularly for clinicians who may not be aware the patient has an ITB pump [18]. Delayed or missed diagnosis is the principal driver of the high case-fatality rate. Treatment requires definitive restoration of intrathecal baclofen delivery, with bridging measures including high-dose benzodiazepines, cyproheptadine, and—in refractory cases—dexmedetomidine or propofol [19] [20].

Withdrawal can be precipitated by catheter fracture, catheter displacement, pump battery failure, missed refill appointments, programming errors, or mechanical pump failure. The most common cause is catheter malfunction, accounting for approximately 40% of reported episodes [16]. A national survey of physicians found that approximately 75% of centres lacked formal protocols for managing anticipated baclofen delivery interruption [21].

2.3. Perioperative Considerations for ITB Pump Patients

The published literature on perioperative management of ITB pump patients is almost exclusively composed of case reports and expert commentary, reflecting the relative rarity of formal evidence. Saleh *et al.* (2025) provide the most recent practical guide, and Nadherny *et al.* (2019) conducted a systematic review of 42 articles covering procedural considerations including MRI, electrocautery, radiation therapy, and general perioperative care [8] [22].

Key perioperative principles include: early device identification and documentation; coordination with the ITB-managing specialist; ensuring adequate reservoir volume prior to scheduled procedures; continuation of ITB infusion intraoperatively in the vast majority of cases; avoidance of shortwave diathermy near the pump; temperature monitoring to avoid pump hyperthermia (>39°C can accelerate drug delivery); and postoperative monitoring for withdrawal symptoms with a low threshold for specialist review [8] [22] [23].

Anaesthetic interactions are clinically relevant. Baclofen potentiates CNS depressants including opioids and benzodiazepines, and patients on ITB may demonstrate greater-than-expected responses to inhalational agents. A case report described severe seizures following propofol induction in an ITB pump patient [23]. Regional anaesthesia requires careful planning with fluoroscopic guidance, placing needles caudal to the catheter entry point [24].

2.4. Evidence for Educational Interventions in Perioperative Medicine

The medical education literature robustly supports pre/post survey methodology for evaluating targeted knowledge interventions. Mazmanian and Davis reviewed

28 controlled studies of continuing medical education (CME) and found 79% demonstrated improvements in physician knowledge [25]. The Cochrane review by Forsetlund *et al.* confirmed that interactive educational formats consistently outperform didactic ones, and multi-component interventions produce stronger and more durable effects [26].

In perioperative and anaesthesia settings specifically, pre/post designs have demonstrated knowledge improvements of 24% - 32% following targeted sessions [27]. Studies measuring parallel knowledge and confidence outcomes consistently show improvements in both domains, with even single-session interventions producing statistically significant gains [28] [29]. The Kirkpatrick model—measuring Reaction, Learning, Behaviour, and Results—provides an accepted evaluation framework for structured medical education programmes [12].

3. Aims and Objectives

3.1. Primary Aim

To assess baseline knowledge and clinical confidence among non-specialist perioperative clinical staff regarding intrathecal baclofen pump identification and management, and to evaluate the impact of a structured teaching session on these outcomes.

3.2. Secondary Objectives

- To quantify the proportion of staff unaware of the life-threatening risk of baclofen withdrawal syndrome prior to education.
- To assess confidence in both preoperative identification and perioperative management before and after the intervention.
- To evaluate knowledge retention using a post-education multiple-choice question.
- To determine whether participants could identify appropriate specialist referral pathways following the intervention.
- To assess participant satisfaction with the teaching session and its perceived educational value.
- To provide data to support the development of institutional protocols and the integration of ITB pump management into perioperative training curricula.

4. Methods

4.1. Study Design

A prospective single-cohort pre/post intervention study was conducted. Participants completed an anonymous questionnaire survey immediately prior to a structured teaching session (pre-education survey) and a second survey immediately following the session (post-education survey). This design permits within-participant comparison of knowledge and confidence outcomes, aligns with Kirkpatrick Level 2 evaluation (Learning), and is the most widely used design in post-

graduate medical education research.

4.2. Setting and Participants

The study was conducted at a single institution. Participants were non-specialist clinical staff spanning four training grades: intern, senior house officer (SHO), registrar, and specialist registrar (SpR). A total of 41 participants completed both surveys. Participation was voluntary and anonymous (**Table 1, Figure 1**).

Table 1. Participant training grade distribution.

