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ORIGINAL RESEARCH

From Limited Use to Standard Practice: Retrospective Analysis of Droperidol Administration by Emergency Medical Services (2018–2023)

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Video Abstract

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Objective: This retrospective observational study investigates the usage trends of droperidol (a dopamine receptor antagonist) by Emergency Medical Services (EMS) from 2018 to 2023, focusing on its evolving role in prehospital care.

Methods: Using the ESO Solutions, Inc. (ESO) national dataset, we analyzed 56,232,761 EMS cases over six years, examining the rates of droperidol administration by EMS clinicians. We assessed systolic blood pressure (SBP) and heart rate abnormalities after administration, and usage across primary impressions, procedures, and airway interventions. The total database cases grew from 5,536,297 in 2018 to 13,957,073 in 2023, with participating agencies increasing from 1,234 to 3,068.

Results: Our findings show an increase in droperidol administration, with doses rising from one in 2018 to 22,372 by 2023. The fraction of doses per million cases increased from 0.18 in 2018 to 1,603 in 2023. Droperidol usage grew from <0.01% of cases in 2018 to 0.2% in 2023. Primary impressions most associated with droperidol use were Behavioral/Psychiatric (23.4%), Pain (16.1%), and Neurological (13.8%). Among procedures, 12-lead ECG (21.7%) and patient restraint (21.1%) were most frequent. For cases receiving ECGs, top impressions were Gastrointestinal (34.0%) and Neurological (26.0%), with common age ranges being 60–69 (16.7%) and 50–59 (16.6%). Within airway management, oxygen administration was used in 69.40% of cases, followed by ETCO2 capnography (16.1%). Post-administration, 77.3% of patients maintained normal SBP, while 10.2% experienced hypotension and 12.4% hypertension. Regarding heart rate, 69.7% exhibited normal rates, with bradycardia in 13.4% and tachycardia in 17.0%.

Conclusion: Increasing droperidol utilization by EMS reflects growing adoption in clinical practice. This research highlights the need for ongoing emphasis on evidence-based practices in prehospital care, and advocating for enhanced training and protocol development. Limitations include potential underreporting and variability in protocol adherence, suggesting the need for further investigation into usage barriers and facilitators.

Keywords: droperidol, emergency medical services, prehospital care, conscious sedation, agitation, EMS pharmacology

Introduction

Droperidol has long been recognized for its effectiveness in managing agitation, nausea, and psychosis in emergency department settings. Its rapid onset of action and reliable sedative properties make it a valuable tool for clinicians handling acute, agitated patients. Additionally, droperidol has been utilized in various procedures for its antiemetic and tranquilizing effects,[1–8] contributing significantly to patient care in controlled environments. Pharmacologically, droperidol is a butyrophenone derivative classified as a typical antipsychotic that exerts its effects primarily through dopamine D2 receptor antagonism, with additional alpha-adrenergic and serotonergic activity. When administered parenterally, it has a rapid onset of action within minutes and a moderate duration of effect. Reported adverse effects include sedation, hypotension, extrapyramidal symptoms, and QT interval prolongation.

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Beyond its primary use as a sedative, droperidol has shown promise in other medical applications. Recent studies suggest potential analgesic benefits, particularly in the management of acute pain scenarios.[9,10] Its versatile pharmacological profile extends its utility to a broader spectrum of emergency care. In hospital settings, droperidol use is guided by physician oversight and continuous monitoring, whereas prehospital use has historically been more limited and variable, reflecting differences in EMS protocols, monitoring capabilities, and scope of practice. In most EMS systems, droperidol administration is restricted to paramedics operating under established medical oversight protocols, which may include online or offline physician direction, standardized dosing ranges, and requirements for monitoring vital signs and cardiac rhythm. Understanding these operational and procedural considerations is important for interpreting prehospital droperidol use.

Despite the documented benefits of droperidol in hospital settings, its application in the prehospital environment remains underexplored; current literature highlights its role in the treatment of agitated patients.[1,2,6,11–14] The dynamic and often unpredictable nature of prehospital care requires medications that are both effective and safe for field use. Studying usage of droperidol in this context is crucial for optimizing patient outcomes, as it could provide EMS personnel with a reliable option for managing agitation and other symptoms before hospital admission.

