ORIGINAL RESEARCH

To study the Clinical and Forensic Insights into Anesthetic Drug Use in Suspected Pediatric Abuse

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ABSTRACT

Aim: This study aimed to evaluate the clinical and forensic patterns of anesthetic drug usage in suspected cases of pediatric abuse. The objective was to analyze the types, dosages, and safety of anesthetics used during forensic and clinical procedures, and to assess the psychological and physiological impact on pediatric patients. **Materials and Methods:** This prospective observational study was conducted over one year, involving 120 pediatric patients aged 1 to 15 years, who were referred to the forensic unit with suspected cases of physical, sexual, emotional, or combined forms of abuse. Data collection included patient demographics, types of abuse, anesthetic drugs administered (e.g., propofol, sevoflurane, fentanyl, midazolam, dexmedetomidine), dosage patterns (high vs. low), and the total duration of anesthesia. Vital signs were monitored during anesthesia, and post-anesthetic recovery times, adverse drug reactions (ADRs), and complications were recorded. Two anesthesia protocols were followed: general anesthesia for major procedures and sedation for less invasive forensic examinations. Surgical parameters and forensic implications were also assessed. **Results:** Of the 120 patients, the largest age group was 6-10 years (41.67%), with a slight male predominance (54.17%). Physical abuse was the most common type (45.83%), followed by sexual abuse (37.50%). Propofol (54.17%) was the most commonly used anesthetic, followed by sevoflurane (37.50%) and fentanyl (33.33%). Dosage patterns showed that propofol and sevoflurane were administered in higher doses for more complex procedures. Most patients (70.83%) recovered from anesthesia within 60 minutes, and 66.67% experienced no ADRs. Nausea and vomiting were the most common ADRs (12.50%), followed by hypotension (8.33%). Minor surgeries accounted for 58.33% of the surgical interventions, with the majority lasting less than an hour. Psychological stress markers were observed in 25% of the patients during forensic examinations. **Conclusion:** This study highlights the critical role of anesthesia in facilitating clinical and forensic evaluations in suspected pediatric abuse cases. Propofol, sevoflurane, and fentanyl were the most commonly used anesthetics, tailored to the complexity of the procedures. Careful monitoring and individualized anesthetic protocols ensured the safety and emotional well-being of pediatric patients. Future research is needed to further refine anesthetic practices in these sensitive cases.

Keywords: Pediatric abuse, anesthetic drugs, forensic examination, propofol, sedation

INTRODUCTION

The administration of anesthesia plays a pivotal role in pediatric healthcare, especially in cases where children require medical procedures under difficult circumstances. One of the most sensitive and challenging areas where anesthesia is employed is in the forensic and clinical evaluation of suspected pediatric abuse. The usage of anesthetic drugs in such cases is not only crucial for managing the child's physical pain but also for alleviating psychological distress and ensuring the thoroughness of medical and forensic examinations. Patterns of anesthetic drug usage in pediatric abuse cases are influenced by multiple factors, including the severity of the abuse,

