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Original Article

Anaesthesia Section

Nebulised Dexmedetomidine versus Nebulised Lignocaine in Blunting the Haemodynamic Response to Laryngoscopy and Endotracheal Intubation: A Randomised Control Study

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ABSTRACT

Introduction: Direct laryngoscopy followed by intubation induces a stress response leading to haemodynamic changes that are often transient, unpredictable, and variable. Both dexmedetomidine and lignocaine have been used in nebulised form successfully to blunt haemodynamic stress response, but they have never been compared previously.

Aim: To compare nebulised dexmedetomidine and nebulised lignocaine in blunting the haemodynamic response to laryngoscopy and endotracheal intubation.

Materials and Methods: This randomised, double-blinded study was conducted on 135 patients with American Society of Anesthesiologists (ASA) physical Status I and II, aged 18 to 60 years, planned for surgery under general anaesthesia with endotracheal intubation. Patients were divided into three groups of 45 each using a computer-generated random number table. Patients in group D were nebulised with dexmedetomidine 1 µg/kg, with lignocaine 1.5 mg/kg in group L, and with normal saline in group C. The primary objective was to compare nebulised dexmedetomidine and nebulised lignocaine in blunting the haemodynamic response to laryngoscopy and endotracheal intubation with respect to Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure, and Mean Arterial Pressure (MAP). The secondary objective was to study side-effects associated with the use of nebulised dexmedetomidine and lignocaine.

Results: The demographic profile was found to be comparable in all three groups. The mean age was 40.44±11.77 years, 40.04±12.33 years, and 42.89±11.57 years in group D, group L, and group C, respectively, with a p-value of 0.4. The rise in HR during intubation and at all later time points was found to be less in group D and group L compared to group C. Additionally, the rise in HR was found to be higher in group L compared to group D. Similarly, the attenuation effect on SBP and Diastolic Blood Pressure (DBP) was greater in group D patients.

Conclusion: Both nebulised dexmedetomidine and lignocaine were effective in attenuating the pressor response during laryngoscopy and intubation, with dexmedetomidine being more effective than lignocaine without any adverse haemodynamic effects.

Keywords: Cardiovascular, Endotracheal, Hypertension, Ischaemia

INTRODUCTION

An anaesthesiologist plays a key role in securing the airway while providing general anaesthesia to the patient. Endotracheal intubation is the gold standard for securing the airway [1]. Direct laryngoscopy followed by intubation induces a stress response leading to haemodynamic changes, which are often transient, unpredictable, and variable [2]. This response usually lasts for 30 seconds to 10 minutes [3]. It is associated with certain cardiovascular changes such as tachycardia, a rise in blood pressure, and a wide variety of cardiac arrhythmias [1].

The mechanisms underlying the haemodynamic responses are not completely understood, although they have been attributed to a reflex sympathetic discharge caused by stimulation of the upper respiratory tract. A typical pressor response can lead to an average increase in blood pressure by 40-50% and heart rate by 20%, as well as an elevation of both epinephrine and norepinephrine levels [4]. These effects are generally well tolerated by overall healthy patients but can be lethal to patients with pre-existing conditions such as coronary artery disease, recent myocardial infarction, hypertension, the geriatric population, preeclampsia, and cerebrovascular pathologies such as tumours, aneurysms, or increased intracranial pressure, etc., and are at an increased risk of morbidity and mortality [5]. Various drugs have been tried via various routes, such as beta blockers, opioids, calcium channel blockers, and lignocaine, to blunt haemodynamic changes [6].

Recently, drugs like dexmedetomidine are being used via the intravenous route and have also proved effective in nebulised form to blunt haemodynamic response to laryngoscopy and endotracheal intubation. Dexmedetomidine, a selective alpha-2 adrenoreceptor agonist, is short-acting and has sedative, analgesic, antisialogogue, and sympatholytic properties [7]. It is administered via multiple routes with different values of bioavailability. Dexmedetomidine has the potential to produce bradycardia and hypotension when administered as an intravenous bolus. To avoid these side-effects, the nebulisation route has been preferred recently. Moreover, nebulised dexmedetomidine has a bioavailability of 65% through the nasal mucosa and 82% through the buccal mucosa [8,9].