The primary objective of this retrospective observational study is to investigate the evolving role of droperidol in prehospital care over a six-year period. Specifically, the study aims to quantify trends in droperidol administration over time, identify the primary clinical impressions and procedures associated with its use, evaluate the impact of droperidol on key physiological parameters such as systolic blood pressure and heart rate, and analyze trends in EMS agency participation and case volumes to contextualize the observed increases in droperidol usage.

Methods

Study Design and Setting

This study is a retrospective descriptive analysis aimed at characterizing the use and outcomes of droperidol administration in the prehospital setting.

Data Source

Data for this study were obtained from ESO Solutions, Inc. (ESO), a widely used electronic patient care record (ePCR) system utilized by EMS agencies across the United States. The dataset contains standardized fields capturing patient demographics, vital signs, clinical impressions, medications administered, interventions, and transport details. Data entry is guided by standardized templates and mandatory fields, ensuring consistency across EMS agencies. While minor variations exist between agencies, the dataset represents a consistent minimum dataset for key variables such as vital signs, medication administration, and primary impressions. The dataset includes information on 56,232,761 prehospital care incidents across 6 years.

Urbanicity was classified using the ESO dataset variable, which assigns agencies to urban, suburban, or rural categories based on Centers for Medicare & Medicaid Services (CMS) defined population criteria. These classifications were used to evaluate whether patterns of droperidol administration differed by geographic context.

Inclusion/Exclusion Criteria

Inclusion criteria were as follows: Adult patients (aged 18 years and older), patients who received droperidol during prehospital care, and cases with complete documentation on patient demographics, indications for droperidol administration, and patient response post-administration. Exclusion criteria included patients under 18 years of age, cases where droperidol was administered outside of the prehospital setting (eg, prior to EMS arrival), and records lacking critical information on droperidol administrations.

Outcomes

The primary outcome of interest was the rate of droperidol administration. Secondary outcomes included primary impressions; patient response post-administration, quantified through changes in vital signs using standard clinical

definitions (tachycardia: heart rate >100 bpm; bradycardia: heart rate <60 bpm; hypertension: systolic >140 mmHg or diastolic >90 mmHg; hypotension: systolic <90 mmHg or diastolic <60 mmHg); the frequency of medical procedures performed concurrently with droperidol use; the prevalence of airway interventions, both invasive and noninvasive; and temporal trends in droperidol utilization over the study period. For vital sign analyses, only patients with both pre- and post-administration measurements were included. Patients with pre-existing abnormalities (tachycardia, bradycardia, hypertension, or hypotension) at baseline were excluded to focus the analysis on changes that occurred following droperidol administration.

Statistical Analysis

Python was utilized to extract selected data from the ESO research datasets, and to perform statistical analyses. Descriptive statistics were employed to summarize and characterize the indications for droperidol use and primary and secondary outcomes. This included calculating frequencies, percentages, means, and standard deviations where appropriate. Trend analysis was performed to examine the patterns and rate of droperidol utilization over the study period (2018–2023). This included assessing changes in the frequency of droperidol administration and identifying any significant shifts in practice patterns among EMS clinicians. For analyses of physiological responses, only cases with both pre- and post-administration vital signs were included. Patients lacking a complete set of pre- and post-administration values were excluded from the vital sign analyses but were still included in overall demographic summaries and descriptive statistics.

A Priori Variable Framework

An a priori variable framework was established to guide data extraction and analysis, based on the study objectives, prior literature, and the structure of the ESO dataset. Variables were selected to characterize patient demographics, clinical presentation, intervention details, and outcome measures associated with prehospital droperidol administration.

Key demographic variables included age, sex, race/ethnicity, weight, and urbanicity of EMS response. Clinical presentations were captured through primary and secondary EMS impressions. Intervention-related variables encompassed droperidol dose, use of airway interventions, application of physical restraints, and electrocardiogram (ECG) performance following administration. Outcome measures were defined a priori and included changes in systolic blood pressure and heart rate, and the presence of any additional EMS procedures.

This structured template informed both data extraction and the descriptive analyses and ensured consistency in coding and interpretation throughout the study. All variables were identified prior to conducting statistical analysis.

This study involved the use of de-identified, retrospective data, and as such, individual patient consent was not required. The research was conducted in compliance with relevant regulations and institutional guidelines to ensure the privacy and confidentiality of patient information. Approval from the University of Missouri Institutional Review Board (IRB) was obtained prior to data extraction and analysis.