the medical and emotional needs of the child, the type of procedure being conducted, and the specific responses of pediatric patients to anesthesia.[1] Pediatric abuse, encompassing physical, sexual, emotional, and psychological harm, often necessitates medical and forensic evaluations to document injuries, provide treatment, and collect evidence for legal proceedings. These evaluations may involve invasive procedures that can be distressing for the child, making the administration of anesthesia or sedation essential. Anesthetic protocols in such cases are carefully chosen to balance the need for effective pain management, the reduction of psychological trauma, and the need for accurate forensic documentation.[2] In cases of suspected physical abuse, children may present with injuries such as fractures, lacerations, bruising, or internal trauma. These injuries may require diagnostic imaging, surgical intervention, or other invasive procedures to assess the full extent of the damage. Anesthetic drugs, such as propofol or sevoflurane, are commonly used in general anesthesia protocols to induce unconsciousness and ensure the child remains immobile and unaware during procedures. Sedatives like midazolam and dexmedetomidine are also used to reduce anxiety and provide mild to moderate sedation, especially in cases where full anesthesia may not be necessary. The choice of anesthetic drug and dosage is influenced by the child's medical history, the extent of their injuries, and the complexity of the forensic or medical procedures.[3] Sexual abuse cases present unique challenges in pediatric anesthesia. The physical examinations required to collect forensic evidence of sexual abuse can be invasive and traumatizing, especially for younger children. Anesthesia is often used to ensure the child is not subjected to further emotional harm during these evaluations. The use of sedatives or general anesthetics in sexual abuse cases must be carefully managed to avoid adverse psychological effects while ensuring the child's comfort and safety. Additionally, anesthetic protocols in these cases must consider the potential for underlying injuries, such as trauma to the genital or rectal areas, which may require surgical intervention.[4] Emotional and psychological abuse, while less likely to result in physical injuries requiring medical treatment, still demands a sensitive approach to anesthesia. Children who have experienced severe emotional abuse may exhibit heightened anxiety, fear, and resistance to medical procedures. In such cases, sedatives like midazolam or dexmedetomidine are used to help the child relax and to minimize distress during medical or forensic examinations. The primary goal in these situations is to create a calm environment that enables the healthcare provider to conduct the necessary assessments without causing further psychological harm.[5]

The dosage patterns of anesthetic drugs in pediatric abuse cases are another key aspect of anesthesia management. Children vary widely in their responses to anesthesia, with factors such as age, weight, medical history, and emotional state all playing a role in determining the appropriate drug dosage. High doses of anesthetics like propofol or sevoflurane may be required for more invasive procedures, while lower doses may suffice for mild sedation during forensic evaluations. The anesthesiologist's ability to tailor the dosage to the individual child is crucial in minimizing risks such as over-sedation, respiratory depression, or adverse drug reactions.[6] Monitoring and safety during the administration of anesthesia in suspected abuse cases is paramount. Pediatric patients are at a higher risk of complications during anesthesia due to their smaller body size, developing physiology, and varying emotional responses. Continuous monitoring of vital signs, including heart rate, blood pressure, oxygen saturation, and end-tidal CO2, is essential to ensure the child's safety during and after the procedure. Any signs of distress, adverse drug reactions, or complications must be promptly addressed to avoid long-term harm. Additionally, post-anesthetic recovery times are closely monitored, with most children recovering within 30 to 60 minutes after the procedure. However, for more complex cases involving high doses or longer surgeries, recovery may take longer, and the child may require extended observation to ensure a full and safe recovery.[7,8] Forensic implications also play a critical role in the patterns of anesthetic drug usage in pediatric abuse cases. The thoroughness of forensic examinations, including the collection of physical evidence and documentation of injuries, is directly influenced by the effectiveness of anesthesia in minimizing the child's movement and distress. Anesthesia allows healthcare providers to conduct a more accurate and detailed examination, which is crucial for legal proceedings and the long-term safety of the child.

MATERIALS AND METHODS

This research was designed as observational study aimed at evaluating the patterns of anesthetic drug usage in suspected cases of pediatric abuse. The study included a total of 120 pediatric patients, ranging from 1 to 15 years of age, who were referred to the forensic unit of the hospital on suspicion of physical, sexual, emotional, or combined forms of abuse. These patients underwent clinical or forensic procedures that required the administration of anesthesia.

Inclusion Criteria

- Pediatric patients aged between 1 to 15 years.
- Children referred to the forensic unit with suspected abuse.
- Cases where anesthesia was required for forensic examination or clinical intervention.
- Informed consent obtained from legal guardians for study participation.

Exclusion Criteria

- Children with pre-existing neurological or psychiatric disorders.
- Patients with known allergies to anesthetic drugs.
- Children with chronic illnesses or immunosuppressive conditions.
- Cases where legal consent was not obtained.

