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# Topical airway anesthesia for awake endoscopic intubation using the spray-as-you-go technique with high oxygen flow

--Manuscript Draft--

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| **Abstract:** | The willingness to cooperate is an absolute precondition for the successful awake intubation of the patients' trachea. Whilst drug-sedation of the patients can jeopardize their spontaneous breathing, topical anesthesia of the airway is a popular technique. The spray-as-you-go technique represents one of the simplest opportunities to anesthetize the airway mucosa. The application of local anesthetic through the working channel of the flexible endoscope is a widespread practice throughout anesthetists as well as pulmonologists. There is neither need for additional devices nor a special training as a pre-requisite to perform this technique. However, a known clinical problem is coughing and gaging reflex caused by the strike of the liquid anesthetic onto the airway mucosa and other sensitive structures like the vocal cords. A method to avoid this is the use of oxygen applied through the working channel with the idea of fogging the local anesthetic into finer particles. Furthermore, the oxygen flow provides a higher oxygen supply and contributes to a better view dispersing mucus secretions and blood away from the lens. With the Enk Fiberoptic Atomizer Set using a high oxygen flow of 10 l/min we maximized those benefits, caused less coughs with the result of highly satisfied and therefore cooperative patients. Possible, but very rare complications of using oxygen flow including gastric insufflation; organ rupture or barotrauma did not arise. We contribute the complication-free use of high oxygen flow to the special built of the Set, permitting flow and pressure release. |
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# Cover Letter

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June 15th, 2016

Dear Editor,

On behalf of all co-authors, I am submitting the manuscript entitled " Topical airway anesthesia for awake endoscopic intubation using the spray-as-you-go technique with high oxygen flow" as a possible candidate for publication in "JoVE".

We describe a method of topical anesthesia of the airway for awake endotracheal intubation using “atomised” lidocaine. This method is more efficient than previously described methods to achieve topical anesthesia of the upper airway and the treachea.

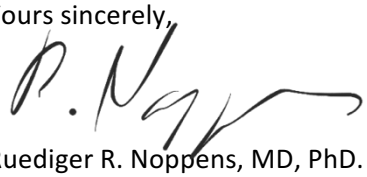
All authors have contributed intellectually to the work and attest the validity and legitimacy of data as well as the accuracy of the methods described.

There are no conflicts of interest, sources of financial support, corporate involvement, or patent holdings.

JoVE editor Mr. Ronald Myers assisted with the present manuscript.

Thank you for considering this manuscript for publication in "JoVE".

Yours sincerely,



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**TITLE:**

# Topical airway anesthesia for awake-endoscopic intubation using the spray-as-you-go technique with high oxygen flow

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**KEYWORDS:**
Medicine, Anesthesiology, Difficult airway management, Awake intubation, Fiberoptic intubation, Topical anesthesia, Spray-as-you-go technique

**SHORT ABSTRACT:**
The topical anesthetic lidocaine was atomized using a high oxygen flow through the working channel of a flexible intubating endoscope to achieve topical airway anesthesia for awake endotracheal intubation. We prefer this modified spray-as-you-go technique for endoscopic intubation to classical bolus application because of higher patient satisfaction and better compliance.

**LONG ABSTRACT:**
A patient's willingness to cooperate is an absolute precondition for successful awake intubation of the trachea. Whilst drug-sedation of patients can jeopardize their spontaneous breathing, topical anesthesia of the airway is a popular technique. The spray-as-you-go technique represents one of the simplest opportunities to anesthetize the airway mucosa. The application of local anesthetic through the working channel of the flexible endoscope is a widespread practice for anesthetists as well as pulmonologists. There is neither need for additional devices nor special training as a pre-requisite to perform this technique. However, a known clinical problem is the coughing and gagging reflex that may occur when the liquid anesthetic strikes the airway mucosa and other sensitive structures like the vocal cords. This can be avoided by the use of oxygen applied through the working channel with the aim of fogging the local anesthetic into finer particles. Furthermore, the oxygen flow provides a higher oxygen supply

and contributes to a better view, dispersing mucus secretions and blood away from the lens. Using an atomizer with a high oxygen flow of 10 l/min we maximized these benefits, caused less coughing and had more satisfied and therefore cooperative patients. Possible, but very rare complications of using oxygen flow including gastric insufflation, organ rupture or barotrauma did not arise. We attribute the complication-free use of high oxygen flow to the design of the set, which permits flow and pressure release.