Results

Demographics

Demographic information of patients who received droperidol and were included in the analysis are highlighted in Table 1. A total of 23,632 adult patients received droperidol in the prehospital setting between 2018 and 2023. The cohort was approximately evenly split by sex (49.1% female, 48.5% male, 2.4% unknown) and predominantly White/Caucasian (58.0%), with Black/African (20.7%) and Hispanic/Latino (11.7%) patients representing the largest minority groups. Most patients were classified as non-Hispanic/Latino (73.6%), with 14.9% having unknown ethnicity. Regarding geographic context, the majority of encounters occurred in urban areas (96.5%), with smaller proportions in rural (2.1%) and super rural (1.4%) locations.

Table 1 Demographic Characteristics of Adult Patients Who Received Droperidol in the Prehospital Setting (2018–2023)

Variables	All
n	23,632
Sex	
Female	11593 (49.1%)
Male	11464 (48.5%)
Unknown	575 (2.4%)
Race	
White/Caucasian	13712 (58.0%)
Black/African	4879 (20.7%)
Hispanic/Latino	2767 (11.7%)
American Indian, AK	447 (1.9%)
Asian	333 (1.4%)
HI Pac Island	108 (0.5%)
Unknown	1386 (5.9%)
Ethnicity	
Not Hispanic/Latino	17398 (73.6%)
Hispanic/Latino	2711 (11.5%)
Unknown	3523 (14.9%)
Urbanicity	
Urban	22797 (96.5%)
Rural	500 (2.1%)
Super Rural	335 (1.4%)
Unknown	0 (0.00%)

Notes: Demographic information of patients who received droperidol and were included in the analysis are highlighted in Table 1.

Primary Outcome

Droperidol use has increased over the analyzed time period, even when corrected for the growing size of the ESO database. Table 2 displays the number of total doses per year, as well as correction for the number of cases included over time. The sharpest increase in droperidol administration occurred in 2021; the percentage increase in administration of droperidol per million cases from 2020 to 2023 is 2868.9%. A Poisson regression on the raw counts of droperidol administration to address the low counts in early years and control for total population size confirmed a statistically significant increase in droperidol administration over time ($p < 0.01$).

Secondary Outcomes

The top three primary impressions reported by EMS clinicians prior to droperidol administration were categorized as behavioral/psychiatric (23.6%), pain (16.1%), and neurological (13.8%), with further characterization displayed in Table 3.

Table 2 Yearly Frequency and Rate of Droperidol Administration in the Prehospital Setting (2018–2023)

Year	2018	2019	2020	2021	2022	2023	Total
Count (doses)	1	59	464	4575	15,444	22,372	42915
Percentage (doses/cases)	<0.01%	<0.01%	<0.01%	0.05%	0.1%	0.2%	0.08%
Doses/Million Cases	0.2	8.0	54.0	476.3	1389.2	1602.9	763.2
Total Cohort (cases)	5536297	7,422,710	8,594,071	9,605,322	11,117,288	13,957,073	56,232,761

Notes: Data reflect annual counts of droperidol doses administered by EMS clinicians, total EMS cases in the dataset, and calculated administration rates per million encounters. Percentage values represent droperidol doses as a proportion of total cases per year. A Poisson regression model confirmed a statistically significant increase in administration over the study period ($p < 0.01$).

Table 3 Frequency of Droperidol Administration by EMS Clinicians According to Primary Clinical Impression

Primary Impression	Count	Percentage
Total	23046	100.00%
Behavioral/Psychiatric	5383	23.4%
Pain	3714	16.1%
Neurological	3188	13.8%
Substance Use Disorders	2954	12.8%
Nausea/Vomiting	2505	10.9%
Overdose/Poisoning	1655	7.2%
Trauma	1579	6.9%
Other	522	2.3%
Cardiovascular	343	1.5%
General Symptoms/Conditions	319	1.4%
Respiratory	295	1.3%
Gastrointestinal	223	1.0%
Endocrine/Metabolic	200	0.9%
Infectious Diseases	166	0.7%

Notes: Clinical impressions were documented by EMS clinicians at the time of patient encounter. Categories reflect the most frequently reported primary impressions preceding droperidol administration. Percentages represent the proportion of each impression relative to all documented primary impressions.