Methodology

This prospective observational study collected data from medical records, anesthesia charts, and forensic reports of pediatric patients suspected of abuse. Demographic information, including age, gender, weight, and relevant medical history, was recorded. Cases were categorized by the type of abuse suspected physical, sexual, emotional, or a combination. Anesthetic drug usage was documented, focusing on the types of drugs administered, such as general anesthetics (propofol, sevoflurane, fentanyl) or sedatives (midazolam, dexmedetomidine), and dosage patterns (both high and low doses). The total duration of anesthesia was also recorded, along with vital signs monitored during anesthesia, such as heart rate, blood pressure, and oxygen saturation. Post-anesthesia recovery data, including sedation levels, recovery time, and any complications or adverse drug reactions (ADRs), were collected.

Anesthesia Protocols:

Two anesthetic protocols were applied based on clinical needs. **General anesthesia (GA)** was used for major forensic or surgical interventions that required deep sedation or general anesthesia. Drugs like propofol, sevoflurane, fentanyl, and muscle relaxants were used in these cases. **Sedation** was applied for less invasive forensic examinations, using midazolam and dexmedetomidine to manage anxiety and allow thorough examination.

Surgical Parameters:

In cases where surgical intervention was necessary due to abuse-related injuries, surgical parameters such as the type of surgery, its duration, and outcomes were meticulously documented. The study also recorded post-surgical recovery times, any complications, and whether further medical or forensic interventions were required.

Forensic Implications:

Forensic examinations were conducted to confirm abuse, and anesthesia was frequently required to alleviate distress and anxiety in children, enabling thorough examinations. The study also explored correlations between the type of abuse and the anesthetic protocol chosen for both forensic and surgical procedures.

Outcome Measures:

The primary and secondary outcome measures included the prevalence and types of anesthetic drugs used, focusing on high and low dosage patterns. Post-anesthetic recovery times were evaluated along with complications or ADRs. Forensic and surgical parameters were examined to assess the association between anesthetic drug use, type of abuse, forensic findings, and surgical outcomes. Observations were also made on the psychological and physiological responses to anesthesia, such as stress markers and clinical responses, to evaluate the emotional and physical impact on the pediatric patients. Throughout the anesthesia procedures, vital signs, including heart rate, blood pressure, oxygen saturation, and end-tidal CO_2, were continuously monitored to ensure patient safety. Any adverse events or complications were closely observed, and post-anesthetic recovery was monitored to track ADRs or complications that occurred during the recovery phase.

Statistical Analysis

The collected data were analyzed using SPSS version 25.0. Descriptive statistics were used to summarize demographic data, anesthetic usage, and outcome measures. Continuous variables, such as age, weight, and anesthesia duration, were presented as means ± standard deviations (SD). Categorical variables, including gender, type of abuse, and adverse reactions, were expressed as frequencies and percentages. Comparative statistical analyses were performed using chi-square tests for categorical data and independent t-tests for continuous data, with a significance level of $p<0.05$ considered statistically significant.

RESULTS

Demographic Characteristics of Pediatric Patients: Table 1 outlines the demographic characteristics of the 120 pediatric patients. The largest age group represented was children aged 6-10 years, accounting for 41.67% (n=50) of the sample. Patients aged 1-5 years made up 33.33% (n=40), while those aged 11-15 years comprised 25% (n=30). The gender distribution shows a slight predominance of male patients (54.17%, n=65) compared to females (45.83%, n=55). The average weight of the children was 24.5 ± 5.6 kg, indicating a broad range of body sizes, which is important for tailoring anesthetic doses. Among the types of abuse suspected, physical abuse was the most common (45.83%, n=55), followed by sexual abuse (37.50%, n=45). Emotional abuse and combination cases accounted for 8.33% (n=10) each. These figures underscore the prevalence of physical and sexual abuse among pediatric patients requiring anesthesia for forensic and medical evaluations.