**INTRODUCTION:**

Topical anesthesia of the airway for awake intubation is generally recommended to improve patient comfort, which will help make the procedure a success. The spray-as-you-go technique with high oxygen flow is a simple and safe concept that is finding a high level of acceptance among patients. The atomization of the local anesthetic by oxygen at a flow rate of 10 l/min results in less stimulation of the cough and gag reflex.

Faced with negative feedback from several patients, we decided to refine the standard institutional spray-as-you-go technique. This classical bolus application of local anesthetic consisted of two injections, each of 5 ml lidocaine 2% plus 5 ml air in a 10 ml syringe, first into the vocal cords and then, after a 2-min waiting time, into the trachea. Patients complained about the feeling of being drowned by the splash of the bolus striking their airway mucosa.

The spray-as-you-go technique is commonly used worldwide[1]. This technique involves local anesthetic application through the working channel of a flexible intubating endoscope while advancing the tip through the upper and lower airway with the goal of intubating the patient´s trachea. There are multiple approaches in practice and several descriptions of methods in the literature. Initial experiences with the spray-as-you-go-technique in combination with application of a constant oxygen flow through the working channel were published in the 1990s[2]. The focus here was on oxygen flow effects like cleaning the lens by dispersing mucus secretions and blood away from the lens and elevating the inspiratory oxygen delivery. The advantage of the oxygen flow in aiding atomization of local anesthetic was shown previously by Piepho and colleagues[3]. They described a vaporization technique, where the supply of 3 l/min oxygen resulted in less coughing by the patients. On the assumption that a flow of 10 l/min would atomize the local agent into finer particles that would evoke even less coughing, we successfully tested the atomizer at this higher flower rate. The atomizer consists of a small volume, kink-resistant, flexible, pressure-certified oxygen tube and a connecting tube. These are connected to a three-way sidearm fitting with a small flow-control opening.

The atomizer technique can be used for all airway situations. However, the device should be used cautiously distal from higher-grade airway stenosis caused by e.g. tumor masses. The lack of backflow of oxygen could cause increased airway pressure and increases the risk of barotrauma. Also, the atomizer is a useful tool in an emergency setting. The preparation of the set needs less than a minute and the user needs no special training. In the following we present detailed operating instructions for the spray-as-you-go technique with high oxygen flow, illustrating the separate working steps.

**PROTOCOL:**
All procedures were approved by the ethics committee of the medical association of the State Rhineland-Palatinate and performed in accordance with the Declaration of Helsinki.

**1. Atomizer**[4]
1.1 Remove the set from package. Inspect the product to ensure there is no damage.
Note: The device is intended for one-time use. Please refer to the instructions for use for further information about storage and supply (see materials and equipment table).

**2. General preparation of the patient**
2.1 Administer premedication, e.g. Lorazepam 1–2.5 mg the evening before and/or 2–4 mg 1–2 hours before the intervention (with attention to contraindications).

2.2 Establish monitoring parameters such as pulse oximetry ($SpO_2$), electrocardiography (ECG) and non-invasive blood pressure (NIBP).
Note: Monitor patient sedation using e.g. Ramsay Sedation Scale and Bispectral Index monitoring. Close monitoring of the level of sedation can help prevent potential complications of e.g. respiratory depression.

2.3 Secure a peripheral intravenous access.

**3. Topical anesthesia of the upper airway**
3.1 Apply 1 ml mixture of lidocaine 2% with phenylephrine 0.25% to each nostril.

