



## Experiences of Healthcare Professionals with Camera-Assisted Double Lumen Tubes: A Qualitative Study

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### 1. Abstract

**1.1. Study objective:** Double Lumen Tubes (DLT) with an integrated camera have been introduced to possibly ease the intubation procedure during one lung ventilation. We wanted to investigate healthcare professionals' opinions about camera-DLTs compared to regular DLTs.

**1.2. Design:** A qualitative study, that reports questionnaire data collected electronically from anesthesiologists and anesthesiology nurses at the Department of Thoracic Surgery.

**1.3. Setting:** The study was conducted at the Department of Thoracic Surgery on Odense University Hospital.

**1.4. Main Results:** Seventeen out of 72 answered the questionnaire (23.6%). Out of the 17 respondents, 12 respondents (70.6%) preferred the camera-DLT. The most frequent advantage chosen for the camera-DLT was "continuous visualisation" (n=14, 82,4%), followed by "no need for bronchoscope" (n=8, 47,1%) and "good for training and education" (n=8, 47,1). The most frequent disadvantage (n=6, 35,3%) persons were problems with secretions on the lens which could not be easily cleared, followed by no need for a bronchoscope (n=5, 29,4%) and design features (n=4, 23,5%).

**1.5. Conclusions:** The camera-DLT seems superior to the regular-DLT in healthcare professionals' opinions at our department, though further studies are needed to enlighten this as the response rate was quite low and no other studies to date have investigated this topic

### 2. Keywords

Intubation; One-lung ventilation; Double-lumen tube; Thoracic surgery

### 3. Introduction

Intubation with a double-lumen tube (DLT) is essential for thoracic surgeries. Placement of a regular DLT (reg-DLT) requires the use of a bronchoscope to check for correct placement of the DLT after intubation[1-3]. DLTs can in some patients be difficult to insert and they are prone to move if the patient is put in another position during surgery[2]. Currently, a physician is required to check for correct tube placement if it is suspected that the tube has moved. Correct tube placement is essential for a successful procedure as it keeps the operative lung deflated and secure sufficient ventilation of the non-operative lung[2,4].

To eliminate or minimize the need for bronchoscopy during intubation, DLTs with an integrated camera (cam-DLT) have been designed to allow continuous visualisation of the tube when placed in the bronchus. Additionally, cam-DLTs are thought to reduce the number of malpositions and potentially reduce the intubation time due to its camera modalities[4]. The aim of this study was to investigate healthcare professionals' opinions about cam-DLTs compared to reg-DLTs after the implementation of the cam-DLT at a thorax surgical department. We also wanted to investigate if the cam-DLT resulted in fewer self-reported minor complications (cough, hoarseness and sore throat) when compared to the reg-DLT.

### 4. Methods

#### 4.1. Study design and approval

This qualitative study with a Randomized Controlled Trial (RCT) element reports questionnaire data collected from anesthesiologists and anesthesiology nurses at the Department of Thoracic Surgery, Odense University Hospital (OUH), Denmark and patient outcome data after intubation with the cam-DLT compared to the reg-DLT. Patient outcome data were collected during the study "A randomized Controlled Study Comparing the vivasight Double-lumen Tube with a Conventional Double-lumen Tube (CDLT) in Adult Patients Undergoing Thoracic Surgery – A Clinical and Economic Evaluation"[1]. Questionnaire data from the novice physicians were also collected during that study. Ethical approval for the collection of patient data was given on 18-06-2018 by the Regional ethics committee. The cam-dlts used in this study were the vivasight-DL, which was recently implemented at our department. The vivaSight-DL (ETView Medical Ltd., Israel/Ambu A/S, Ballerup, Denmark) is a single-use, left-sided DLT with an integrated camera and light source at the distal part of the tracheal lumen. It connects to a standard monitor and thereby allows for continuous visualisation of DLT placement. It also has an integrated flushing system to help keep the camera lens clean. After correct placement, the camera focuses on the carina and provides visual confirmation of the bronchial cuff in the main bronchus. The reg-DLT was the Shiley DLT (Shiley <sup>TM</sup> Medtronic, Minnesota, US), which is also used at our department in combination with a fiberoptic bronchoscope to secure correct placement of the tube.