Types of Anesthetic Drugs Used: Table 2 presents the types of anesthetic drugs administered to the 120 pediatric patients. Propofol was the most frequently used drug, administered to 54.17% (n=65) of the patients, followed by sevoflurane at 37.50% (n=45), and fentanyl at 33.33% (n=40). Sedative drugs, including midazolam (25%, n=30) and dexmedetomidine (16.67%, n=20), were also commonly used, primarily for less invasive procedures. Muscle relaxants were employed in

12.50% (n=15) of the cases, likely reflecting their use in more complex surgical or forensic interventions. These findings highlight the preference for propofol as a general anesthetic agent in pediatric patients and the frequent use of sevoflurane and fentanyl in combination.

Dosage Patterns (High vs. Low) of Anesthetic Drugs: Table 3 provides information on the dosage patterns of anesthetic drugs. Propofol was given in high doses to 37.50% (n=45) of patients and in low doses to 16.67% (n=20). Sevoflurane followed a similar pattern, with 25% (n=30) receiving high doses and 12.50% (n=15) receiving low doses. Fentanyl was administered in high doses to 20.83% (n=25) and in low doses to 12.50% (n=15). For both midazolam and dexmedetomidine, the high- and low-dose groups were evenly distributed, with 12.50% (n=15) receiving each dosage pattern. This table illustrates that high-dose administration was more common for propofol, sevoflurane, and fentanyl, particularly for longer and more complex procedures.

Post-Anesthetic Recovery Times: Table 4 examines the recovery times following anesthesia. A significant portion of patients (37.50%, n=45) recovered within 30 minutes, while 33.33% (n=40) had recovery times of 30-60 minutes. A smaller group (20.83%, n=25) required 60-120 minutes to recover, and only 8.33% (n=10) had recovery times exceeding 120 minutes. These findings suggest that most children recovered from anesthesia within an hour, but longer recovery periods were necessary for certain patients, likely depending on the anesthetic drugs and procedures used.

Incidence of Adverse Drug Reactions (ADRs): Table 5 addresses the incidence of ADRs in the study. A majority of patients (66.67%, n=80) experienced no ADRs. However, 12.50% (n=15) reported nausea and vomiting, 8.33% (n=10) experienced hypotension, and 4.17% (n=5) had bradycardia. Additionally, 8.33% (n=10) suffered from allergic reactions. These results indicate that while the majority of pediatric patients tolerated anesthesia well, some experienced common side effects such as nausea and hypotension, underscoring the need for careful monitoring during and after anesthetic administration.

Surgical Parameters: Table 6 provides data on surgical parameters for the 60 patients who required surgical intervention. Most of these surgeries were minor (58.33%, n=35), while 41.67% (n=25) were classified as major surgeries. The majority of surgeries (66.67%, n=40) lasted less than an hour, with 25% (n=15) taking between 1 and 2 hours. Only 8.33% (n=5) of surgeries exceeded 2 hours. These findings highlight that while surgical intervention was necessary in about half of the cases, most surgeries were minor and relatively short in duration.

Forensic and Psychological Implications: Table 7 explores forensic and psychological implications. Among the suspected abuse cases, 45.83% (n=55) involved physical abuse, 37.50% (n=45) were related to sexual abuse, and emotional abuse and combination cases each accounted for 8.33% (n=10). Psychological stress responses, as indicated by elevated stress markers, were observed in 25% (n=30) of the patients, while 75% (n=90) did not exhibit notable stress markers. These results suggest that a significant minority of abused children exhibit psychological stress during anesthetic procedures, reflecting the emotional toll of their traumatic experiences.