Training Grade	n	%
Intern	3	7.3%
Senior House Officer (SHO)	18	43.9%
Registrar	11	26.8%
Specialist Registrar (SpR)	9	22.0%
Total	41	100%

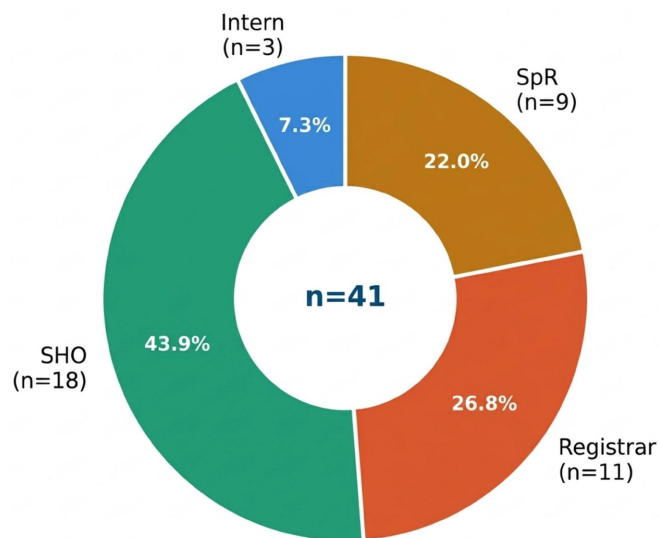


Figure 1. Training grade distribution of study participants (n = 41).

4.3. Educational Intervention

The educational intervention consisted of a structured teaching session specifically designed to address perioperative management of patients with intrathecal baclofen pumps. Content covered the following domains:

- Mechanism of action, indications, and device components of ITB therapy
- Preoperative identification of ITB pump patients and documentation requirements
- Perioperative risks and the clinical syndrome of intrathecal baclofen withdrawal
- Intraoperative management principles including pump continuation, electro-

- cautery, and temperature monitoring
- Postoperative monitoring and recognition of early withdrawal signs
- Specialist referral pathways and emergency management of suspected withdrawal

4.4. Survey Instruments

The pre-education survey, as represented in **Table A1**, comprised seven items assessing: baseline awareness that ITB pumps are used for spasticity management; prior clinical exposure to ITB pump patients; confidence in preoperative identification (four-point Likert scale: very confident, somewhat confident, neutral, not confident); awareness of life-threatening withdrawal risk; confidence in perioperative management (four-point Likert scale); and interest in further education on this topic.

The post-education survey comprised eight items assessing: overall understanding of ITB pumps following the session (four-point Likert scale); confidence in preoperative assessment (four-point Likert scale); confidence in perioperative management (four-point Likert scale); a multiple-choice knowledge question on complications of ITB delivery interruption (baclofen withdrawal, hypoglycaemia, or pulmonary embolism); awareness of specialist referral pathways; whether the session improved perioperative awareness; and overall session usefulness (four-point Likert scale: very useful, useful, neutral, not useful).

4.5. Statistical Analysis

Descriptive statistics were used throughout, with results presented as frequencies and percentages. Given the non-parametric ordinal nature of Likert-scale confidence data, comparisons between pre- and post-education responses are presented graphically using grouped and stacked bar charts. The study was designed as a quality improvement and educational evaluation project and was exempt from formal ethical review under institutional policy; all participation was voluntary and anonymous.

5. Results

5.1. Pre-Education Findings: Baseline Awareness and Knowledge

5.1.1. Awareness of ITB Pumps in Spasticity Management

The majority of participants (80.5%, $n = 33$) were aware prior to the teaching session that intrathecal baclofen pumps are used in the management of spasticity. A minority (19.5%, $n = 8$) were not aware. Despite this general awareness, very few had direct clinical experience: only 17.1% ($n = 7$) reported having previously encountered a patient with an ITB pump in clinical practice, while 82.9% ($n = 34$) had not (**Figure 2**, **Figure 3**).

5.1.2. Awareness of Life-Threatening Withdrawal Risk

A critical finding was the very low baseline awareness of the risk of life-threatening baclofen withdrawal syndrome following delivery interruption. Only 31.7% (n

= 13) of participants were aware of this risk. A further 22.0% (n = 9) were unsure, and 46.3% (n = 19) were completely unaware. Taken together, 68.3% of clinical staff had insufficient awareness of this potentially fatal complication—representing a significant patient safety knowledge gap (Figure 4, Table 2).

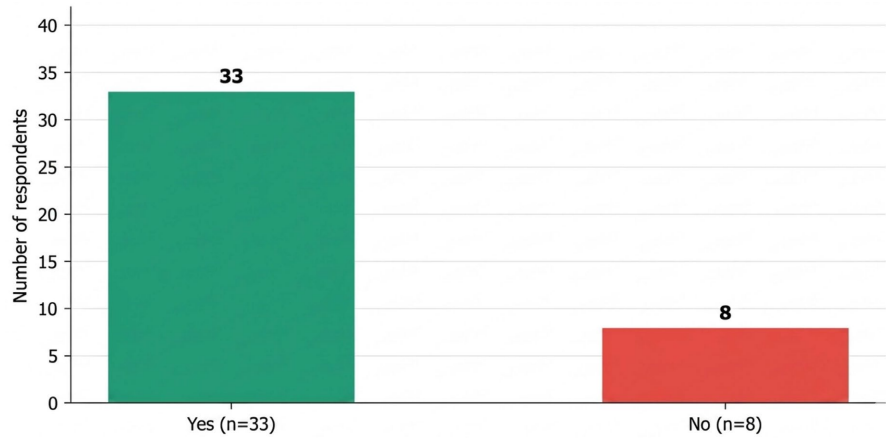


Figure 2. Pre-education awareness that ITB pumps are used for spasticity management.