Vital sign analyses following droperidol administration excluded patients with pre-existing abnormalities (tachycardia, bradycardia, hypertension, or hypotension) to focus on changes post-administration. Hypertension (systolic blood pressure >140 mmHg or diastolic >90 mmHg) was observed in a subset of patients at 5, 10, and 15 minutes post-administration, while hypotension (systolic <90 mmHg or diastolic <60 mmHg) occurred in a smaller proportion, most frequently at 20 minutes post-administration. Rates of hypotension were statistically significant over time based on chi-square tests for trend (see Table 4). Tachycardia (heart rate >100 bpm) was noted in a subset of patients at 5, 10, and 15 minutes, and bradycardia (heart rate <60 bpm) occurred in a smaller proportion at 20 minutes post-administration. Rates of bradycardia were statistically significant based on chi-square tests for trend (see Table 5).

Our analysis also considered the frequency with which patients who received droperidol received an airway intervention. 69.4% of patients received supplemental oxygen, 22.1% received end-tidal monitoring (digital or otherwise), and 3.9% received an NPA. Table 6 highlights all charted airway interventions.

Given concern for QT prolongation as a result of droperidol administration, we analyzed the settings in which EMS clinicians employed ECGs following droperidol administration. The top three impressions in patients that received an

Table 4 Systolic Blood Pressure Changes Following Droperidol Administration by EMS Clinicians at Timed Intervals (2018–2023)

Status	Total	5	10	15	20	25	30
Total	4936	1783 (36.1%)	1402 (28.4%)	919 (18.6%)	425 (8.6%)	261 (5.3%)	146 (3.0%)
Hypotension (p = 0.04)*	10.2%	9.2%	9.5%	10.5%	13.4%	13.0%	13.7%
Hypertension (p = 0.8)	12.4%	12.3%	12.6%	13.5%	12.0%	11.1%	9.6%
Normal (p = 0.4)	77.4%	78.5%	78.0%	76.1%	74.6%	75.9%	76.7%

Notes: Hypertension was defined as SBP >140 mmHg, and hypotension as SBP <90 mmHg. Patients with pre-existing SBP outside these ranges were excluded from the analysis. "Normal" indicates SBP remained within 90–140 mmHg. Time points represent minutes post-administration. Percentages indicate the proportion of patients in each category at each time interval. Statistical significance was assessed using a chi-square test for trend; hypotension demonstrated a statistically significant association following droperidol administration (designated by an asterisk (*) symbol).

Table 5 Heart Rate Changes Following Droperidol Administration by EMS Clinicians at Timed Intervals (2018–2023)

Status	Total	5	10	15	20	25	30
Total	2605	997 (38.3%)	768 (29.5%)	404 (15.51%)	222 (8.5%)	140 (5.4%)	74 (2.8%)
Bradycardia (p = 0.03)*	13.4%	11.0%	13.4%	14.6%	15.8%	20.0%	17.6%
Tachycardia (p = 0.3)	17.0%	19.4%	15.6%	15.4%	15.8%	15.0%	14.9%
Normal (p = 0.8)	69.7%	69.6%	71.0%	70.1%	68.5%	65.0%	67.6%

Notes: Heart rate changes are categorized relative to baseline measurements prior to droperidol administration. Tachycardia and bradycardia were defined as heart rates >100 bpm and <60 bpm, respectively, in patients who were not tachycardic or bradycardic at baseline. "Normal" indicates heart rate remained within this range. Percentages reflect the proportion of patients in each category at each time interval. Statistical significance was assessed using a chi-square test for trend. The association between droperidol administration and bradycardia was found to be statistically significant (designated by an asterisk (*) symbol).

Table 6 Frequency of Airway Interventions Among Patients Receiving Droperidol in the Prehospital Setting (2018–2023)

Airways	Count	Percentage
Total	8682	100.0%
Oxygen	6025	69.4%
ETCO2 monitoring	1921	22.1%
NPA	342	3.9%
Suction	126	1.5%
Other	158	<2.0%

Notes: Airway interventions were documented by EMS clinicians during prehospital care encounters involving droperidol administration. Categories include both non-invasive and invasive techniques. Percentages represent the proportion of encounters with each intervention relative to the total number of cases in which any airway procedure was performed.

ECG were gastrointestinal, neurological, and psychiatric/behavioral. The most common age range to receive an ECG in this setting were patients aged 60–69 years, followed by 50–59 years (see Table 7).