Lignocaine has been successfully used and time-tested to blunt haemodynamic response to laryngoscopy and endotracheal intubation via the intravenous route, spray, and nebulisation. During fibreoptic bronchoscopy awake intubation, lignocaine nebulisation is widely used and proved effective. Common adverse effects of lignocaine include headache, dizziness, drowsiness, confusion, visual disturbances, tinnitus, tremor, and paresthesia [10]. Topical use of lignocaine rarely causes many side-effects [11].

For patients who are not well-suited to tolerate bradycardia, hypotension, or postoperative sedation during brief procedures, nebulised dexmedetomidine may be a good substitute for the intravenous route with negligible adverse effects [12].

The purpose of this study was to compare the effect of nebulised dexmedetomidine and nebulised lignocaine in blunting the haemodynamic response to laryngoscopy and endotracheal intubation.

MATERIALS AND METHODS

This randomised double-blind study was undertaken in the Department of Anaesthesiology, Pt. B.D.S. PGIMS Rohtak from April 2021 to May 2022. Ethical clearance (BREC/Th/20/Anaesth/22) and clinical trial registration (CTRI/2022/12/048464) were obtained for the study. Written informed consent was obtained from all the patients.

Inclusion criteria: There were 135 ASA grade I and II patients in the age group of 18 to 60 years of either sex, undergoing elective surgeries under general anaesthesia with endotracheal intubation.

Exclusion criteria: Patients not consenting for the study, patients with an anticipated difficult airway, seizure disorders, Body Mass Index (BMI) >30 kg/m^2, drug allergy, with decreased autonomic control such as the elderly, diabetic patients, and patients with poor cardiopulmonary reserve were excluded from the study. Patients on antidepressants/antipsychotics/antihypertensive drugs like beta-blockers and pregnant patients were excluded.

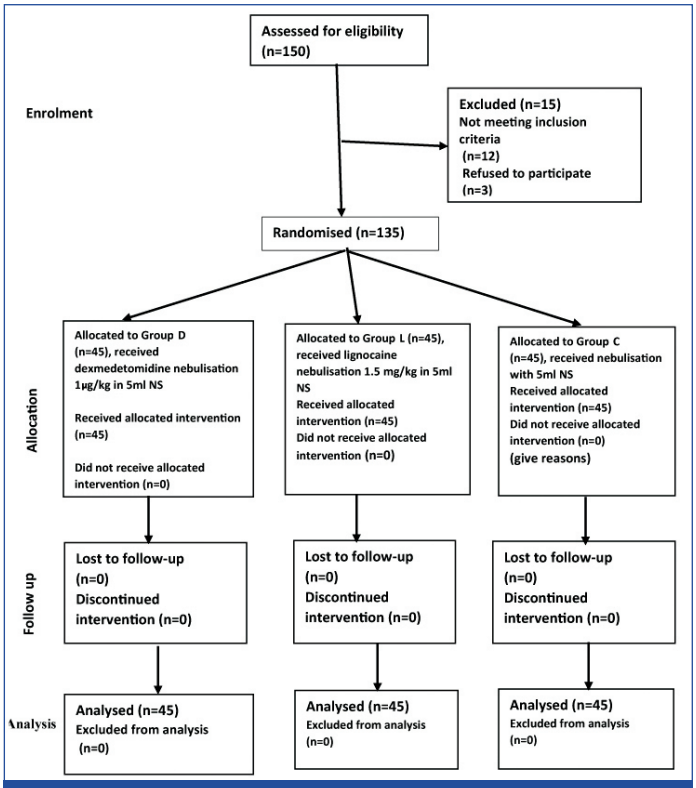
Sample size calculation: In the present study, there were three groups, and the following formula was used to calculate the sample size: $2(Z\alpha+Z1-\beta)2\sigma^2$.

The minimum required sample size at a 5% level of significance and 80% power was obtained: n=Size per group. SD=Standard Deviation=4. Mean difference (Neb RE)=97.36-94.9=2.46 Zα/2= Z0.05/2=Z0.025=1.96. From the Z table at a type I error of 5 Zβ=Z0.20=0.842- at 80% power=2*(1.96+0.84)2*(4)2/(2.46)2= 15.68 *16/6.05=250.88/6.05=41=45. Hence, the sample size was taken as 45 in each group.