#### 4.2. Data collection

##### 4.2.1. Questionnaire:

An electronic questionnaire was sent to the employee mail of all anesthesiologists and anesthesiology nurses at our department. Survey data were anonymously collected using the website questionpro. Respondents were asked to provide their job title (doctor, nurse, surgeon, other) and to rate the ability of the cam-DLT and the reg-DLT to visualise

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the anatomic landmarks relevant for intubation and confirmation (5-point scale from very poor to excellent). Respondents were asked about which of the two tubes they preferred for one-lung ventilation (OLV) and to state the reason why. Additionally, the respondents were asked to choose three main advantages of the cam-DLT (Continuous visualisation, No need for a bronchoscope, Design features, Availability, Single-use, The monitor [aView], The Y-connector, Enables fast and effective one-lung ventilation, Provides an extra measure of patient safety, Better procedure flow (less time spent on repositioning the tube), Good for training and education, Cost-effective compared to conventional dlt or Other). Afterwards, respondents were asked to choose three disadvantages associated with the cam-DLT (No disadvantages, No need for a bronchoscope, Continuous visualisation, Design features, Availability, Single-use, The monitor [aView], The Y-connector, Enables fast and effective one-lung ventilation, Provides an extra measure of patient safety, Better procedure flow (less time spent on repositioning the tube), Good for training and education, Cost-effective compared to conventional dlt or Other). Respondents stating "Other" were asked to specify.

#### 4.2.2. Patient outcome and novice physicians:

Patient outcome data were collected during another study [1]. The study design will only be briefly mentioned here and a more detailed explanation of the study design is provided in the appendix. Fifty patients fulfilled the inclusion criteria and were randomly assigned into two groups. One group was to undergo surgery while intubated with the cam-DLT, while the control group was to be intubated with the reg-DLT. Patients were included if they were evaluated as being eligible for OLV with a left-sided DLT after admission to the Department of Thoracic Surgery. Exclusion

## 5. Results

The electronic questionnaire was emailed to 72 healthcare professionals and was completed by 17 (23.6%). Mainly physicians answered the questionnaire (n=12, 70.6%). The rest were nurses (n=5, 29.4%). When asked to evaluate the ability of the cam-DLT to visualise the anatomic landmarks relevant for intubation and confirmation, four respondents answered acceptable (23.5%), 11 respondents answered good (64.7%) and two respondents answered excellent (11.8%). The ability of the reg-DLT to visualise the anatomic landmarks relevant for intubation and confirmation was rated as poor by two respondents (11.8%), as acceptable by four respondents (23.5%), as good by ten respondents (58.8%), and excellent by one respondent (5.9%) (Table 1). When asked which tube they preferred, 12 respondents (70.6%) preferred the cam-DLT (Table 1).

**Table 1:** Summary of preference for the two tubes and of the ability to visualize anatomical landmarks relevant for intubation.

	Cam-DLT	Reg-DLT
Preferred	12 (70.6%)	5 (29.4%)
Ability to visualize anatomical landmarks <sup>1</sup>		
- excellent	2 (11.8%)	1 (5.9%)
- good	11 (64.7%)	10 (58.8%)
- acceptable	4 (23.5%)	4 (23.5%)
- poor	0 (0%)	2 (11.5%)
- very poor	0 (0%)	0 (0%)

1 Wilcoxon rank-sum test, 2-sided, p=0.4805

Baseline characteristics for the subjects in the randomised study were the same for both groups and there were no differences in gender, age, weight, height, BMI or ASA-score in the two groups (Table 3). For six subjects in the intervention group and six subjects in the control group the questionnaire was not completed. One respondent completed the questionnaire in cooperation with one of the novice physicians since the subject only spoke German. There was no difference in self-reported life quality or general health prior to surgery between the two groups (p=0.35 and p=0.65, respectively).