3.2 Apply lidocaine 10% spray twice directly onto the mucosa of the oropharynx, spraying from the tip to the back of the tongue. Ask the patient to gargle the lidocaine in the mouth for as long as possible.
Note: Anesthesia of the supraglottic airway can be performed alternatively using cotton-tipped swabs or nasopharyngeal airways, drops, gel, swish and gargling, aspirating and spraying local anesthetics.

**4. Analgo-sedation**
4.1 Start analgo-sedation using i.v. medication, e.g. initial sufentanil bolus (< 60 kg: 5 µg; >60 kg: 10 µg; >100 kg: 15 µg).
Note: Dose drug-induced sedation at the lowest level possible in order to prevent apnea or airway constriction.

4.2 Give an extra sufentanil i.v. bolus, e.g. 5 µg, as 'rescue' treatment until a Ramsay Sedation Score of 2 (cooperative, oriented, tranquil) is achieved.

**5. Equipment preparation**
5.1 Assemble and check the flexible intubation endoscope according to institutional standards.

5.2 Connect the oxygen tube of the atomizer to the oxygen flow meter directly.

**Caution!** Oxygen flow meters with humidifier bottles must not be used.

5.3 Attach the connecting tube to the luer on the working channel of the endoscope. Set the oxygen flow rate to 10 l/min, as recommended in the instruction manual.

5.5 Connect a 1 ml syringe containing the lidocaine 2% solution to the three-way sidearm fitting.
Note: Lidocaine 2% with its favorable efficacy profile is a suitable anesthetic.

**6. Atomizer technique**
6.1 Close the flow-control opening using a finger. Rapidly inject the medication. Immediately release the flow-control opening.
Note: A syringe must be connected to the three-way sidearm fitting to obtain a continuous low oxygen flow through the working channel.

6.2 While advancing the flexible endoscope in the airway, inject the local anesthetic using the atomizer at the following sites: inside nostril, on posterior nares; epiglottis; glottis; and vocal cords.

6.3 Repeat these steps as often as required while advancing the endoscope ("spray-as-you-go"). Before passing through the vocal cords, wait for 2 min to allow sufficient drug effect at the site.
Note: Monitor sedation level of patient and top up sedation using i.v. medication (e.g. sufentanil 5 µg), as needed.

**7. Flexible endoscopic intubation**
7.1 Advance the endoscope carefully through the glottis into the trachea and position the tip of the endoscope just above the carina. Railroad a suitable sized, cuffed and lubricated flexible endotracheal tube over the endoscope into the trachea under rotation.
Note: Avoid accidental advancement of the endoscope tip into a main stem bronchus.

7.2 Confirm placement of the endotracheal tube in the trachea just above the carina by visual control via the endoscope. Remove the endoscope, leaving the endotracheal tube in place.

7.3 Confirm the endotracheal position of the tube by measuring end tidal $CO_2$ using capnography in the spontaneously breathing patient.

7.4 Induce general anesthesia, e.g. intravenous Propofol 2 mg/kg/body weight. Start ventilating the patients according to current standards.

**REPRESENTATIVE RESULTS:**
We performed awake flexible endoscopic intubation using the presented topical anesthesia technique in 48 patients. We succeeded in intubating all patients except one, who suffered from a stenosing tumor of the pharynx, which made it impossible to advance the tube.
The quality of awake intubation comfort was evaluated by patients, anesthetists and nurses

using an 11-point visual analog scale (VAS) from 0 = not unpleasant to 10 = intolerable. The atomizer technique met with broad acceptance, and the evaluation of comfort showed good performance. On the first postoperative day, patients rated their level of comfort with a median (Interquartile range (IQR)) VAS score of 1 (1–3). Anaesthetists and nurses rated the technique as VAS 2 (1–4 and 1–3 respectively).

[Place Figure 1 here].

The incidence of coughing is a surrogate measure of the quality of awake-intubation. A trained and skilled study nurse, who was not involved in patient treatment at any time, exclusively collected data during the procedure to avoid reporting bias. We evaluated coughing when topical anesthesia was applied (protocol includes five injections of lidocaine). The median number of coughs during the period of intubation was 6 (3–10).