The primary outcome of the study was to compare nebulised dexmedetomidine and nebulised lignocaine in blunting the haemodynamic response to laryngoscopy and endotracheal intubation with respect to HR, MAP, SBP, and DBP. The secondary outcome was to study the side effects associated with the use of nebulised dexmedetomidine and lignocaine.

Study Procedure

Patients were divided into three groups of 45 each using a computer-generated randomisation number table and closed envelope method. A consort diagram is given in [Table/Fig-1]. A detailed history was taken from all patients. The purpose and protocol of the study were explained to all patients. After the patient was shifted to the premedication room, consent, detailed history, and clinical status were reconfirmed. All the routine monitors {Electrocardiogram (ECG), Non Invasive Blood Pressure (NIBP), Oxygen Saturation (SpO_2)} were attached, and baseline haemodynamic parameters (HR, SBP, and DBP, MAP, and SpO_2) were noted. Dexmedetomidine at a dose of 1 µg/kg (mixed with normal saline to a total volume of 5 mL) nebulisation was administered if the patient belonged to group D, with a nebuliser face mask and at a continuous flow of 100% oxygen at six litre/minute for 10 minutes before the induction of anaesthesia [2]. Group L patients received nebulisation with 2% lignocaine 1.5 mg/kg mixed with normal saline to a total volume of 5 mL for 10 minutes [13]. Group C patients received nebulisation with 5 mL normal saline 10 minutes before the induction of anaesthesia. The control group was included so that both study drugs could be evaluated for their effect on the stress response. However, all patients in either group received standard care for the laryngoscopy response by receiving i.v. fentanyl for the induction of anaesthesia. The drug was prepared by an anaesthesiology technician who was not part of the study at any time. Therefore, both the patient and the investigator were blinded to the study drug.



[Table/Fig-1]: Consort diagram.

After nebulisation for 10 minutes, all haemodynamic parameters (HR, SBP, DBP, MAP, and SpO_2) were noted again, and the patient was then shifted to the Operation Table (OT).

On the OT table, all routine monitors (ECG, NIBP, and SpO_2) were attached, and values (SBP, DBP, MAP, and SpO_2) were noted before the induction of anaesthesia (T0). Anaesthesia technique remained the same in all three groups with the administration of injection glycopyrrolate, fentanyl, propofol, and vecuronium. Direct laryngoscopy using an appropriate size Macintosh blade and intubation with an appropriately sized endotracheal tube were performed by an experienced anaesthesiologist, and the endotracheal tube was connected to the ventilator. The patient was left undisturbed for 10 minutes after intubation to note vital parameters like HR, blood pressure (SBP, DBP), MAP, and SpO_2 by an anaesthesia resident doctor at the following time points: baseline (Tb), before induction (T0), during laryngoscopy, during intubation, and postintubation at 1, 3, 5, and 10 minutes (T1, T3, T5, and T10), marking the end of the study. The surgical procedure was then allowed to commence, and anaesthesia was maintained with isoflurane (1-2%) in oxygen and nitrous oxide (40:60%) along with intermittent bolus injections of intravenous vecuronium 1 mg. After the surgical procedure, any residual neuromuscular blockade was reversed with injections of glycopyrrolate and neostigmine, and the patient's trachea was extubated upon meeting extubation criteria before being shifted to the Postanaesthesia Care Unit (PACU). Any complications such as bradycardia, hypotension, nausea, and vomiting were recorded during the operative period.

STATISTICAL ANALYSIS

The data was coded and entered into a Microsoft Excel spreadsheet. Analysis was conducted using Statistical Package for Social Sciences (SPSS) version 20.0 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included calculating percentages, means, and standard deviations. The Analysis of Variance (ANOVA) test was applied for quantitative data to compare two and more than two observations. The Chi-square test was used for quantitative data comparison of all clinical indicators, with a p-value of ≤0.05 considered significant.