In patients that received droperidol, 21.1% also received patient restraints. The frequency by which other procedures were associated with droperidol use was analyzed (see Table 8). In addition to the above findings, 5.4% of patients who received droperidol were noted as having a contact-only report, meaning transport was not initiated.

Discussion

The findings of this study demonstrate that droperidol is not only a primary agent for managing agitation and behavioral disturbances but is also utilized for a broader range of clinical indications in the prehospital setting. The most common primary impressions preceding droperidol administration included behavioral/psychiatric conditions, pain, and neurological complaints, reflecting its diverse utility beyond agitation management. Notably, its application for substance use disorders and nausea/vomiting underscores the adaptability of droperidol in addressing emergent symptoms that EMS personnel frequently encounter.

The cohort receiving droperidol was predominantly urban (96.5%) and majority White/Caucasian, with most patients identified as non-Hispanic. The relatively low representation of rural patients likely reflects the distribution of participating EMS agencies, which are concentrated in urban areas. Direct comparisons with the general US population or patients not receiving droperidol were not performed, and future work could explore potential demographic differences in prehospital droperidol use.

The analysis of physiological responses provides critical insights into the drug's safety profile in the prehospital environment, which has been extensively studied in the in-hospital environment.[3,6,15,16] The observed trends in systolic

Table 7 Frequency of Electrocardiogram Use by Age Group Among Patients Receiving Droperidol in the Prehospital Setting (2018–2023)

Age Range	Count	Percentage
Total	5306	100.0%
18-29	527	9.9%
30-39	787	14.8%
40-49	848	16.0%
50-59	878	16.6%
60-69	885	16.7%
70-79	794	15.0%
80-89	468	8.8%
90+	119	2.2%

Notes: ECG use was recorded by EMS clinicians following droperidol administration. Age categories reflect distribution among patients who received an ECG during the prehospital encounter. Percentages represent the proportion of ECGs performed in each age group relative to the total number of ECGs administered in this context.

Table 8 Frequency of Additional EMS Procedures Performed During Encounters Involving Droperidol Administration (2018–2023)

Other Procedures	Count	Percentage
Total	33747	100.0%
12-lead ecg	7321	21.7%
Patient restraint	7126	21.1%
Other	6336	18.8%
Stretcher	2487	7.4%
Contact report only	1837	5.4%
3-lead ecg	1824	5.4%
Spinal motion restriction	1310	3.9%
Surgical mask on patient	1026	3.0%
Consult	937	2.8%
Peace and health officer hold	906	2.7%
Warming	370	1.1%
Involuntary psychiatric hold	326	1.0%
Ultrasound	217	0.6%
Bandaging	210	0.6%
Spit sock	209	0.6%
Stairchair	150	0.4%
BLS assessment	136	0.4%
Trauma alert	125	0.4%
Bleeding control	109	0.3%

Notes: Procedures listed were documented by EMS clinicians during patient encounters involving droperidol use. "Other procedures" include both clinical interventions and administrative actions recorded in the patient care record. Percentages reflect the frequency of each procedure relative to the total number of documented procedures within this subset.

blood pressure and heart rate changes highlight its potential hemodynamic impact. Specifically, the transient increase in hypertension and tachycardia during the initial 15 minutes post-administration, followed by an increased proportion of hypotension and bradycardia at later intervals, suggests a need for vigilance in monitoring vitals post-dosing. These findings support results from in-hospital studies.[5,6,16,17] In the prehospital setting, EMS clinicians must be equipped with the training and skills to recognize and manage potential adverse events, including the ability to provide appropriate interventions for hemodynamic changes. This emphasizes the need for continued patient observation, clinical judgment, and familiarity with emergency protocols to ensure safe and effective use of droperidol in the field.

The increasing utilization of droperidol over the study period reflects its growing acceptance and integration into EMS protocols. The sharpest increases post-2020 may correlate with increased availability of the medication. This trend also aligns with the growing demand for pharmacological options that balance efficacy, safety, and ease of administration in dynamic prehospital environments.

The findings of this study align with existing literature highlighting the effectiveness of droperidol in managing agitation and behavioral disturbances.[1,3,5,12,15,16,18] Previous research has established its rapid onset, safety, and tolerability, making it a preferred option in emergency settings. However, this study extends the understanding of its prehospital applications by demonstrating its use for pain management and nausea, areas that are less explored in literature.[9,10]

Contrasting with hospital-based studies, where droperidol is primarily used in controlled environments, this analysis provides novel insights into its administration in unpredictable prehospital conditions. The trends in airway interventions, ECG use, and the co-administration of patient restraints highlight the practical considerations and challenges faced by EMS clinicians. These observations contribute to a nuanced understanding of the role of droperidol in prehospital care and its broader implications for emergency medical practice.