**Table 3:** Baseline characteristics of the patients.

Group	Age (years)(mean ±SD)	Gender (male (%))	Weight (kg)(mean±SD)	Height (cm)(mean±SD)	BMI (kg/cm <sup>2</sup> )(mean±SD)	ASA-score (mean±SD)
VivaSight DL (n=30)	65.8 (±10.02)	17 (56.67%)	74.73 (±19.14)	172.47 (±9.32)	24.92 (±5.21)	1.53 (±0.63)
cDLT (n=22)	68.5 (±7.16)	10 (45.45)	76.23 (±17.12)	172.78 (±9.56)	25.36 (±4.44)	1.59 (±0.50)
p-value	0.44	0.58	0.69	0.76	0.62	0.81

criteria were known tracheobronchial anomalies or tracheal pathology, age <18, required rapid sequence induction, required emergency procedure, anticipated difficult airways, prior systemic infection or suspected tuberculosis, patients where the use of other one-lung isolation devices or techniques (tracheostomy, nasal intubation, etc.) was warranted or if they were unsuited for intubation with a DLT. Within 48 hours after completion of the surgery, patients were contacted by a research assistant via phone and asked to complete a questionnaire. Subjects rated their overall life quality and general health four weeks prior to surgery (5-point scale from poor to excellent). Subjects were asked if they had experienced any side effects (cough, hoarseness, or sore throat) and if experienced, they were asked to rate their respective side effects from mild to severe (3-point scale from mild to severe). Six novice physicians participating in the study were asked to complete a questionnaire, asking which tube they preferred and why, and what they thought the advantages and disadvantages of the cam-DLT were.

#### 4.3. Statistics:

Statistical analysis was done in Stata 16.0 and statistical significance was set to 0.05. A two-sided Wilcoxon rank-sum test was used to test for statistically significant differences in the questionnaire and in patient characteristics, and standard and mean deviation were obtained for weight, height, age, body mass index and American Society of Anesthesiologists (ASA)-score. A two-sided Fisher's exact test was used to assess for any statistically significant differences between groups in regards to gender.

The main reason for the preference of the cam-DLT was easy placement and continuous visualisation. Preference for the reg-DLT over the cam-DLT was mostly because of problems with secretions on the cam-DLT, impairing visibility. One respondent reported a preference for the reg-DLT because of "Force of habit". Other reasons were difficulties with the placement of the cam-DLT and patient safety, as a person deemed it safer to use a bronchoscope for control of tube placement rather than the integrated camera in the cam-DLT. The most frequent advantage chosen for the cam-DLT was "continuous visualisation" (n=14, 82.4%), followed by "no need for bronchoscope" (n=8, 47.1%) and "good for training and education" (n=8, 47.1%). The most frequent disadvantage reported was "other" (n=12, 70.6%), followed by no need for a bronchoscope (n=5, 29.4%) and design features (n=4, 23.5%) (Table 2).

**Table 2:** The most chosen advantages and disadvantages for the cam-DLT.

	Advantage	Disadvantage
1	Continuous Visualisation (n=14, 82.4%)	Other (n=12, 70.6%)
2	No need for a bronchoscope (n=8, 47.1%)	No need for a bronchoscope (n=5, 29.4%)
3	Good for training and education (n=8, 47.1%)	Design features (n=4, 23.5%)

In the intervention group, 16 subjects (53%) experienced cough vs. 13 subjects (59%) in the control group, 10 subjects (33%) vs. 11 subjects (50%) experienced hoarseness and three subjects (13%) vs. two subjects (13%) experienced sore throat within 48 hours after the surgery. There were no statistically significant differences between the two groups ( $p=0.74$  for cough,  $p=0.11$  for hoarseness and  $p=0.91$  for sore throat) (Table 4). None of the subjects in the intervention group experienced any severe cough, hoarseness, or sore throat, while one subject in the control group experienced severe sore throat and one subject experienced severe hoarseness. Three subjects in the intervention group experienced moderate cough and one subject experienced moderate sore throat. No

subjects in the control group experienced any moderate side effects (Table 4). All six novice physicians (100%) preferred to use the reg-DLT. One physician preferred the reg-DLT because of insufficient experience with the cam-DLT, while another physician had this preference due to being able to maintain competences with a bronchoscope when using the reg-DLT. The remaining four physicians preferred the reg-DLT because of challenges they had experienced with the cam-DLT. Advantages mentioned of the cam-DLT were continuous visualisation, no need of flexible bronchoscope, easy set-up. Disadvantages mentioned were problems with the placement of the tube, price, only left-sided tubes available and problems with cleaning the lens of the cam-DLT.