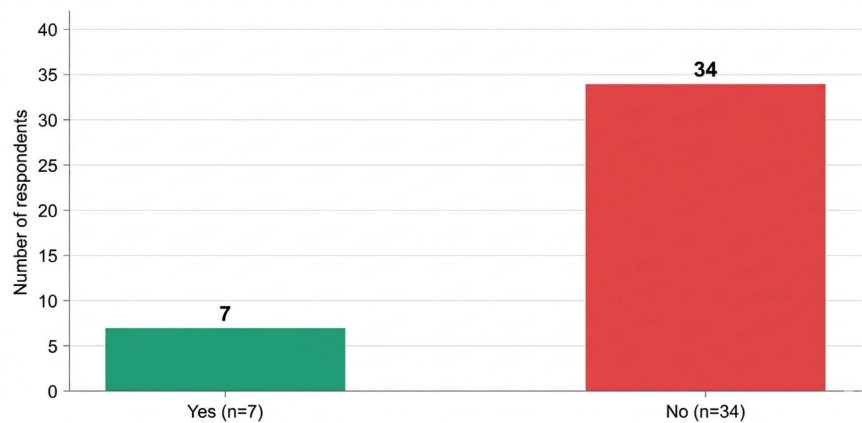


Figure 3. Prior clinical exposure to a patient with an intrathecal baclofen pump.

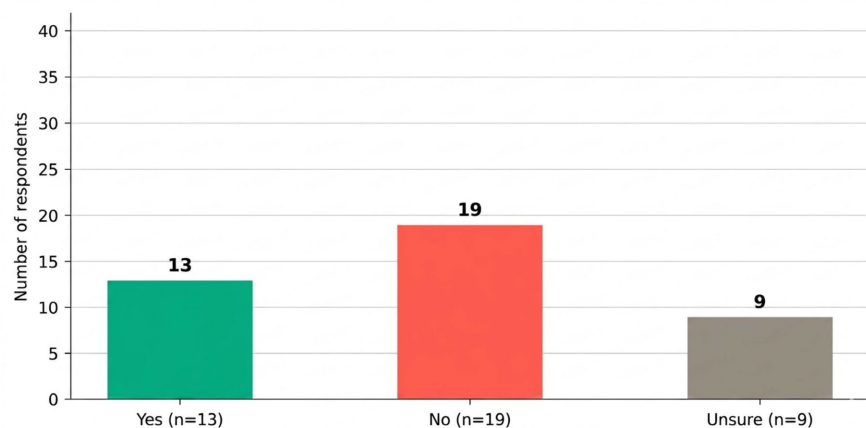


Figure 4. Pre-education awareness of life-threatening baclofen withdrawal risk.

Table 2. Pre-education baseline awareness and knowledge outcomes (n = 41).

Knowledge/Awareness Domain	Yes	No	Unsure/N/A
Aware ITB pumps used for spasticity?	33 (80.5%)	8 (19.5%)	—
Previously encountered an ITB pump patient?	7 (17.1%)	34 (82.9%)	—
Aware ITB interruption causes withdrawal?	13 (31.7%)	19 (46.3%)	9 (22.0%)

5.2. Pre-Education Confidence Levels

Baseline confidence in both domains of perioperative ITB pump management was strikingly low, with a marked concentration of responses at the lowest confidence level (Table 3).

Table 3. Pre-education confidence levels in preoperative identification and perioperative management (n = 41).

Confidence Level	Pre-op Identification (n)	Pre-op Identification (%)	Periop Management (n)	Periop Management (%)
Very Confident	0	0.0%	0	0.0%
Somewhat Confident	11	26.8%	0	0.0%
Neutral	6	14.6%	11	26.8%
Not Confident	24	58.5%	30	73.2%

5.2.1. Confidence in Preoperative Identification

No participant (0%) rated themselves as very confident in identifying an ITB pump patient during preoperative assessment. 26.8% (n = 11) were somewhat confident, 14.6% (n = 6) were neutral, and 58.5% (n = 24) were not confident. Accordingly, 73.2% of participants had insufficient confidence (neutral or not confident) in this core perioperative task.

5.2.2. Confidence in Perioperative Management

Confidence in perioperative management was even critically lower. No participant (0%) was very confident, and no participant (0%) was even somewhat confident in the perioperative management of ITB pump patients. 26.8% (n = 11) were neutral, and 73.2% (n = 30) were not confident—meaning no participant at any training grade had positive confidence in perioperative management prior to the intervention.