The findings of this study highlight the use of droperidol for a range of clinical presentations in the prehospital setting, including agitation, pain, and nausea. The observed hemodynamic effects underscore the need for EMS clinicians to monitor patients for potential hypotension and bradycardia following administration. These results provide insight into current practice patterns and physiological responses to droperidol in the field, informing the safe and appropriate use of the medication within existing EMS protocols.

The study's results also emphasize the need for comprehensive training and education for EMS personnel on the appropriate use of droperidol. Understanding its pharmacological profile, potential side effects, and monitoring requirements is critical to ensuring safe and effective administration. Pharmacodynamically, droperidol acts primarily through dopamine D2 receptor antagonism, producing sedative, antiemetic, and antipsychotic effects, while additional alpha-adrenergic and serotonergic activity may contribute to hemodynamic changes observed in the prehospital setting. Compared with other commonly used EMS sedatives, droperidol offers a rapid onset and moderate duration of action; midazolam, a benzodiazepine, primarily enhances GABAergic inhibition, providing anxiolysis and sedation but with less antiemetic effect, whereas haloperidol, another butyrophenone, shares D2 antagonism with droperidol but may be associated with longer onset times and higher risk of extrapyramidal symptoms. Including these comparisons provides EMS clinicians with perspective on selecting the most appropriate agent for specific clinical scenarios. Additionally, the observed trends in ECG use post-administration highlight the necessity of equipping EMS clinicians with the skills and tools to detect and manage potential cardiac side effects, such as QT prolongation.

Limitations

This study's retrospective design presents inherent limitations, including potential biases related to data collection and reporting. Variability in documentation practices across EMS agencies may impact the consistency and reliability of the dataset. Additionally, while the study provides valuable descriptive insights, its observational nature limits the ability to establish causality between droperidol administration and patient outcomes.

The study includes race and ethnicity data for descriptive purposes but did not examine differences in droperidol administration by race or ethnicity. Therefore, we cannot comment on whether the cohort reflects the broader population or whether disparities exist in prehospital use. Future research could investigate these potential differences, as prior

studies have identified racial and ethnic disparities in the use of sedation and restraints in both emergency department and EMS settings.

The analysis is also constrained by the lack of granular data on certain factors, such as concurrent medication use or detailed timelines of symptom resolution. These gaps highlight the need for prospective studies to validate these findings and explore additional dimensions of droperidol in prehospital applications.

Conclusions

In summary, this study describes the current use of droperidol in prehospital care, highlighting its application beyond agitation management to include pain, nausea, and other emergent conditions. The observed trends in administration and associated physiological responses provide valuable insights into its real-world use and safety profile in EMS settings. These findings inform EMS clinicians and educators about typical practice patterns and underscore the importance of targeted training and appropriate monitoring when administering droperidol in the field.

Future research should focus on prospective investigations to establish causal relationships, assess patient-centered outcomes, and evaluate long-term safety. Comparative studies examining droperidol alongside other prehospital sedatives, such as midazolam and haloperidol, would further clarify its relative efficacy and safety and help guide evidence-based decision-making in EMS practice.

ESO Data Set Statement

The content derived from this data set remains the property of ESO Solutions, Inc. ESO is not responsible for any claims arising from works based on the original data, text, tables, or figures.

Declaration of Generative AI in Scientific Writing

The authors did not use a generative artificial intelligence (AI) tool or service to assist with preparation or editing of this work. The authors take full responsibility for the content of this publication.

Data Sharing Statement

The data supporting the findings of this study are available from ESO. Restrictions apply to the availability of these data, which were used under license for this study.

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Author Contributions

Rachel Schuler conceptualized and designed the study, served as principal investigator, drafted the manuscript, and is the corresponding author. Paul Schuler conducted the data extraction and statistical analysis and contributed to interpretation of the results. Christopher Sampson provided mentorship, supervised the project, and critically reviewed the manuscript for intellectual content. 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.

Disclosure

Christopher Sampson is an Associate Medical Director for Teleflex. The authors report no other conflicts of interest.

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