**Table 4:** Self-reported patient outcome for the two groups.

	Cough		Hoarseness		Sore Throat	
	cam-DLT	reg-DLT	cam-DLT	reg-DLT	cam-DLT	reg-DLT
	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)
Severe	0 (0%)	0 (0%)	0 (0%)	1 (5%)	0 (0%)	1 (5%)
Moderate	3 (10%)	0 (0%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)
Mild	13 (43%)	13 (59%)	10 (33%)	10 (45%)	2 (7%)	1 (5%)
No	8 (27%)	3 (14%)	14 (47%)	5 (23%)	21 (70%)	14 (64%)
Missing data	6 (20%)	6 (27%)	6 (20%)	6 (27%)	6 (20%)	6 (27%)
Total	30 (100%)	22 (100%)	30 (100%)	22 (100%)	30 (100%)	22 (100%)
P-value	0,7445		0,1116		0,9111	

## 6. Discussion

Of the 17 healthcare professionals who answered the questionnaire, 12 (70.6%) preferred the cam-DLT over the reg-DLT. The most preferred advantage was "continuous visualisation", while the most frequent disadvantage was "other", being described as issues with secretions on the lens, which was difficult to clean properly. There were no statistically significant differences in self-reported patient outcomes. All six novice physicians (100%) preferred the reg-DLT over the cam-DLT.

The response rate was considered low. A possible explanation could be that the questionnaire was sent to physicians and nurses' employee email and therefore it may have been forgotten during the busy workday at a hospital. This introduces a risk of bias.

In this study, six of the 12 respondents who preferred the cam-DLT over the reg-DLT commented that their preference was due to easier and faster placement of the tube. This correlates with findings from previous studies, showing that intubation times with the cam-DLT are faster than the reg-DLT [2,5]. Only one physician reported that the cam-dlt was "more rigid and difficult to pass through the vocal cords" and another physician commented that the cam-dlts "a little more difficult to place". Koopman et al. also mentioned more resistance than usual when passing the vocal cords using a cam-DLT [3]. However, there was no control group in that study, and it is therefore difficult to adjudicate if the perceived resistances occurred more often with the usage of cam-DLT. Massot et al. also reported a possible stiffness of the cam-DLT [6].

One main advantage of the cam-DLT is continuous visualisation, which was chosen as an advantage by 14 of 17 respondents in this investigation. Continuous visualisation could eliminate or minimize the need of using a bronchoscope during intubation and surgery. However, while eight respondents found "no need for a bronchoscope" to be an advantage of the cam-DLT, five respondents found this to be a disadvantage. The healthcare professionals' preference in bronchoscope usage during surgery could explain this difference. One of the novice physicians preferred the reg-dlts as it allowed the novice physician to maintain competences with a flexible

bronchoscope. This point was emphasized by another physician who commented that "loosing skills in bronchoscopy" was a disadvantage of the cam-DLT. While the cam-DLT allows for continuous visualisation during surgery, it seems that sometimes bronchoscope usage is also important for healthcare professionals. That said, bronchoscope usage is not completely eliminated by the usage of the cam-DLT. Data collected during other studies suggest, that bronchoscope usage occasionally may be needed when using the cam-DLT. These studies [3,4] were able to reduce the usage of flexible bronchoscope by 87% and 86.6%, respectively when using a cam-DLT. Contradictory, two studies [2,5] were able to eliminate the use of a flexible bronchoscope completely.