5.2.3. Interest in Further Education

The demand for further education on this topic was overwhelming. 95.1% (n = 39) of participants indicated they would be interested in further teaching or guidelines on the perioperative management of intrathecal baclofen pumps. 4.9% (n = 2) responded “maybe”. No participant indicated they would not be interested in further education (Figure 5).

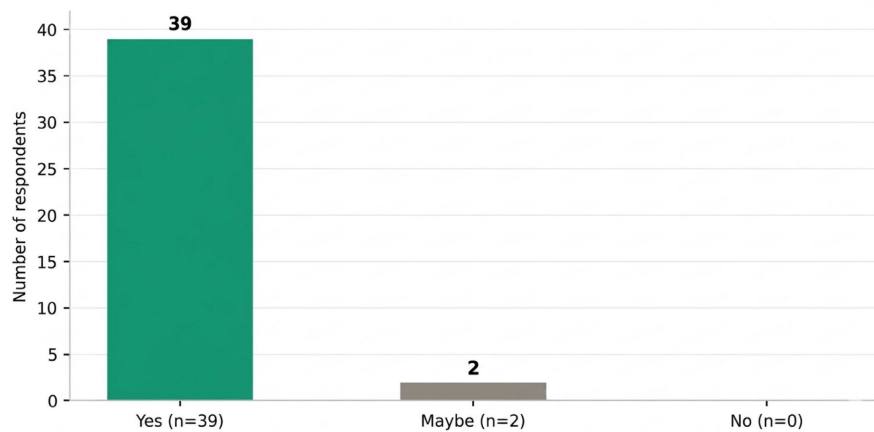


Figure 5. Interest in further teaching or guidelines on perioperative ITB management (pre-education).

5.3. Post-Education Confidence Levels

Following the teaching session, confidence shifted dramatically across all assessed domains, with a complete elimination of the “not confident” category in both perioperative identification and management (Table 4).

Table 4. Post-education confidence levels in preoperative identification and perioperative management (n = 41).

Confidence Level	Pre-op Identification (n)	Pre-op Identification (%)	Periop Management (n)	Periop Management (%)
Very Confident	23	56.1%	36	87.8%
Somewhat Confident	18	43.9%	5	12.2%
Neutral	0	0.0%	0	0.0%
Not Confident	0	0.0%	0	0.0%

5.3.1. Confidence in Preoperative Identification

Post-education, 56.1% (n = 23) of participants were very confident and 43.9% (n = 18) were somewhat confident in pre-operative identification of ITB pump patients. No participant (0%) was neutral or not confident. This represents a transformation from a baseline where 73.2% were neutral or not confident to a post-intervention state where 100% reported positive confidence.

5.3.2. Confidence in Perioperative Management

The shift in perioperative management confidence was even more marked. Post-education, 87.8% (n = 36) were very confident and 12.2% (n = 5) were somewhat confident. No participant was neutral or not confident—a complete reversal from the pre-education baseline where 100% of participants had insufficient confidence (neutral or not confident) in perioperative management (Figures 6-8).

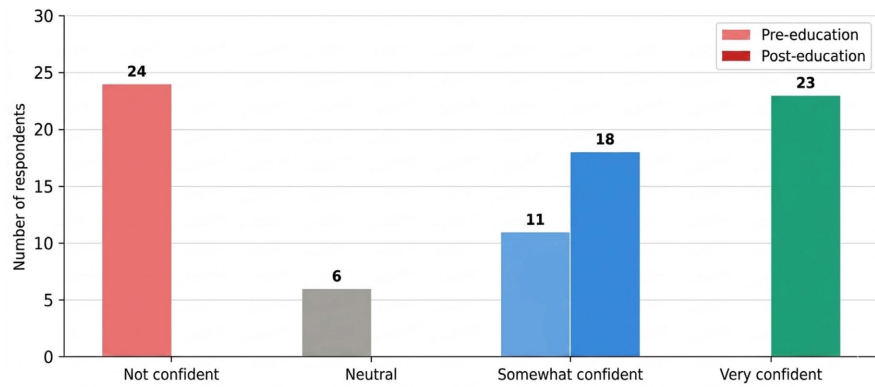


Figure 6. Confidence in preoperative identification of ITB pump patients—pre vs post education.

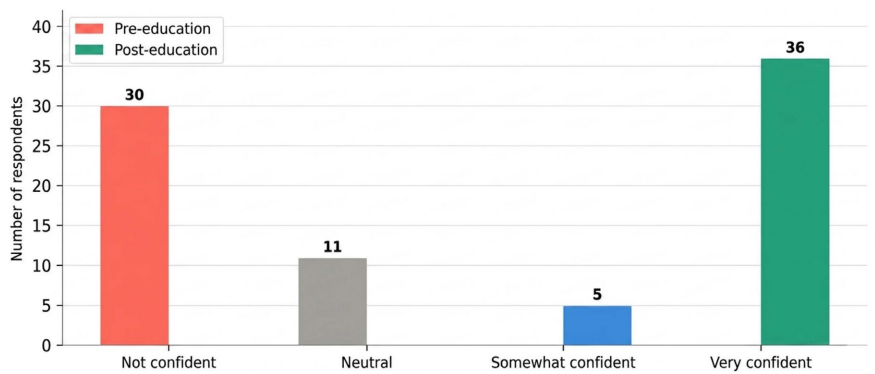


Figure 7. Confidence in perioperative management of ITB pump patients—pre vs post education.