RESULTS

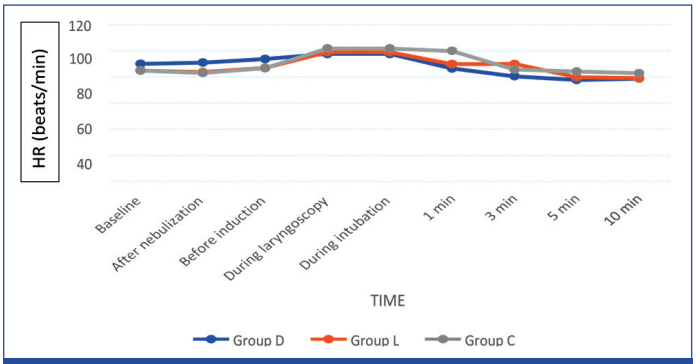
Demographic profile: There was no significant difference in age, gender, and BMI among the three groups [Table/Fig-2].

Characteristics	Group D (n=45)	Group L (n=45)	Group C (n=45)	p-value
Age in years (mean±SD)	40.04±11.77	40.04±12.33	42.89±11.57	0.4
Gender n (%)				
Males	32 (71.1)	37 (82.2)	17 (37.8)	0.46
Females	13 (28.9)	8 (17.8)	28 (62.2)	
BMI in kg/m^2 (mean±SD)	24.99±2.46	26.16±2.83	25.68±3.24	0.15

[Table/Fig-2]: Demographic data.
(test used for statistical analysis- ANOVA for age and BMI, Chi-square for gender)

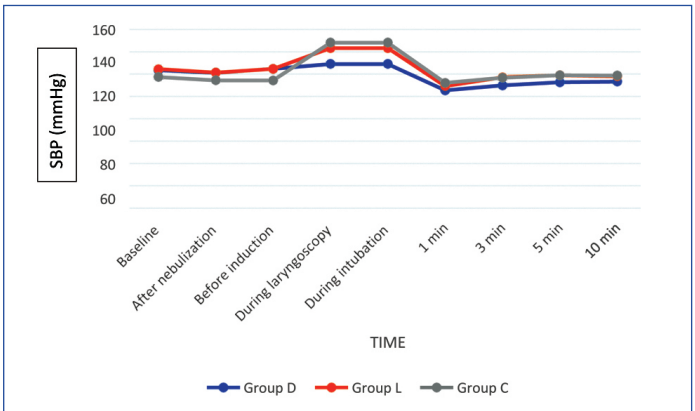
Haemodynamic Parameters

HR (beats/min): Baseline HR was comparable in all the groups (p-value=0.19). Significant changes in HR were noted after nebulisation, during intubation, at 1, 3, 5, and 10-minute time points with p-values of 0.008, 0.001, 0.001, 0.001, 0.001, 0.001, respectively, which were statistically significant. The rise in HR during intubation and at all later time points was found to be less in group D and group L compared to group C. Additionally, the rise in HR was found to be higher in group L compared to group D [Table/Fig-3].



[Table/Fig-3]: Heart Rate (HR) at different time points.
(test used for statistical analysis- ANOVA)

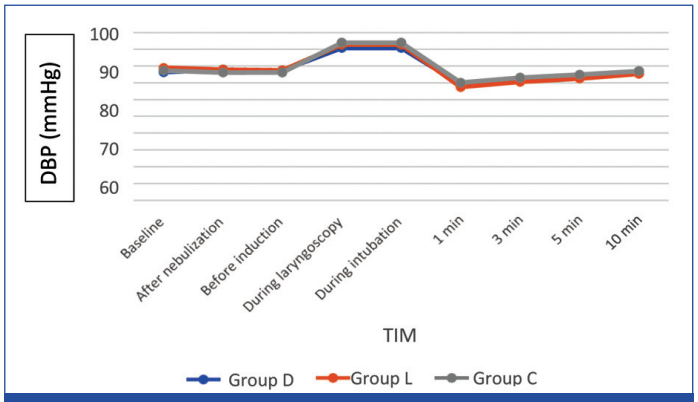
SBP (mmHg): Baseline SBP was comparable in all three groups. Before induction, during laryngoscopy, and during intubation, there was a significant difference in SBP among the three groups with p-values of 0.002, 0.001, 0.001, respectively. A rise in SBP was observed during laryngoscopy and intubation in all groups; however, this rise was significantly higher in group C. Group L patients had a greater rise in SBP at these time points compared with group D patients [Table/Fig-4]. Intergroup comparison found a non significant difference at 1, 3, 5, and 10-minute time points.