Another frequent advantage of the cam-DLT chosen by eight of 17 respondents was "good for training and education". One nurse who preferred the cam-DLT stated: "[...] Very nice screen picture of the vivaSight, also good in educational/colleague cooperation". The continuous visualisation of the cam-DLT seems to be an advantage for educational purposes, as the screen allows for easy visualisation for colleagues in teaching situations. This advantage was also found in another study [3]. Two respondents also mentioned that the reg-DLT was useful in education as one of them said: "bronchoscopy to verify the position is a good educational thing about these [reg-DLT] tubes". As such, the cam-DLT was more frequently favoured for educational purposes, but there may be situations where the use of a reg-DLT involving the use of a flexible bronchoscope may be more beneficial.

The reg-DLT was preferred by two respondents out of 17 because they encountered problems with secretions on the camera lens which could not be easily flushed away. This disadvantage was reported by six respondents in the questionnaire with one commenting to "still need a bronchoscope for the hard cases or when there is a lot of secretion." Another healthcare professional commented that it was a disadvantage that "1. The possibility that secretions can block the camera lens. 2. and if so, it can be very difficult to restore visualisation." This was also reported as a problem by the novice physicians. This is a problem exclusive to the cam-DLT and though it has a

saline, data from this questionnaire suggests that this is may not be enough in some cases. This problem was also observed in two other studies [3,4]. The reg-DLT does not have this problem, as the bronchoscope can be retracted and cleaned. No statistically significant differences in side effects was found between the two groups. This study was not constructed to have enough power to detect any statistically significant differences. No significant differences in intubation-related side effects congruence with two earlier studies which also reported no differences in side effects when comparing the two tubes [2,5]. Most physicians and nurses preferred the cam-DLT over the reg-DLT, while all of the six novice physicians preferred the reg-DLT. This difference in opinions could be explained by the novice physicians' inexperience with the cam-DLT, as all of them were more experienced with the reg-DLT. They also reported trouble with placement as a disadvantage, whereas the cam-DLT seems to be easier to place for most physicians. Another possible explanation for the novice physicians' preference for the reg-DLT could be that the cam-DLT is new. One of the physicians in this questionnaire preferred the cam-DLT because of "force of habit" and a nurse commented "[translated] After having used the VivaSight-DL, I have become more confident in using it and can see an advantage in continuous visualisation". This could suggest that the introduction of a new device in a department could be met with resistance at first as there may be a preference for the old known device as suggested by the physicians and nurse. Data from this study suggest that the cam-DLT was more popular than the reg-DLT. Earlier studies have shown faster intubation times [2,5] and an earlier study has also shown the cam-DLT to be more cost-effective compared to the Shiley DLT [1]. We found no differences in self-reported intubation related side effects. The cam-DLT was preferred by 12 of 17 respondents over the reg-DLT, but some respondents had trouble with secretions on the lens which in some cases could not be easily cleaned. The cam-DLT also seems to be good for educational purposes, although some reported educational situations where the reg-DLT seems to be superior. Most found the cam-DLT easier to place, but especially the novice physicians disagreed. It could be interesting to further investigate if novice physicians have more trouble with the cam-DLT compared with the reg-DLT, however as data from this study was anonymized, we do not know if the two physicians reporting trouble with placement of the cam-DLT in the questionnaire were novice physicians as well.

### 6.1. Strengths and limitations:

To our knowledge, this study is the first to qualitatively describe physicians' and nurses' opinion of the cam-DLT. Another strength of this study was the possibility for physicians and nurses to answer in the category "other" which allowed them to answer outside of the categories provided by us. This allowed us to discover the problems with secretions which otherwise due to the design of the questionnaire could have been lost. Only 17 of the 72 healthcare professionals answered the questionnaire, thus this low response rate could introduce bias and skew the results. Patient data related to intubation side effects were collected during another study [1], which did not have enough power to detect differences in self-reported patient outcome. The sample size for the novice physicians (n=6) was small, allowing for bias which should also be considered. Our study design with a questionnaire does not allow for follow-up questions afterwards like in an interview, which could further explain some of the comments made by the healthcare professionals. Also, the questionnaire was limited in that physicians and nurses were not asked to provide advantages and disadvantages for the reg-DLT which could have been interesting for a better comparison of the two tubes.