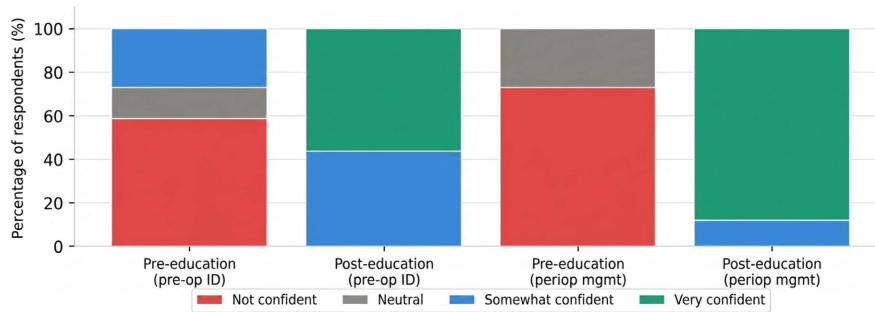


Figure 8. Full confidence distribution (%) pre vs post education across both domains.

5.3.3. Overall Post-Education Understanding

When asked to rate their overall understanding of intrathecal baclofen pumps following the session, 75.6% (n = 31) rated themselves as very confident and 24.4% (n = 10) as somewhat confident. No participant was neutral or not confident in their overall understanding (Figure 9).

5.4. Post-Education Knowledge Assessment

A multiple-choice question asked participants to identify the potential complica-

tion of interruption of intrathecal baclofen delivery from three options: baclofen withdrawal (correct answer), hypoglycaemia, and pulmonary embolism. All 41 participants (100%) correctly identified baclofen withdrawal as the answer, in contrast to the pre-education baseline where only 31.7% had baseline awareness of this risk. No participant selected either incorrect option (Figures 10-12, Table 5).

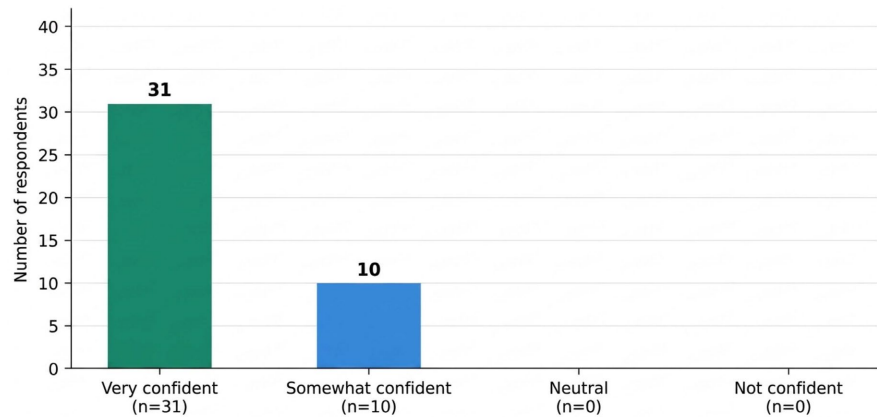


Figure 9. Post-education overall understanding of intrathecal baclofen pump.

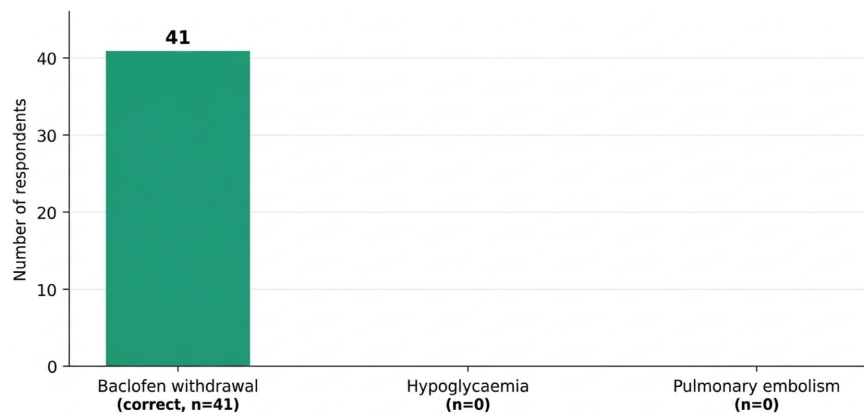


Figure 10. Post-education knowledge test: complication of ITB delivery interruption (n = 41).