Further criteria used to evaluate the safety of awake-intubation were the time required for intubation and the consumption of local anesthetic in relation to neurological toxicity. The mean duration of awake-intubation was 5 (3–6) min. This period included the time required to administer the topical anesthetic using the atomizer. The atomized sprays could be administered one after another (spray as you go). Under the assumption that the atomized lidocaine penetrates deeper into the airway mucosa and for this reason acts faster, the protocol included only a 2-min waiting time before passing through the vocal cords.

Use of the atomizer with a high oxygen flow led to a widespread distribution of local anesthetic. The average consumption of lidocaine 2% using the atomizer technique was 100 mg. The cardiovasculary stability was probably a result of effective topical airway anesthesia in combination with an acceptable sedation protocol.

[Place Table 1 here].

**FIGURE AND TABLE LEGENDS:**

**Figure 1: Comfort level of patients undergoing awake endoscopic intubation on the first postoperative day, and comfort evaluation by anesthetists and nurses**

VAS 0 = not unpleasant, VAS 10 = intolerable. Symbol, median; error bars, IQR

**Table 1: Stability of the cardiopulmonary indices from the initiation of topical anesthesia to immediately after insertion of the endotracheal tube.**

Data were documented at baseline and every minute thereafter.
Data show median and IQR

**DISCUSSION:**

Here we demonstrate topical anesthesia using an atomizer with high oxygen flow for awake-endoscopic intubation. The first study to evaluate the atomizer technique compared it with classical boluses of topical anesthesia via the working channel of the flexible intubating endoscope[5]. Patients in the atomizer group evaluated their level of comfort as better than

those in the control group and experienced fewer coughs and distinct coughing episodes. In addition, the atomizer technique was faster and less local anesthetic was required.

When investigators compared the atomizer, using low oxygen flow, with translaryngeal injection for awake-intubation in patients at risk of cervical spine injury, there were no differences between the groups in terms of comfort evaluation[6]. The spray-as-you-go technique with high oxygen flow is one variation of several different described spray-as-you-go techniques.

A major advantage of all spray-as-you-go techniques is their flexibility, involving selectively and repetitively anesthetizing the airway, which makes these techniques a suitable choice for most endoscopic intubations.

The classical bolus application of local anesthetic regularly evokes patient discomfort. Several efforts have been made to reduce this limitation. For example, the use of an epidural catheter cut to the length of the flexible intubating endoscope and inserted through the working channel is repeatedly recommended in the literature[7,8,9]. The outcome of this modification has not yet been confirmed due to the lack of prospective, controlled and randomized studies. However, a limitation of the epidural catheter technique is that an experienced operator is needed to successfully maneuver the local anesthetic application. Additionally, using an epidural catheter for local anesthetic application was reported to be costly and time consuming[8,10].

An additional advantage of the spray-as-you-go technique is its ease of handling. Nebulization of local anesthetic requires additional equipment (e.g. ultrasonic nebulizer) and additional time prior to endoscopic intubation. Furthermore, the spray-as-you-go technique can be used for almost every patient, while a cooperative patient and knowledge of anatomy and the identification of landmarks are fundamental requirements when performing an airway nerve block.

Intra-arterial injection, hematoma formation and tracheal injury such as subcutaneous emphysema are feared complications due to the invasiveness of performing blocks, but complications caused by the spray-as-you-go technique are rare.

Potential complications of using a constant oxygen flow (3 to 5 l/min) through the working channel of an intubation endoscope include gastric insufflation and organ rupture[11,12,13]. Complications may occur during difficult visualization of airway structures, a prolonged procedure or accidental esophageal intubation. Barotrauma of the lung is theoretically possible if the intubation endoscope is passed through a narrowed glottis and passage of the tracheal tube is delayed because of a narrowed airway. For these reasons, some authors do not recommend applying oxygen through the working channel of an intubation endoscope[14]. None of the above-mentioned complications was observed in the two studies investigating the atomizer[5,6]. This could be attributed to the flow-control opening of the atomizer, a 2 mm hole placed opposite the injection port of the three-way-sidearm fitting, which allows flow and pressure release if no injection is performed. It is assumed that there is no continuous high

oxygen flow and pressure at the distal end of the working channel of the endoscope, because oxygen can escape through the flow-control opening. Only at the time of injection, when it is closed, might the subsequent airway structures be under a higher pressure.