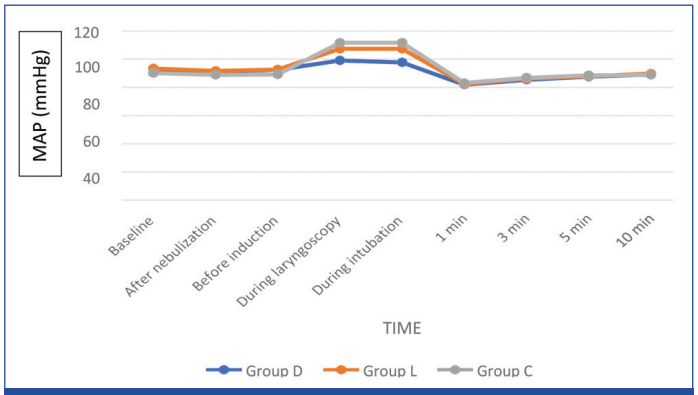
[Table/Fig-4]: Systolic Blood Pressure (SBP) at all-time points.
(the test used for statistical analysis- ANOVA)

DBP (mmHg): Intergroup comparison showed a statistically insignificant p-value. However, a comparison of the mean showed a clinically more attenuation of DBP in group D from baseline value [Table/Fig-5].

MAP (mmHg): Intergroup comparison showed a statistically insignificant p-value [Table/Fig-6].



[Table/Fig-5]: Diastolic Blood Pressure (DBP) at all time points.
(the test used for statistical analysis- ANOVA)



[Table/Fig-6]: Mean Blood Pressure (MAP) at all time points.
(the test used for statistical analysis- ANOVA)

Oxygen Saturation (SpO_2) (%): The p-value at all times was statistically insignificant, showing that SpO_2 remained comparable in all three groups at all time points.

Complications: None of the patients in any group experienced any complications or adverse events such as bradycardia, hypotension, nausea, or vomiting.

DISCUSSION

The results of this study demonstrated that nebulised dexmedetomidine is superior to lignocaine nebulisation in attenuating the haemodynamic stress response to laryngoscopy and intubation. Haemodynamic stress response following direct laryngoscopy can prove to be lethal to patients with pre-existing conditions such as coronary artery disease, recent myocardial infarction, hypertension, the geriatric population, preeclampsia, and cerebrovascular pathology [4]. The risks mentioned mandate the need to blunt the haemodynamic stress response to laryngoscopy and intubation. Drugs like dexmedetomidine are being widely used via intravenous route and have proven effective in nebulised form to blunt haemodynamic response to laryngoscopy and endotracheal intubation [8]. Since nebulised medication administration prevents cough, laryngospasm, vocal cord irritation, and temporary nasal discomfort, it may be chosen over intranasal spray administration. Therefore, nebulised dexmedetomidine can effectively blunt the haemodynamic stress response to laryngoscopy and intubation without any significant adverse effects to provide a sedated and calm patient [8].

A recent study by Singh V et al., comparing intravenous vs nebulised dexmedetomidine to blunt the laryngoscopy stress response found that the nebulised form provides greater haemodynamic stability and less sedation in the postoperative period [12]. Hence, both lignocaine and dexmedetomidine have been used in nebulised form in doses of 2 mg/kg of 2% solution and 1 µg/kg, respectively, to blunt the haemodynamic stress response to laryngoscopy and intubation, but

these two drugs have never been compared. In a study by Soloman S et al., 2% lignocaine nebulisation was used in a dose of 2 mg/kg to blunt haemodynamic stress response; however, the majority of patients complained of taste disturbances [13]. Therefore, present study used lignocaine nebulisation in a dose of 1.5 mg/kg.

All three groups in the present study were comparable with respect to age, gender profile, BMI, and ASA physical status. These results were similar to the study done by Jarineshin H et al., [14]. All baseline haemodynamic parameters were comparable in all three groups. Significant differences in HR were noted after nebulisation, during intubation, at 1, 3, 5, and 10-minute time points with p-values of 0.008, 0.001, 0.001, 0.001, 0.001, 0.001, respectively, which were statistically significant.