### 6.2. Conclusion:

In this qualitative study, we wanted to investigate physicians' and nurses' opinions about the cam-DLT and the reg-DLT. The cam-DLT was preferred by 70.6% of the respondents over the reg-DLT while all novice physicians preferred the reg-DLT. Advantages for the cam-DLT was continuous visualisation, no need for a bronchoscope and good for training and education. Disadvantages were problems with secretions on the lens and no need for a bronchoscope. Patient self-reported intubation-related side effects did not differ between the cam-DLT and the reg-DLT.

**6.3. Funding:** VivaSight tubes were provided by the manufacturer, ETview Medical Ltd., Israel/Ambu A/S, Ballerup, Denmark. Sara Larsen received a research grant for the study "A randomized Controlled Study Comparing the VivaSight Double-lumen Tube with a Conventional Double-lumen Tube (cdlt) in Adult Patients Undergoing Thoracic Surgery – A Clinical and Economic Evaluation" [1] during which some of our data was collected.

## 7. Appendix

**7.1. Study design:** Data for this study were collected during the study "A randomized Controlled Study Comparing the VivaSight Double-lumen Tube with a Conventional Double-lumen Tube (cdlt) in Adult Patients Undergoing Thoracic Surgery – A Clinical and Economic Evaluation" [1] (Registered on clinicaltrials.gov (NCT03817879)). After obtaining orally and written consent, 50 patients fulfilling the inclusion criteria were randomly assigned into two groups using a computer-generated random number list (www.randomizer.org). One group was to undergo surgery while intubated with the VivaSight-DL, while the control group was to be intubated with the conventional DLT. Due to dropouts in both groups, it was necessary to recruit additionally 20 patients and randomly assign them to the two groups to get 50 patients.

**7.2. Study Population:** We included patients who were evaluated as being eligible for an OLV with a left-sided DLT after admission to the Department of Thoracic Surgery, Odense University Hospital (OUH). Exclusion criteria were known tracheobronchial anomalies or tracheal pathology, age <18, required rapid sequence induction, required emergency procedure, anticipated difficult airways, prior systemic infection or suspected tuberculosis, patients where the use of other one lung isolation devices or techniques (tracheostomy, nasal intubation, etc.) was warranted or if they were unsuited for intubation with a DLT.

### 7.3. Anaesthesia procedure:

All patients received identical standard preoperative and operative care and received an intercostal blockade prior to surgery. Patients were monitored with invasive blood pressure, ECG, end-tidal CO<sub>2</sub> and pulse oximeter. General anesthesia was induced with an intravenous bolus injection of propofol 2-3 mg/kg, remifentanyl 0.5-1 g/kg and patients were preoxygenated at least 2 minutes with a face mask. General anesthesia was maintained with intravenous propofol and remifentanyl. Neuromuscular blockade was achieved using rocuronium 0.6 mg/kg and confirmed by nerve stimulation. After induction of general anesthesia, patients were intubated by the novice physicians with a conventional Macintosh laryngoscope. The tubes were advanced past the vocal cords and in the VivaSight DL group further advanced until a clear picture of the patient's carina was seen on the monitor or in the cDLT group after passage rotated to the left and advanced until slight resistance was met. The positioning of the cDLT was confirmed using a fiberoptic bronchoscope and reconfirmed after placing the patient in the lateral position.

## 8. Disclosures

VivaSight tubes were provided by the manufacturer, ETview Medical Ltd., Israel/Ambu A/S, Ballerup, Denmark. Sara Larsen received a research grant for the study "A randomized Controlled Study Comparing the VivaSight Double-lumen Tube with a Conventional Double-lumen Tube (cdlt) in Adult Patients Undergoing Thoracic Surgery – A Clinical and Economic Evaluation" [1] during which some of our data was collected. Sara Larsen is now an employee at Ambu. The other authors declare no conflict of interest. The funding source had no involvement in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

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