There are no data on the pressure at the distal tip of the endoscope working channel when administering oxygen or the distribution and penetration depth of local anesthetic on, and in, the airway mucosa. This, as well as the mechanism as to how high flow oxygen atomizes local anaesthetic, would be worth investigating.

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**DISCLOSURES:**
The authors have nothing to disclose.

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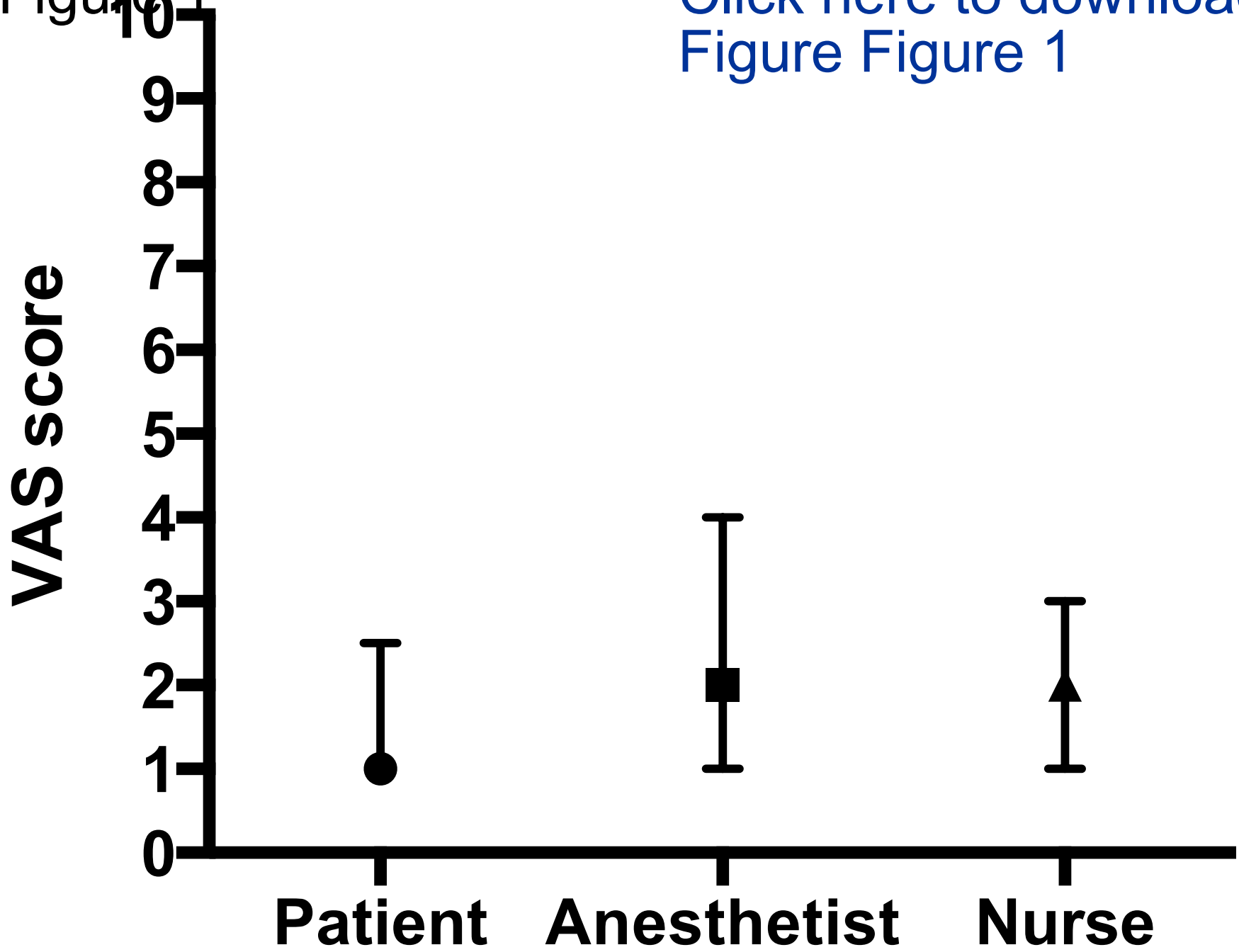
Figure 1