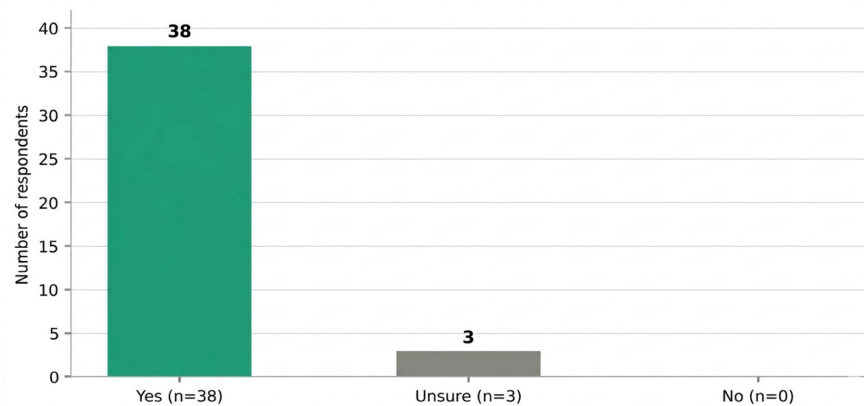


Figure 11. Post-education: Did the teaching session improve perioperative awareness?

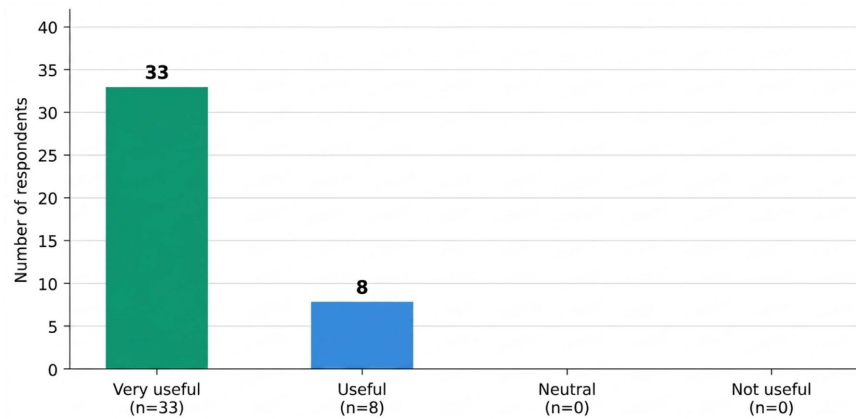


Figure 12. Post-education: Overall usefulness of the teaching session.

Table 5. Post-education outcome summary (n = 41).

Post-Education Outcome	n	%
Session improved perioperative awareness—Yes	38	92.7%
Session improved perioperative awareness—Unsure	3	7.3%
Session improved perioperative awareness—No	0	0.0%
Overall usefulness—Very useful	33	80.5%
Overall usefulness—Useful	8	19.5%
Overall usefulness—Neutral or Not useful	0	0.0%
100% correct on knowledge test (withdrawal)	41	100%
Know specialist contact post-education	41	100%

5.5. Specialist Referral Awareness

Following the teaching session, 100% of participants (n = 41) reported that they would know who to contact for specialist advice if they encountered a patient with an intrathecal baclofen pump in the perioperative setting. No participant responded “no”. This outcome is particularly clinically important, as rapid specialist escalation is the key first step in managing suspected withdrawal syndrome.

5.6. Teaching Session Evaluation

5.6.1. Impact on Perioperative Awareness

92.7% (n = 38) of participants stated that the teaching session improved their awareness of perioperative considerations for patients with intrathecal baclofen pumps. 7.3% (n = 3) were unsure. No participant indicated the session had not improved their awareness.

5.6.2. Overall Session Usefulness

The session was rated as useful or very useful by 100% of participants. 80.5% (n = 33) rated it as very useful, and 19.5% (n = 8) as useful. No participant rated the session as neutral or not useful.

5.7. Summary: Confidence Shift across All Domains

Figure 13 summarises the proportion of respondents meeting threshold knowledge or confidence criteria across all domains, comparing pre- and post-education values. The most striking shifts were in perioperative management confidence (0% → 100% positive confidence) and knowledge of withdrawal risk (31.7% pre-education → 100% post-education knowledge test score) (**Figure 13**).