The HR increased at the time of laryngoscopy and intubation in all patients in either group, which is due to the well known phenomenon of the haemodynamic stress response. However, the rise in HR during intubation and at all later time points was found to be less in group D and group L compared to group C. This result proved that both dexmedetomidine and lignocaine attenuate the haemodynamic stress response to laryngoscopy and intubation. Also, the rise in HR was found to be higher in group L compared to group D. It showed that the attenuation effect is greater with dexmedetomidine compared to lignocaine. These results are similar to the studies done by Mishra S et al., and Shrivastva P et al., [15,16]. A study by Mishra S et al., found that after laryngoscopy and intubation, linear mixed-effect modeling showed a significantly lower trend of increase in HR in the dexmedetomidine nebulisation group (1 µg/kg) versus the saline group (p-value=0.012) [15]. In a study by Shrivastava P et al., comparing dexmedetomidine nebulisation vs saline for the laryngoscopy response, they observed that the HR was attenuated in the treatment group in a statistically significant manner with the p-values before laryngoscopy (p-value=0.015), after intubation (p-value=0.024), after one minute (p-value=0.001), after five minutes (p-value=0.003), and after 10 minutes of intubation (p-value=0.013) [16]. Bradycardia may be associated with dexmedetomidine use as a bolus injection [17].

In the present study, dexmedetomidine nebulisation was administered over 10 minutes with continuous monitoring of HR, and none of the patients developed bradycardia requiring atropine. This finding further supports that nebulisation is a more suitable route to avoid cardiovascular side-effects. These results are consistent with a recent systematic review and meta-analysis conducted by Gupta M et al., where they concluded that dexmedetomidine nebulisation effectively attenuates the stress response to laryngoscopy without the risk of bradycardia and hypotension [18].

Cardiovascular response during laryngoscopy and intubation increases SBP significantly. Rise in SBP was observed in all groups during these procedures, it was notably higher in group C. Before induction, during laryngoscopy, and during intubation, there were significant differences in SBP among the three groups, with p-values of 0.002, 0.001, and 0.001, respectively. Additionally, group L patients exhibited a greater rise in SBP at these time points compared to group D patients. Dexmedetomidine was found to provide more attenuation in the haemodynamic stress response during laryngoscopy and intubation compared to lignocaine. Notably, no significant incidents of hypotension were observed with dexmedetomidine and lignocaine when compared to the control group. These findings align with previous studies conducted by Shrivastva P et al., where they reported a statistically significant difference in SBP between the two groups (dexmedetomidine nebulisation vs. saline nebulisation) recorded before laryngoscopy (p-value=0.019), after intubation (p-value=0.007), after one minute of intubation (p-value <0.001), after five minutes (p-value <0.001), and after 10 minutes (p-value=0.010) of intubation [16].

Comparison of mean DBP shows more attenuation of Diastolic Blood Pressure with group D from baseline value. This is attributed to the alpha-2 agonist actions resulting in decreased levels of epinephrine and decreased vasoconstriction. Intergroup comparison of MAP shows insignificant p-value. The results of present study regarding DBP and MAP are consistent with a study conducted by Ganesan P et al., [19]. These findings are further supported by a recent study conducted by Paul NS et al., where they found that nebulised dexmedetomidine effectively attenuates the rise in SBP and DBP following laryngoscopy and intubation [20].

None of the participants experienced any complications or desaturation below 95%. Haemodynamic stress response settled down within 10 minutes in all three groups. Thus, present study found that dexmedetomidine was more effective than lignocaine in blunting the haemodynamic response to laryngoscopy and intubation. To the best of our knowledge, this was the first study to compare nebulised dexmedetomidine and nebulised lignocaine in blunting haemodynamic stress response to intubation.

Limitation(s)

The ASA physical status III and IV patients and patients with a difficult airway were not included. The time required for laryngoscopy and intubation was not taken into account. Results cannot be extrapolated to high-risk patients with co-morbidities. Also, complications were assessed only until the immediate postoperative period. Thus, further studies are required to establish its safety and superiority for this purpose.

CONCLUSION(S)

Nebulisation with dexmedetomidine (1 µg/kg) and lignocaine (1.5 mg/kg) both attenuates the pressor response during laryngoscopy and intubation. However, dexmedetomidine is more effective than lignocaine in blunting the haemodynamic response to laryngoscopy and intubation without any haemodynamic adverse effects. Provision of a calm, sedated patient is a novel response seen with dexmedetomidine nebulisation.

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