| | ATOMIZER (n=48) |
|---|---|
| Vital parameters | |
| Oxygen saturation (%) | |
| Baseline | 98 [96-99] |
| Lowest | 98 [95-99] |
| End | 99 [98-100] |
| Heart rate (bpm) | |
| Baseline | 73 [67-89] |
| Highest | 98 [96-99] |
| End | 82 [72-95] |
| Systolic blood pressure (mmHg) | |
| Baseline | 154 [138-168] |
| Highest | 164 [152-183] |
| End | 154 [141-175] |
| Diastolic blood pressure (mmHg) | |
| Baseline | 86 [79-95] |
| Highest | 94 [87-103] |
| End | 87 [82-97] |

Excel Spreadsheet- Table of Materials/Equipment

Click here to download Excel Spreadsheet- Table of Materials/Equipment Materials.xlsx

| Name of the Material / Equipment | Company | Comments / Discription |
|---|---|---|
| Lidocaine 10% pump spray | e.g. AstraZeneca | |
| Opiod for i.v. administration | | Any opiod can be used. We prefer eithe |
| Enk Fiberoptic Atomizer Set | Cook Medical | Catalogue number: C-EFNS-100 |
| Lidocaine 2% | e.g. AstraZeneca | |
| Intubation endoscope | e.g. Karl Storz Endoscope | We prefer a fibrescope with an outer d |
| Endotracheal tube | e.g. Rüsch | Size of the endotracheal tube needs to |
| Anesthetic drug, e.g. Propofol 1% | e.g. AstraZeneca | |

er Sufentanil or Fentanyl

iamter of 5 mm and a working channel with a diamter of 2 mm
be adjusted to the patient. We prefer a ID 6.5mm for nasal approach and ID 7.0 mm for oral app

roach

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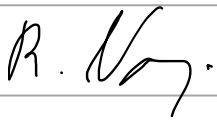
| Signature: |  Date: 15th June, 2016 |

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# Line-by-line Response Letter (Revision of Version 5516_R1_070516)

Manuscript JoVE55116R1 “Topical airway anesthesia for awake endoscopic intubation using the spray-as-you-go technique with high oxygen flow.

Version 55116_R1_070516

**Editorial comments:**

- Please keep the editorial comments from your previous revisions in mind as you revise your manuscript to address peer review comments. For instance, if formatting or other changes were made, commercial language was removed, etc., please maintain these overall manuscript changes.
- **Formatting:**
  - Please define all abbreviations at first occurrence (ie ECG, IQR etc.).
    All abbreviations are now defined at first occurrence.
  - Table 1 should have a title in the legends.
    We included a title to the legends.
  - References – Please include DOI where available.
    We included DOI where it was available.
- Please copyedit the manuscript for awkward English and correct use of punctuation. Such editing is required prior to acceptance, and is recommended to be performed by a native English speaker.
  We submitted the document to Proof-Reading-Servive.com for editing and proofreading. Please find attached the certificate (Certificate_201608-19131029.pdf).
- **Some specific examples are indicated below:**
  - Line 49 – “insufflation; organ rupture” – wrong punctuation.
    ; changed into ,
  - Line 75 – “On the assumption that a flow of 10 l/min atomizes the local agent in finer particles evoking even less coughs we tested successfully the atomizer” – awkward phrasing
    Thank you for pointing this out! We now reworded the sentence.
  - Please use “their” rather than “his” or “her”.
    We corrected the manuscript accordingly.
  - 3.2 – “Apply lidocaine 10% spray twice directly”
    “his” changed into “the”
  - 5.2 – “Oxygen flow meters with humidifier bottles most not are used.”
    Was changed to “Oxygen flow meters with humidifier bottles must not be used”.
  - 5.5 note – “is a suitable anesthetic effect” – effect is not the correct word.
    Is now changed to “efficacy profile”
  - Line 172 – “except of one”
    Changed to “except one”
  - Please use American English throughout. For example, “randomised" should be “randomized”, and “visualisation" should be “visualization”.