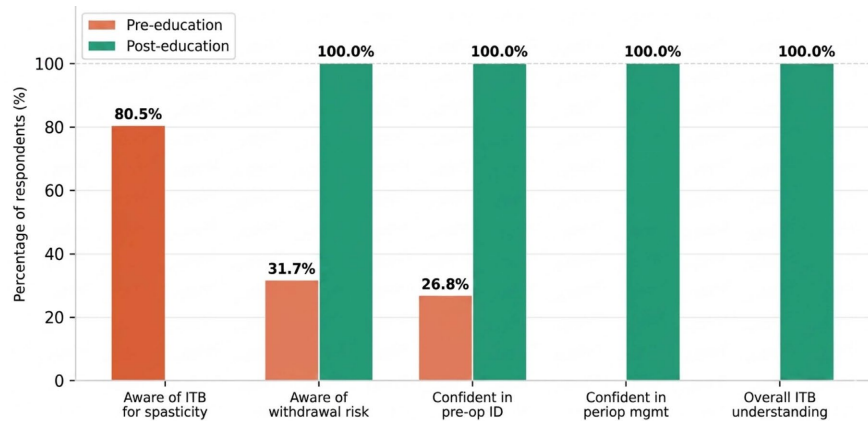


Figure 13. Summary: % of respondents meeting knowledge/confidence threshold—pre vs post education.

6. Discussion

6.1. Principal Findings

This study makes two principal contributions. First, it provides the first formal quantification of the perioperative knowledge gap regarding intrathecal baclofen pumps among non-specialist clinical staff. Second, it demonstrates that a single structured teaching session can produce dramatic, uniform improvements in knowledge, confidence, and specialist referral awareness across all training grades.

The pre-education data paint a concerning picture. While the majority of participants (80.5%) were aware that ITB pumps are used for spasticity in general terms, only 17.1% had ever directly encountered an ITB pump patient in clinical practice. More critically, 68.3% were either unaware or unsure that ITB delivery interruption can cause life-threatening withdrawal syndrome—the very complication most likely to arise in a perioperative setting and the one most likely to cause serious harm if not recognised promptly.

6.2. The Patient Safety Significance of the Knowledge Gap

The clinical stakes of this knowledge gap cannot be overstated. Intrathecal baclofen withdrawal syndrome has a documented case-fatality rate of approximately 22% in FDA-reported episodes, and Coffey *et al.* explicitly concluded that human error played a causal or contributing role in the majority of withdrawal events, and that most episodes were preventable [10]. A clinician who does not know the patient has an ITB pump, does not know what withdrawal looks like, or does not

know who to call for specialist advice, cannot be expected to prevent or manage this complication safely.

The finding that 73.2% of participants were not confident in perioperative management—with no participant at any training grade reporting very high confidence—validates this concern. Unlike many knowledge gaps that are theoretical, this one is directly actionable: the pump can be identified before surgery, infusion can be maintained intraoperatively, and specialist advice can be sought proactively. The knowledge gap, therefore, creates preventable risk.

This finding aligns with evidence from analogous domains. Stone *et al.* documented that many anaesthesia practitioners caring for patients with cardiac implantable electronic devices lacked the knowledge and skills to independently manage them perioperatively [11]. If knowledge gaps are formally documented for CIEDs—devices that are far more common and better incorporated into medical curricula—the inference for rare devices like ITB pumps is even more concerning. A national survey by Schmitz *et al.* found that approximately 75% of sites lacked established protocols for anticipated baclofen delivery interruption [21], corroborating the absence of institutional infrastructure to support safe management.

6.3. Interpretation of Post-Education Outcomes

The post-education results, as represented in **Table A2**, are remarkable. The complete elimination of the “not confident” category across both preoperative identification (from 58.5% to 0%) and perioperative management (from 73.2% to 0%) following a single session is a clinically meaningful, not merely statistically notable, result. The 100% score on the knowledge test, combined with 100% awareness of specialist referral pathways, suggests that the teaching content was both comprehensive and well-targeted to the critical knowledge deficits identified at baseline.

These outcomes are consistent with the broader medical education literature, which demonstrates that interactive, targeted teaching sessions produce reliable improvements in both knowledge and confidence [25] [26]. Studies measuring parallel confidence and knowledge outcomes consistently show improvements in both domains following even single-session interventions [28] [29]. The effect sizes observed in this study—a zero-to-maximum shift in management confidence and a doubling of withdrawal risk awareness—are at the upper end of what has been reported in comparable educational intervention studies.

6.4. Demand for Education and Implications for Training

The near-unanimous pre-education demand for further teaching (95.1%) is itself an important finding. It indicates not only that participants recognised the knowledge gap—a prerequisite for meaningful engagement with educational content—but also that they were motivated to address it. This represents an optimal condition for educational interventions, which are most effective when learners are aware of, and concerned by, their own knowledge deficit.

The results strongly support the integration of ITB pump perioperative man-

agement into standardised anaesthetic and surgical training curricula. Currently, ITB pump management is not a mandated topic in most postgraduate training programmes in anaesthesia or surgery, and there is no widely-adopted institutional protocol. The evidence presented here—that clinical staff at all training grades, including specialist registrars, were not confident in this area before a targeted teaching session—provides a clear rationale for change.

Beyond training integration, these findings support the development of accessible bedside reference resources—including algorithmic guidelines for perioperative ITB management and clear escalation pathways—that can serve as just-in-time decision support for clinicians who encounter these patients in any setting.