Table 1: Demographic Characteristics of Pediatric Patients

Parameter	n = 120	Percentage (%)
Age Group		
1-5 years	40	33.33%
6-10 years	50	41.67%
11-15 years	30	25.00%
Gender		
Male	65	54.17%
Female	55	45.83%
Weight (kg)		
Mean ± SD	24.5 ± 5.6	-
Type of Abuse Suspected		
Physical	55	45.83%
Sexual	45	37.50%
Emotional	10	8.33%
Combination	10	8.33%

Table 2: Types of Anesthetic Drugs Used in Pediatric Abuse Cases

Anesthetic Drugs	n = 120	Percentage (%)
Propofol	65	54.17%
Sevoflurane	45	37.50%
Fentanyl	40	33.33%
Midazolam	30	25.00%

Dexmedetomidine	20	16.67%
Muscle Relaxants	15	12.50%

Table 3: Dosage Patterns (High vs. Low) of Anesthetic Drugs

Drug	High Dose (n)	Percentage (%)	Low Dose (n)	Percentage (%)
Propofol	45	37.50%	20	16.67%
Sevoflurane	30	25.00%	15	12.50%
Fentanyl	25	20.83%	15	12.50%
Midazolam	15	12.50%	15	12.50%
Dexmedetomidine	10	8.33%	10	8.33%

Table 4: Post-Anesthetic Recovery Times

Recovery Time	n = 120	Percentage (%)
< 30 minutes	45	37.50%
30-60 minutes	40	33.33%
60-120 minutes	25	20.83%
> 120 minutes	10	8.33%

Table 5: Incidence of Adverse Drug Reactions (ADRs)

ADR	n = 120	Percentage (%)
None	80	66.67%
Nausea/Vomiting	15	12.50%
Hypotension	10	8.33%
Bradycardia	5	4.17%
Allergic Reactions	10	8.33%

Table 6: Surgical Parameters

Surgical Procedure	n = 60 (out of 120)	Percentage (%)
Minor Surgery	35	58.33%
Major Surgery	25	41.67%
Duration of Surgery		
< 1 hour	40	66.67%
1-2 hours	15	25.00%
> 2 hours	5	8.33%

Table 7: Forensic and Psychological Implications

Implication	n = 120	Percentage (%)
Type of Abuse		
Physical Abuse	55	45.83%
Sexual Abuse	45	37.50%
Emotional Abuse	10	8.33%
Combination of Abuse	10	8.33%
Psychological Stress Response		
Observed (high stress markers)	30	25.00%
Not observed	90	75.00%

DISCUSSION

The distribution of age and gender in this study reflects findings from other similar research. The largest age group (6-10 years, 41.67%) aligns with a study by Hornor et al. (2021), which found that children aged 6-11 were the most common victims of pediatric abuse presenting in medical settings.[9] The slight male predominance (54.17%) also aligns with data from Sedlak et al. (2010), which showed higher rates of reported physical abuse in male children, although sexual abuse tends to be equally distributed across genders.[10] In this study, physical abuse was the most prevalent (45.83%), followed by sexual abuse (37.50%). These findings are consistent with Finkelhor et al. (2020), which identified physical abuse as the most common form of child abuse in medical evaluations, but with increasing rates of sexual abuse cases requiring forensic analysis.[11]

The prevalence of propofol use (54.17%) is comparable to studies such as those by Bailey et al. (2020), where propofol was the most frequently administered anesthetic in pediatric cases due to its rapid onset and short duration.[12] Sevoflurane, used in 37.50% of cases here, has similarly been favored in

pediatric anesthesia due to its minimal respiratory irritation and smooth recovery profile, as supported by research from Tobias et al. (2019).[13] The use of fentanyl (33.33%) mirrors findings from Roberts et al. (2020), where opioids were frequently administered in combination with general anesthetics to manage procedural pain.[14] These studies also underscore the rising use of dexmedetomidine (16.67%) and midazolam (25%) in less invasive forensic procedures, consistent with our findings, where both sedatives were employed for milder sedation needs, particularly in forensic examinations.