- **Additional detail is required**:

- 2.3 Please clarify. Where is the placement?
  We now are more specific: peripheral.
- 4.2 – Please clarify “rescue” treatment. When would this be used?
  … until a Ramsay Sedation Score of 2 (cooperative, oriented, tranquil) is achieved.
- 6.2 – Is the anesthetic injected or sprayed? Is the atomizer used or is it injected with a needle?
  We used the Atomizer

- **Discussion:**
  - Please discuss the critical steps of the protocol.
  - The discussion ends awkwardly. Please end on discussion of the future applications of the method.

- If your figures and tables are original and not published previously, please ignore this comment. For figures and tables that have been published before, please include phrases such as “Re-print with permission from (reference#)” or “Modified from..” etc. And please send a copy of the re-print permission for JoVE’s record keeping purposes.
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  We now included available DOIs.

- IMPORTANT: Please copy-edit the entire manuscript for any grammatical errors you may find. The text should be in American-English only. This editing should be performed by a native English speaker (or professional copyediting services) and is essential for clarity of the protocol and the manuscript. Please thoroughly review the language and grammar prior to resubmission. Your JoVE editor will not copy-edit your manuscript and any errors in your submitted revision may be present in the published version.
  We submitted the document to Proof-Reading-Servive.com for editing and proofreading. Please find attached the certificate (Certificate_201608-19131029.pdf).

- NOTE: Please include a line-by-line response letter to the editorial and reviewer comments along with the resubmission.

**Reviewers' comments:**

**Reviewer #1:** *Manuscript Summary:* In this manuscript a technique is described for the administration of local anesthetics. The use of Enk Fiberoptic Atomizer Set(TM) with high flow oxygen results with advantages including less coughing and gaging reflex and high patient satisfaction. *Major Concerns:* During awake intubation we commonly use spray as to go technique and classical bolus administration for the application of local anesthetics. When compared with the spray-as-you-go technique, the atomizer technique has better results including fewer coughing episodes. Besides

this technique is quicker and results in less lidocaine administration with higher patient comfort. I think this manuscript is quite important because it gives valuable information about an alternative method of lidocaine administration during awake fiberoptic intubation. I recommend acceptance for this article. *Minor Concerns:* N/A *Additional Comments to Authors:* N/A

**Reviewer #2:** *Manuscript Summary:* N/A *Major Concerns:* It is a well designed study but I have my doubts that the high flow of oxygen as recommended by the authors would add to dispersing mucus secretions and blood thus providing a better view. Such a high flow could well be an impediment in the better visualization of the glottis. Moreover, I am not convinced that it would be of help in curtailing the coughs. The authors are advised to provide an explanation if possible in the Discussion section to allay our apprehension in this regard. *Minor Concerns:* N/A *Additional Comments to Authors:* N/A

Thank you very much for your valuable comment. When we initially used this techniques we were surprised how effective this technique was in some patients. Our observations led to our study hypothesis. We would like to encourage the reviewer to read the original article which includes all the data of our trial (Pirlich, N., Lohse, J.A., Schmidtmann, I., Didion, N., Piepho, T., & Noppens, R.R. A comparison of the atomizer with boluses of topical anaesthesia for awake fibreoptic intubation. *Anaesthesia* **71**, 814-822, doi: 10.1111/anae. 13496 (2016).