6.5. Limitations

This study has several limitations that should be acknowledged in interpreting its findings. First, the pre- and post-surveys were administered at a single time point, and long-term knowledge retention was not assessed. Given the well-documented decay of knowledge following educational interventions, follow-up assessment at 3 and 6 months would substantially strengthen the conclusions, and would allow assessment of Kirkpatrick Level 3 (Behaviour change) outcomes.

Second, the study was conducted at a single institution with a relatively small sample ($n = 41$), limiting generalisability. A multi-centre study would enable stratified analysis by training grade and specialty, allowing identification of subgroups with the greatest baseline knowledge deficit and differential response to the intervention.

Third, the pre/post survey design without a control group introduces the possibility of response shift bias—where participants rate their pre-education confidence lower in retrospect after gaining knowledge (a “response shift”). However, given the floor-level pre-education scores (0% very confident in perioperative management), this bias would if anything underestimate the true baseline deficit rather than overestimate the post-education improvement.

Fourth, self-reported confidence, while a validated and widely-used outcome measure in medical education research, does not directly measure clinical performance. Direct observation of clinical behaviour or simulation-based assessment would provide stronger evidence of translatable competency gains.

Fifth, the study does not capture outcomes beyond the immediate post-session period, and cannot confirm whether the teaching session resulted in changes to clinical practice (Kirkpatrick Level 3) or patient outcomes (Kirkpatrick Level 4). Future work should incorporate prospective clinical follow-up.

7. Conclusions

This study identifies and quantifies a significant perioperative patient safety knowledge gap regarding intrathecal baclofen pumps among non-specialist clinical staff. Prior to a targeted educational intervention, 68.3% of participants were unaware or unsure of the life-threatening risk of baclofen withdrawal syndrome,

and no participant at any training grade was confident in perioperative ITB pump management. These deficits exist despite the documented 22% case-fatality rate associated with withdrawal in FDA-reported episodes, and despite evidence that the majority of withdrawal events are preventable.

A single structured teaching session produced uniform, dramatic improvements across all measured outcomes. All 41 participants (100%) achieved correct knowledge test scores and positive confidence ratings in both preoperative identification and perioperative management. All participants knew who to contact for specialist advice, and 100% rated the session as useful or very useful.

These findings provide a clear evidence base for three institutional priorities: the integration of ITB pump perioperative management into formal postgraduate training curricula in anaesthesia and surgery; the development of accessible institutional guidelines and escalation pathways for perioperative ITB management; and the conduct of multi-centre studies with longer follow-up to evaluate knowledge retention and behavioural change. Given the growing population of patients with implanted ITB devices and the high stakes of inadequate perioperative management, the case for urgent action is compelling.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix: Complete Survey Results

Table A1. Pre-Education survey—full results (n = 41).

Question	Response	n	%
Q1. Training level	Intern	3	7.3%
	SHO	18	43.9%
	Registrar	11	26.8%
	SpR	9	22.0%
Q2. Aware ITB pumps used for spasticity?	Yes	33	80.5%
	No	8	19.5%
Q3. Previously encountered ITB pump patient?	Yes	7	17.1%
	No	34	82.9%
Q4. Confidence in pre-op identification	Very Confident	0	0.0%
	Somewhat Confident	11	26.8%
	Neutral	6	14.6%
	Not Confident	24	58.5%
Q5. Aware ITB interruption causes withdrawal?	Yes	13	31.7%
	No	19	46.3%
	Unsure	9	22.0%
Q6. Confidence in perioperative management	Very Confident	0	0.0%
	Somewhat Confident	0	0.0%
	Neutral	11	26.8%
	Not Confident	30	73.2%
Q7. Interest in further teaching?	Yes	39	95.1%
	No	0	0.0%
	Maybe	2	4.9%

Table A2. Post-Education survey—full results (n = 41).

Question	Response	n	%
Q1. Overall understanding post-teaching	Very Confident	31	75.6%
	Somewhat Confident	10	24.4%
	Neutral	0	0.0%
	Not Confident	0	0.0%
Q2. Confidence in pre-op assessment	Very Confident	23	56.1%
	Somewhat Confident	18	43.9%
	Neutral	0	0.0%
	Not Confident	0	0.0%
Q3. Confidence in perioperative management	Very Confident	36	87.8%
	Somewhat Confident	5	12.2%
	Neutral	0	0.0%
	Not Confident	0	0.0%
Q4. Knowledge test: ITB complication	Baclofen Withdrawal (correct)	41	100%
	Hypoglycaemia	0	0.0%
	Pulmonary Embolism	0	0.0%
Q5. Know who to contact for specialist advice?	Yes	41	100%
	No	0	0.0%
Q6. Teaching session improved awareness?	Yes	38	92.7%
	No	0	0.0%
	Unsure	3	7.3%
Q7. Overall usefulness of session	Very Useful	33	80.5%
	Useful	8	19.5%
	Neutral	0	0.0%
	Not Useful	0	0.0%