Our findings showed that high doses of propofol (37.50%) and sevoflurane (25%) were more frequently used, particularly in longer or more invasive procedures. This pattern aligns with studies like Vargo et al. (2017), which highlighted the necessity of higher doses of anesthetics in complex pediatric surgeries or forensic cases.[15] Similar trends were observed for fentanyl, where 20.83% of patients required higher doses. According to Roberts et al. (2020), higher doses of fentanyl are generally reserved for more invasive procedures or when prolonged sedation is necessary.[14] Interestingly, the balanced use of high and low doses of midazolam and dexmedetomidine (12.50% each) was observed, reflecting current anesthetic trends where these drugs are often used in adjustable dosages based on the child's stress and anxiety levels, as reported by Tobias et al. (2019).[13]

Our study found that 70.83% of patients recovered from anesthesia within 60 minutes, with a large proportion (37.50%) recovering in less than 30 minutes. These findings are consistent with pediatric anesthesia literature, where rapid recovery times are associated with the use of short-acting agents like propofol and sevoflurane (Bailey et al., 2020).[12] Cravero et al. (2019) found similar recovery patterns in pediatric patients undergoing minor surgical procedures or forensic examinations.[16] The 8.33% of patients who required more than 120 minutes to recover likely reflect cases where deeper anesthesia or longer procedures were necessary, a finding also noted by Vargo et al. (2017), where recovery times extended in proportion to the complexity of the procedure and the depth of anesthesia used.[15]

The majority of patients (66.67%) experienced no ADRs, consistent with research by Roberts et al. (2020), which reported similarly high tolerance levels for pediatric anesthetics.[14] Nausea and vomiting (12.50%) were the most common ADRs, aligning with data from Apfel et al. (2019), where nausea and vomiting were noted as common side effects, particularly when opioids like fentanyl were used.[17] The incidence of hypotension (8.33%) and bradycardia (4.17%) was comparable to findings from Tobias et al. (2019), where these cardiovascular effects were linked to the use of high-dose propofol and fentanyl in pediatric patients.[13] The occurrence of allergic reactions (8.33%) was slightly higher than in other studies but still within expected ranges, as documented by Roberts et al. (2020).[14]

Our study found that 58.33% of the surgeries were minor, with most lasting less than an hour (66.67%). This correlates with research by Cravero et al. (2019), where shorter, less invasive procedures, such as minor surgeries related to abuse injuries, were common in pediatric forensic settings. Major surgeries accounted for 41.67%, aligning with findings by Sedlak et al. (2010), which reported that a significant portion of pediatric abuse cases required surgical intervention for trauma management, though most procedures were relatively brief, lasting under two hours.[10]

Among the abuse cases, physical abuse was most common (45.83%), followed by sexual abuse (37.50%), which is consistent with epidemiological data from Finkelhor et al. (2020) that highlights these two forms as the leading causes of forensic evaluation in children.[11] The observation of psychological stress responses in 25% of cases underscores the emotional toll of forensic evaluations on children. This is supported by studies like Hornor et al. (2021), which found that a significant proportion of abused children exhibit signs of psychological stress during medical and forensic procedures, necessitating the use of sedatives to manage anxiety and distress.[9] The use of dexmedetomidine and midazolam in such cases has been well-documented for their anxiolytic effects, as reported by Tobias et al. (2019).[13]

CONCLUSION

In conclusion, this observational study on the patterns of anesthetic drug usage in suspected cases of pediatric abuse highlights the critical role of anesthesia in facilitating both clinical and forensic evaluations. The most commonly used anesthetics, including propofol, sevoflurane, and fentanyl, were administered based on the type of abuse and the complexity of the procedures required. The study underscores the importance of tailored anesthetic protocols to ensure the safety, comfort, and emotional well-being of pediatric patients, while also enabling thorough forensic assessments. Future research is needed to further optimize anesthetic practices in these sensitive cases, ensuring better outcomes for affected children.

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